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modus studio
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479.455.5577
modusstudio.com
contact@modusstudio.com

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PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to all Division 21 Sections. Also refer to Division 01 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.

B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

D. Scope of Work:

1. Plumbing Work: Refer to Section 220500 "Basic Plumbing Requirements".
2. Heating Work: Refer to Section 230500 "Basic HVAC Requirements".
3. Air Conditioning and Ventilating Work: Refer to Section 230500 "Basic HVAC Requirements".
4. Temperature Control Work: Refer to Section 230500 "Basic HVAC Requirements".
5. Fire Protection Work shall include, but is not necessarily limited to:

    a. Furnish and install a new fire protection service to the building including backflow preventer as required by Code.
    b. Furnish and install all fire hydrants and associated piping, valves, and supports including connection to the water main.
    c. Extend existing wet pipe sprinkler system for areas noted on the drawings.
    d. Furnish and install all items listed on the Fire Protection Material List.
    e. Furnish all hydraulic calculations and working sprinkler drawings.
    f. Furnish and install seismic restraint and equipment designed for use in seismic conditions described in Section 210550.
    g. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
    h. Complete all applicable tests, certifications, forms, and matrices.

6. Testing, Adjusting, and Balancing Work: Refer to Section 230500 "Basic HVAC Requirements".

1.3 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:

    a. Plumbing Contractor.
    b. Heating Contractor.
    c. Air Conditioning and Ventilating Contractor.
    d. Temperature Control Contractor.
    e. Fire Protection Contractor.
    f. Testing, Adjusting, and Balancing Contractor.

2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.

    a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.

6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:

    a. Light fixtures.
    b. Gravity flow piping, including steam and condensate.
    c. Electrical busduct.
    d. Sheet metal.
    e. Electrical cable trays, including access space.
    f. Sprinkler piping and other piping.
    g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:

    a. Boiler Feed Pumps.
    b. Burners.
    c. Chillers.
    d. Computer Room Air Conditioning Units.
    e. Condensate Return Stations.
    f. Condensing Units.
    g. Makeup Air Units.
    h. Electric Humidifiers.
    i. Gas Trains.
    j. Package Air Handling Units.
    k. Packaged Rooftop Units.

2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:

    a. Wiring of all devices needed to make the Temperature Control System functional.
    b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
    c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.4 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.

    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.

    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.

3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.

    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

    a. Scale of drawings:

        1) General plans: 1/4 Inch = 1 '-0" (minimum).
        2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
        3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
        4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).
        5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Architect/Engineer and Owner's Representative. The Architect/Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.

2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.5 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all State and Local Codes.
2. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
3. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
4. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
6. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriters' Laboratories, Inc. and approved by FM Global.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for fire protection water service connection.

F. Examination of Drawings:

1. The drawings for the fire protection work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.

2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in fire protection documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.

    a. Any item listed as furnished shall also be installed, unless otherwise noted.
    b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.6 WEB-BASED PROJECT SOFTWARE

A. The General Contractor shall provide a web-based project software site for the purpose of hosting and managing project communication and documentation until completion of the warranty phase.

B. The web-based project software shall include, at a minimum, the following features: construction schedule, submittals, RFIs, ASIs, construction change directives, change orders, drawing management, specification management, payment applications, contract modifications, meeting minutes, construction progress photos.

C. Provide web-based project software user licenses for use by the Architect/Engineer. Access will be provided from the start of the project through the completion of the warranty phase.

D. At project completion, provide digital archive of entire project in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

1.7 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
21 05 00	Owner Training Agenda
21 05 03	Fire Seal Systems
21 05 13	Motors
21 05 29	Hangers and Supports
21 05 48	Vibration Isolation Equipment
21 05 50	Seismic Restraint Systems
21 05 53	Mechanical Identification
21 13 00	Sprinkler Systems
21 13 00	Fire Protection Equipment
21 22 00	Clean Agent Fire Suppression Systems
21 23 00	Fire Suppression Systems
21 30 00	Fire Pumps

B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:

1. Transmittal: Each transmittal shall include the following:

a. Date
b. Project title and number
c. Contractor's name and address
d. Division of work (e.g., plumbing, heating, ventilating, etc.)
e. Description of items submitted and relevant specification number
f. Notations of deviations from the contract documents
g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

a. Date
b. Project title and number
c. Architect/Engineer
d. Contractor and subcontractors' names and addresses
e. Supplier and manufacturer's names and addresses
f. Division of work (e.g., plumbing, heating, ventilating, etc.)

g. Description of item submitted (using project nomenclature) and relevant specification number
h. Notations of deviations from the contract documents
i. Other pertinent data
j. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
b. Unstamped submittals will be rejected.
c. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.
2) Addenda items have been incorporated.
3) Catalog numbers and options match those specified.
4) Performance data matches that specified.
5) Electrical characteristics and loads match those specified.
6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
7) Dimensions and service clearances are suitable for the intended location.
8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

    a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
    b. The Contractor shall clearly indicate the size, finish, material, etc.
    c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
    d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions. or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.

    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.

16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

    a. Submittal file name: 21 XX XX.description.YYYYMMDD
    b. Transmittal file name: 21 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.8 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 01.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:

    a. Material: Delivered cost of product with taxes paid.
    b. Labor: Labor cost, excluding overhead and profit.

3. Itemize the cost for each of the following:

    a. Overhead and profit.
    b. Bonds.
    c. Insurance.
    d. General Requirements: Itemize all requirements.

4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:

    a. Each piece of equipment requiring shop drawings (e.g., fire pump, double interlock pre-action system, backflow preventer, etc.) using the project nomenclature (FP-1, DIPS-1, BFP-1, etc.).
    b. Each sprinkler zone. In addition, break down the material and labor based on geography (building, floor, wing and/or phase).
    c. Each double interlock pre-action system.
    d. Each clean agent fire suppression system.
    e. Each wet agent fire suppression system.
    f. Site utilities (5' beyond building)
    g. Seismic design
    h. Commissioning
    i. Record drawings
    j. Punchlist and closeout

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.9 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:

1. Fire Seal Systems

B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.

C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

B. Protect equipment, components, and openings with airtight covers and exercise care at every stage of storage, handling, and installation of equipment to prevent airborne dust and dirt from entering or fouling equipment to include, but not limited to:

1. Motor windings and ventilation openings.
2. Bearings.
3. Equipment Pipe and Accessories connection openings.
4. Starter and control cabinets.
5. Pump Seals.
6. Engine cooling, air intake, and exhaust openings.

C. Equipment and components that are visibly damaged or have been subject to environmental conditions prior to building turnover to Owner that could shorten the life of the component (for example, water damage, humidity, dust and debris, excessive hot or cold storage location, etc.) shall be repaired or replaced with new equipment or components without additional cost to the building owner.

D. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

E. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

F. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.14 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.

E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.

F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (https://call811.com/) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.

2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried utilities. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. Utilities Bedding: Lay underground utilities on minimum of 6"sand bedding or CA6 crushed stone. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope Around Utilities to 6" Above Utilities: Place sand or CA6 crushed stone to a height of 6" over utilities in 6" layers. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill From 6" Above Utilities to Earthen Grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep.
4. Backfill From 6" Above Utilities to Below Slabs or Paved Area: Where the sand or CA6 crushed stone fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials:

    a. Sand, CA6: Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.

b. Native Soil: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Native soils shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
c. Flowable Fill: Cementitious, self-leveling, self-compacting slurry as defined by the ACI with compressive strength of 50-100psi at 28 days; consisting of a mixture of fine aggregate or filler, water and cementitious materials. Filler material consist of sand, fly ash, spent foundry sand, quarry fines, baghouse dust. Cementitious materials consist of Portland cement, pozzolanic materials, and self-cementing materials. Flowable fill may be placed in a pour instead of 6" layers noted above.

6. Water shall not be permitted to rise in unbackfilled trenches.
7. Dispose of excess excavated earth as directed.
8. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
9. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:

a. Pipe wall penetrations are sealed.
b. Pipe identification is installed.
c. Branch piping in the location of sprinklers shall be dropped to the ceiling.

2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 01.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Inspection report by the State Fire Marshal of the fire protection system.
5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

    a. O&M file name: O&M.div21.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div21.contractor.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.

D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

E. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Maintenance of equipment.
3. Start-up procedures for all major equipment.
4. Explanation of seasonal system changes.
5. Description of emergency system operation.

F. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

G. Minimum hours of instruction for each item shall be:

1. Sprinkler System(s) - 8 hours.

H. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

I. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the fire protection and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM STARTING AND ADJUSTING

A. The fire protection systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

C. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

A. The following paragraphs supplement Division 01 requirements.

B. Maintain at the job site a separate and complete set of fire protection drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations of other control devices, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.

D. Before completion of the project, a set of reproducible fire protection drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.9 PAINTING

A. This Contractor shall paint the following items:

1. All piping in mechanical room
2. Piping exposed in kitchen

B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

D. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.

F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

G. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.

H. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter, paint all pipes and equipment with the following:

1. Bare Metal Surfaces: Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
2. Color of paint shall be as follows:

a. All piping in mechanical room:

1) Fire Protection: Red pipe/white letters

b. Piping exposed in kitchen:

1) All Piping: White

3.10 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.

D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.11 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.12 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

    a. Minimizing the amount of dust generated.
    b. Reducing solvent fumes and VOC emissions.
    c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.

2. Request that the Owner designate an IAQ representative.
3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
6. Request copies of and follow all of the Owner's IAQ and infection control policies.
7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All pumps operating and balanced.
3. Fire protection system operational.
4. Pipes labeled.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 210503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this Section.

B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

A. UL 263 - Fire Tests of Building Construction and Materials

B. UL 723 - Surface Burning Characteristics of Building Materials

C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops

D. UL 2079 - Tests for Fire Resistance of Building Joint Systems

E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)

F. Intertek / Warnock Hersey - Directory of Listed Products

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops

I. The Building Officials and Code Administrators National Building Code

J. International Building Code

K. Uniform Building Code

L. NFPA 5000 - Building Construction Safety Code

M. HCAI - Health Care Access and Information (California)

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Submit Firestopping Installers Certification for all installers on the project.

C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.

D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:

1. Types of penetrating items.
2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
4. F ratings for each firestop system.

E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.

B. Install material prior to expiration of product shelf life.

1.6 PERFORMANCE REQUIREMENTS

A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.

B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:

1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

2. L-Rated Systems: Provide through-penetration firestop systems with L-ratings of not more than 5.0 CFM/sq. ft at both ambient temperature and 400F for smoke barriers.

C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.7 MEETINGS

A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.

1. Review foreseeable methods related to firestopping work.
2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.8 WARRANTY

A. Provide one year warranty on parts and labor.

B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

B. Manufacturers:

1. 3M; Fire Protection Products Division.
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk.
4. Tremco; Sealant/Weatherproofing Division.
5. Johns-Manville.
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Dow Corning Corp.
10. Fire Trak Corp.
11. International Protective Coating Corp.
12. HoldRite

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.

B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.

C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.

D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.

E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.

F. Provide firestopping systems allowing continuous insulation for all insulated pipes.

G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:

    a. F Rating = Floor/Wall Rating
    b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

    a. F Rating = Wall Rating
    b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999

Penetrating Item	UL System No.
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

   a. F Rating = Wall/Floor Rating
   b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.

I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.

B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.

C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.

D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.

B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.

C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:

1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.

B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.

C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.

D. The Contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the Contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The Contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the Contractor's expense.

END OF SECTION

SECTION 210505 - FIRE SUPPRESSION DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mechanical Demolition.

B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

A. Disconnect fire protection systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Remove abandoned piping to source of supply and/or main lines.

C. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

D. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

E. Repair adjacent construction and finishes damaged during demolition and extension work.

F. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.

G. Extend existing installations using materials and methods compatible with existing installations, or as specified.

3.4 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 210529 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to structural plans for additional information.

F. Floor slab is post-tensioned. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid any tension cables or utilities encased in floor construction.

G. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes X-ray or similar non-destructive means.

H. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.5 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. FIRE PROTECTION ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.6 SPECIAL REQUIREMENTS

A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction or as noted on the drawings. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION

SECTION 210529 - FIRE SUPPRESSION SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.

B. Equipment Bases and Supports.

C. Sleeves and Seals.

D. Flashing and Sealing of Equipment and Pipe Stacks.

E. Cutting of Openings.

F. Escutcheon Plates and Trim.

1.2 QUALITY ASSURANCE

A. Support Sprinkler and Standpipe Piping in conformance with NFPA 13.

B. All components shall be UL listed and approved for fire protection systems.

1.3 REFERENCES

A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.

C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

D. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application

E. NFPA 13 - Standard for the Installation of Sprinkler Systems.

F. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 210500.

1.5 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

A. Refer to Section 210550 for additional requirements for seismic restraints.

2.2 HANGER RODS

A. Hanger rods for single rod hangers supporting steel, copper, and CPVC piping shall conform to the following:

1. Hanger Rod Diameter:

a. 4" and smaller: 3/8"
b. 5", 6", and 8": 1/2"
c. 10" and 12": 5/8"
d. 12": 3/4"

B. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.3 PIPE HANGERS AND SUPPORTS

A. General:

1. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58, 69, 89, and 127 (where applicable).

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, and more frequently when required by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings or lugs. Provide sufficient flexibility to accommodate expansion and contraction without compromising fire barrier penetrations and other fixed takeoff locations.

a. Products:

1) Eaton Fig. B3373 Series
2) nVent 510 Series
3) Anvil Fig. 90

2. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.
3. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.
2. Unless otherwise indicated, hangers shall be as follows:

    a. Clevis Type: Service: Bare Metal Pipe, Rigid Plastic Pipe

        1) Products: Bare Steel, Plastic or Insulated Pipe

            a) Anvil Fig. 260
            b) Eaton Fig. 3100
            c) nVent Model 400

    b. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller

        1) Products: Bare Steel Pipe

            a) Anvil Fig. 69
            b) Eaton Fig. B3170NF
            c) nVent Model 115

        2) Products: Bare Copper Pipe

            a) Eaton Fig. B3170CTC
            b) Anvil Fig. CT-69

3. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping.
4. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
5. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
6. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

    a. Clamp Type: Service: Bare Metal Pipe, Rigid Plastic Pipe

        1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.
        2) Pipes subject to expansion and contraction shall have clamps slightly oversized to allow limited pipe movement.
        3) Products: Bare Steel, Plastic or Insulated Pipe

            a) Unistrut Fig. P1100 or P2500

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.)

1) Products:

a) Anvil Fig. 86/92/93
b) Eaton Fig. B3033/B3034
c) nVent Model 300/310/315

b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):

1) Products:

a) Anvil Fig. 218
b) Eaton Fig. B3054 (UL listed only, not FM)

c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):

1) Products:

a) nVent Model Truss-T Bar Joist Hanger (UL listed only, not FM)(UL listed only, not FM)

b) MCL Model M1, M2 or M3 (UL listed only, not FM)

d. Concrete Inserts Single Rod Galvanized:

1) Products:

a) Anvil Fig. 282
b) Eaton Fig. B3014
c) nVent Model 355

e. Concrete Inserts Continuous Strip Galvanized:

1) Products:

a) Unistrut Corp P3200 Series
b) Eaton Fig. B22
c) Anvil AS249

f. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318, current edition. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

g. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

h. Steel Structure Welding:

i. Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.

2.4 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Refer to Section 210550 for additional requirements for concrete bases in seismic applications.
2. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 6 inches on all sides of the equipment (6 inches larger than factory base), except where pad extension would interfere with working space at equipment control panels and electrical panels.
3. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days. Provide minimum 1/2" 45 degree angled or 1/2"radius chamfer on exposed horizontal edges.
5. New Bases in Existing Buildings: for proper bonding of new equipment bases to existing concrete floors: Existing concrete shall be thoroughly cleaned, scarified and a bonding agent applied, in accordance with manufacturer's instructions, prior to placing new concrete. Bonding agent shall be "Weld-Crete" as manufactured by the Larsen Products Corporation or "Nitobind Acrylic" as manufactured by Fosroc, Inc. or approved equivalent.
6. Equipment requiring bases is as follows:

    a. Air Compressor
    b. Day Tank
    c. Fire Pump
    d. Tank

C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.5 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.6 ROOF PENETRATIONS

A. Seal pipes penetrating single-ply roofs with conical stepped pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots. Material shall match roofing membrane.

2.7 PIPE SLEEVES AND LINTELS

A. Each Contractor shall provide pipe sleeves and lintels for all openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Engineer's design.

F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.

G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.

I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

J. Wall Seals ("Link-Seals"):

1. Underground foundation wall penetrations and where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be at least 2 pipe sizes larger than the service pipe and shall include a waterstop/anchor around the mid section of the sleeve, continuously welded to or integral formed with the sleeve. Sleeve material options include galvanized steel, painted steel,HDPE, or PVC.
3. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
4. Sealing element shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40F to 250F
T	Fire Seals (1 hour)	Silicone	-67F to 400F
FS	Fire Seals (3 hours)	Silicone	-67F to 400F
OS	Oil Resistant/Stainless	Nitrile	-40F to 210F

5. Manufacturers:

a. Garlock Pipeline Technologies (GPT) "Link-Seals"
b. O-Z/Gedney Company
c. Calpico, Inc.
d. Innerlynx
e. Metraflex
f. Flexicraft
g. Polywater

2.8 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes duct and pipe openings.

2.9 PIPE PENETRATIONS

A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.10 PIPE ANCHORS

A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.11 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 FIRE SUPPRESSION SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Install roof pipe supports to resist wind movement per manufacturer's recommendations. Method of securing base to roof shall be compatible with roofing materials.
2. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
3. Set all concrete inserts in place before pouring concrete.
4. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
5. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
6. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. For attachments to joists that are concentrically loaded on the joist, a max of 100 pounds may be attached to the joist within a chord panel.
2. For attachments to joists that are eccentrically loaded, a max of 25 lb may be attached to the joist within a chord panel without an additional angle.
3. Multiple attachments are allowed in each chord panel as long as the sum of the loads do not exceed the max load indicated.
4. For loads between 100 lb -200 lb, additional L2x2x3/16" (L51xL51x4.8) ASTM A36 structural steel angles are required and joist must be concentrically loaded.
5. For loading conditions noted above, total sum of loads shall not exceed 200 lbs for an 8 ft segment of joist. For loads greater than 200 lbs and not noted on the drawings, contact engineer prior to installation/
6. No loads shall be supported from joist bridging.
7. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
8. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Spacing of hangers shall in no case exceed the following:

1. Steel (All steel pipe unless otherwise noted):

a. Maximum Spacing:

1) 1-1/2" & under: 12'-0"
2) 2" & larger: 15'-0"

2. Steel (Schedule 10 and Schedule 40 lightweight alternative):

a. Maximum Spacing:

1) All sizes: 12'-0"

3. Hard Drawn Copper:

a. Maximum Spacing:

1) 1" & under: 8'-0"
2) 1-1/4" to 1-1/2": 10'-0"
3) 2" to 3": 12'-0"
4) 3-1/2" & larger: 15'-0"

4. CPVC:

a. Maximum Spacing:

1) 3/4": 5'-6"
2) 1": 6'-0"
3) 1-1/4": 6'-6"
4) 1-1/2": 7'-0"
5) 2": 8'-0"
6) 2-1/2": 9'-0"
7) 3": 10'-0"

I. Installation of hangers shall conform to MSS SP-58, 69, 89, and applicable NFPA standards.

END OF SECTION

SECTION 210550 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Seismic Requirements.

1.2 QUALITY ASSURANCE

A. General:

1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.
2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for seismic restraint.
3. These requirements are beyond those listed in Section 210529 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.
2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

C. Testing Agency: An independent testing agency, acceptable to Authorities Having Jurisdiction, with experience and capability to conduct the testing indicated.

D. Installer: Company specializing in performing the work of this Section.

1.3 REFERENCES

A. International Building Code, Current Adopted Edition.

B. California HCAI - Health Care Access and Information (HCAI)

C. ASHRAE - A Practical Guide to Seismic Restraint.

D. Technical Manual 5-809-10, NAVFAC P-355, Air Force Manual 88-3, Chapter 13.

E. ASCE 7-02, Chapter 9.

F. ASCE 7-05, Chapter 13.

G. ASCE 7-10, Chapter 13.

H. ASCE 7-16, Chapter 13.

I. ASCE 7-22, Chapter 13

J. SMACNA - Seismic Restraint Manual Guidelines for Mechanical Systems.

K. NFPA 13 - Installation of Sprinkler Systems.

L. NFPA 14 - Standpipe and Hose Systems.

1.4 SUBMITTALS

A. Submit under provisions of Section 210500.

B. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a [**Professional**][**Structural**] Engineer licensed in the state where the project is located experienced in seismic restraint design and installation.
2. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of mechanical components with other systems and equipment in the vicinity, including other seismic restraints.
3. Manufacturer's Certifications: [**Professional**][**Structural**] Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
4. System Supports/Restraints - Submit for each condition requiring seismic bracing:

    a. Calculations for each seismic brace and detail utilized on the project.
    b. Plan drawings showing locations and types of seismic braces on contractor fabrication/installation drawings.
    c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
    d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

5. Equipment - Submit for each piece of equipment supplied:

    a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified.
    b. Specific details of seismic design features of equipment and maximum seismic loads imparted to the structural support.
    c. Engineering calculations and details for equipment anchorage and support structure.

C. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance to the exception.

1.5 TESTING AND INSPECTION

A. Special Inspection and Testing shall be done in accordance with Chapter 17 of the Building Code.

B. The [**Owner**][**Contractor**] shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.

C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.

D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.7 DESIGN REQUIREMENTS

A. This project is subject to the seismic bracing requirements of the International Building Code, current adopted edition.

B. This project is subject to the seismic bracing requirements of California Building Code, [**Health Care Access and Information (HCAI)**][**Division of State Architect (DSA) Interpretation of Regulations**].

C. The following criteria are applicable to this project:

1. Seismic Use Group: [**I**][**II**][**III**]
2. Occupancy Category: [**I**][**II**][**III**][**IV**]
3. Risk Category: [**I**][**II**][**III**][**IV**]
4. Seismic Importance Factor: I_E = [**1.0**][**1.25**][**1.5**]
5. Seismic Design Category:[**A**][**B**][**C**][**D**][**E**][**F**]
6. Component Amplification Factors (ap) and Component Response Modification Factors (Rp) shall be taken from Table [**1621.3 in IBC 2000**][**9.6.3.2 in ASCE 7-02**][**13.6-1 in ASCE 7-05**][**13.5-1 in ASCE 7-10**][**13.5-1 in ASCE 7-16**][**13.5-1 in ASCE 7-22**] for the individual equipment or system being restrained.
7. Component Importance Factors (Ip) shall be taken from Section [**1621.1.6 in IBC 2000**][**9.6.1.5 in ASCE 7-02**][**13.1.3 in ASCE 7-05**][**13.1.3 in ASCE 7-10**][**13.1.3 in ASCE 7-16**][**13.1.3 in ASCE 7-22**] for the individual equipment or system being restrained.
8. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

D. Forces shall be calculated with the above requirements and Equation [**16-67, 68, & 69 in section 1621.1.4 of IBC 2000, unless exempted by 1621.1.1**][**9.6.1.3-1, -2, and -3 of ASCE 7-02, unless exempted by 9.6.1**][**13.3-1, -2, and -3 of ASCE 7-05, unless exempted by 13.1.413.3-1, -2, and -3 of ASCE 7-10, unless exempted by 13.1.4**][**13.3-1, -2, and -3 of ASCE 7-16, unless exempted by 13.1.4**][**13.3-1, -2, and -3 of ASCE 7-22, unless exempted by 13.1.4**].

E. Equipment shall meet [**International**][**California**] Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

F. All seismic anchorage and bracing shall comply with the St. Louis County Rules & Regulations on Anchorage & Sway Bracing - Mechanical, Electrical & Plumbing (MEP) System Components.

G. All seismic anchorage and bracing shall comply with FM Global Property Loss Prevention Data Sheet 1-11, Fire Following Earthquakes.

1.8 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.

1.9 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SUPPLIERS

A. Following is a partial list of manufacturer/supplier contact information for seismic restraints:

1. B-Line Systems, Inc. (800) 851-7415, www.b-line.com.
2. Unistrut Corporation http://www.unistrut.us/
3. Kinetics Noise Control (877) 457-2695, www.kineticsnoise.com.
4. Mason Industries, Inc. www.mason-ind.com.
5. Loos & Co., Inc. (800) 321-5667, www.loosnaples.com.
6. Tolco (909) 737-5599, www.tolco.com
7. ISAT 877.523.6060, www.isatsb.com
8. Vibro-Acoustics (416) 291-7371, https://virs.vibro-acoustics.com/

2.2 SEISMIC DESIGN CRITERIA

A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.

B. Definitions

1. Stay in Place:

    a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.

2. Remain Operational:

    a. Requirements for "Stay in Place" listed above shall be met.
    b. The following systems and associated equipment are intended not to fail externally or internally and are intended to continue operation following a seismic event:

        1) Fire Protection

2.3 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record; refer to submittal requirements.
2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer's submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.
3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.
5. All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code.
6. All seismic restraints and combination isolator/restraints shall have verification of their seismic capabilities witnessed by an independent testing agency.

B. Friction from gravity loads shall not be considered resistance to seismic forces.

C. Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14 for the building seismic requirements.

D. Housekeeping Pads:

1. Reinforced housekeeping pads shall be provided to handle shear, tension, and compression forces with proper reinforcement, doweling, and attachments connecting the pad to the structural slab.

2.4 SEISMIC RESTRAINT AND CONSTRUCTION OF EQUIPMENT

A. Equipment supplied for the project shall be designed to meet the requirements of lateral forces calculated using the applicable code and method described above.

B. The following is a partial list of equipment that shall be restrained and that shall be constructed to meet seismic forces described in this section:

1. Fire Protection Equipment
2. Fire Pumps

2.5 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless steel.

2.6 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125, Grade A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.7 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch-thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.

1. Materials for Channel: ASTM A 1011, GR 33.
2. Materials for Fittings and Accessories: ASTM A 635, ASTM A 576, or ASTM A 36.
3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.

1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
2. Wire Rope Cable: Comply with ASTM A 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.

D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of piping, ductwork, conduit, equipment, etc.

B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.

C. All rigid floor mounted equipment shall have a resilient media between the equipment mounting hole and the anchor bolt in concrete.

D. All seismic restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

E. Installation of seismic restraints shall not cause any change in position of equipment, piping, or ductwork, resulting in stresses or misalignment.

F. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

G. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified.

H. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Architect/Engineer's attention prior to specific equipment selection.

I. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

J. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.

K. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit.

L. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.

M. Do not install cables over sharp corners.

N. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.

O. Provide reinforced clevis bolts when required.

P. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.

Q. Post-Installed anchors shall be provided to meet seismic requirements.

R. Vertical pipe risers flexibly supported to accommodate thermal motion and/or pipe vibration shall be guided to maintain pipe stability and provide horizontal seismic restraint.

S. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

T. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent piping.

U. Water tanks shall be secured to their saddles by welding or proper concrete attachment, and those saddles shall be properly attached to the structure.

V. Brace all terminal units with water coils as required by the building code and provide flexible connection to the coil if bracing is required.

W. Independently brace duct mounted equipment (terminal units, in-line fans, etc.) and the associated suspended ductwork.

X. Do not brace a system to two different structures such as a wall and a ceiling.

Y. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

Z. Positively attach all roof mounted equipment to roof curbs. Positively attach all roof curbs to building structure.

AA. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.

BB. Coordinate seismic bracing of architecturally exposed ductwork with the Architect/Engineer.

3.2 SEISMIC RESTRAINT EXCLUSIONS

A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

END OF SECTION

SECTION 210553 - FIRE SUPPRESSION IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Identification of products installed under Division 21.

1.2 REFERENCES

A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

B. ASTM B-1, B-3, and B-8 for copper conductors.

C. ASTM D-1248 for Polyethylene Extrusion Materials, ICEA S-70-547 Weatherproof Resistant Polyethylene Conductors, ICEA S-61-402/NEMA WC5 Thermoplastic Insulated Wire & Cable, ICEA S-95-658/NEMA WC70 Non-Shielded 0 - 2kv Cables.

D. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 210500. Include list of items identified, wording, letter sizes, and color coding.

B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. 3M

B. Bunting

C. Calpico

D. Craftmark

E. Emedco

F. Kolbi Industries

G. Seton

H. W.H. Brady

I. Marking Services.

2.2 MATERIALS

A. All pipe markers shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4"

B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.

E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

H. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.

I. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item.

J. Tracer Wire:

1. Single copper conductors shall be solid or stranded annealed or hard uncoated copper per UL83 and ASTM requirements. Tracer tape or copper-coated steel wire is not acceptable.
2. Conductor shall be insulated with HMWPE as specified and applied in a concentric manner. The minimum at any point shall not be less than 90% of the specified average thickness in compliance with UL 83.
3. Tracer wire shall be continuously spark tested at 7500 Volts DC. Other electrical and mechanical tests shall be in accordance with UL 1581.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Valves:

1. All valves (except shutoff valves at equipment) shall have numbered tags.
2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
5. Attach to handwheel or around valve stem.
6. Number all tags and show the service of the pipe.
7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
8. Provide one 36" x 24" (minimum Plexiglas framed piping schematic showing valve locations with respective tag numbers. Mount directory in location chosen by the Architect/Engineer.
9. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Stencil Painted Pipe Markers:

    a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
    b. Apply primer on non-insulated pipes before painting.
    c. Use background and letter colors as scheduled later in this section.

4. Apply markers and arrows in the following locations where clearly visible:

    a. At each valve.
    b. On both sides of walls that pipes penetrate.
    c. At least every 20 feet along all pipes.
    d. On each riser and each leg of each "T" joint.
    e. At least once in every room and each story traversed.

5. Heat Traced Piping: Provide “Electric Heat Traced” labels on exterior of pipe insulation every 10 feet on opposite sides of pipe, and on all splices, tees, crosses, and power connections for the entire length of heat traced piping.

6. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

F. Tracer Wire:

1. Tracer wire shall be installed on top of all non-metallic buried utilities.
2. Tracer wire shall be taped directly to plastic water or drain pipe.
3. Tracer wire shall not be fastened directly or indirectly to gas piping.
4. Tracer wire when attached shall be secured to the pipe a minimum of every 10 feet and at all changes of direction.
5. Tape shall be Polyken "930-35", Protecto-Wrap "310", or approved equal.
6. Tracer wire shall be continuous between boxes and shall be tested for continuity.
7. Splices in tracer wire shall be made with a water proof splice kit to prevent corrosion. Wire nuts shall not be used.
8. The tracer wire shall daylight to grade through a 2" PVC conduit, at the point of the utility entrance to building. PVC conduit shall be capped and labeled as future contact point to locate the utility.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text shown as follows, regardless of which method or material is used:

1. FIRE PROTECTION WATER: White lettering; red background
2. SPRINKLER WATER: White lettering; red background
3. Tracer Wire - Water Pipe Lines: White lettering; green background
4. Heat Traced Piping: White lettering; green background

B. All piping downstream of the fire protection backflow preventer, upstream of sprinkler zone valves, standpipe piping, and combination sprinkler standpipe piping shall be labeled Fire Protection Water. All piping downstream of sprinkler zone valves shall be labeled Sprinkler Water.

END OF SECTION

SECTION 211302 - FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe, Fittings, Valves, and Connections for Fire Protection System.

B. Wet-Pipe Sprinkler System.

C. Dry-Pipe Sprinkler System.

D. Pre-action Sprinkler System.

E. Standpipe System.

1.2 QUALITY ASSURANCE

A. Welding Materials and Procedures: Conform to ASME Code.

B. Equipment and Components: Bear UL/FM label or marking.

C. Valves: Bear UL/FM label or marking. Provide manufacturer's name and pressure rating marked on valve body. Pressure rating shall match specified pipe system pressure rating. Remanufactured valves are not acceptable.

D. Specialist Firm: Company specializing in sprinkler systems with minimum three years' experience.

E. Sprinkler design drawings submitted by the Contractor shall be prepared by a NICET Water-Based Fire Protection Systems Layout Level III or Level IV designer or PE.

1.3 REFERENCES

A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.

C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.

E. ANSI/ASME B16.9 - Factory-made Wrought Steel Butt-Welding Fittings.

F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.

G. ANSI/ASME B16.25 - Butt-Welding Ends.

H. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

I. ANSI/ASME Section 9 - Welding and Brazing Qualifications.

J. ANSI/ASTM A47 - Malleable Iron Castings.

K. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.

L. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.

M. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.

N. ASME - Boiler and Pressure Vessel Code - Section IX, Welding and Brazing Requirements.

O. ASTM A153 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.

P. AWS A5.8 - Brazing Filler Metal.

Q. AWS B2.2 - Standard for Brazing Procedure and Performance Qualification.

R. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

S. BOCA National Building Code.

T. FM Global - FM Global Approval Guide.

U. FM Global Datasheet 2-0 - Installation Guidelines for Automatic Sprinklers

V. FM Global Datasheet 3-26 - Fire Protection Water Demand for Nonstorage Sprinklered Properties

W. FM Global Datasheet 4-4N - Standpipe and Hose Systems

X. FM Global Datasheet 8-9 - Storage of Class 1, 2, 3, 4, and Plastic Commodities

Y. IBC - International Building Code.

Z. MSS SP-73 - Brazing Joints for Wrought and Cast Copper Alloy Solder Joint and Pressure Fittings.

AA. NFPA 101 - Life Safety Code,

BB. NFPA 13 - Standard for the Installation of Sprinkler Systems.

CC. NFPA 13D - Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes.

DD. NFPA 13R - Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height.

EE. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.

FF. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

GG. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

HH. UBC - Uniform Building Code.

II. UL - Underwriter's Laboratory Fire Protection Equipment Directory.

1.4 SUBMITTALS

A. Submit shop drawings per Section 210500. Indicate pipe materials, joining methods, supports, floor and wall penetration seals, sprinklers, equipment data and ratings, and hydraulic calculations.

B. Submit detailed pipe and sprinkler layout and other calculations and forms as described in NFPA 13.

C. Submit detailed working drawings and obtain review of them in the following order:

1. Engineer/ArchitectState Fire Marshal/Authority Having Jurisdiction
2. Owner's Insurance Company
3. Architect/Engineer
4. Department of Health and Family Services (Hospitals, Nursing Homes, CBRF's only)
5. Local Fire Department
6. Owner's Insurance Company
7. Architect/Engineer

D. Working drawings shall include piping and sprinkler layout, sprinkler types and ratings, sections and elevations at critical points. Show coordination with lighting, ductwork, and diffusers, and indicate basic flow and hydraulic design information, including main location and date that the test was taken.

E. Submit dry-pipe calculations including water delivery time and air supply refill defined in NFPA 13. Water delivery time and air supply shall meet the requirements set forth in NFPA 13.

F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

G. Provide the Owner with one copy of NFPA 25. Standard for the Inspection Testing and Maintenance of Water-based Fire Protection Systems.

1.5 EXTRA STOCK

A. Provide metal storage cabinet, wrenches for each sprinkler type, and extra sprinklers per NFPA 13 and applicable building code.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store valves and sprinklers in shipping containers, with labels in place.

B. Provide temporary protective coating on iron and steel valves.

C. Maintain temporary end caps and closures in place until installation.

1.7 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves to General Contractor for placement in walls and floors. Sleeve location to be determined by the Fire Protection Contractor prior to construction. If additional sleeves are required, they shall be core drilled by the Fire Protection Contractor.

1.8 SYSTEM DESCRIPTION

A. Contractor shall design and install the following water-based fire protection systems for the areas noted on the contract documents:

1. Wet pipe sprinkler system(s)
2. Dry pipe sprinkler system(s)
3. Pre-action sprinkler system(s)
4. Standpipe system(s)

B. Sprinkler systems shall be designed and installed according to the following standard(s):

1. NFPA 13 - Standard for the Installation of Sprinkler Systems
2. FM Global Datasheet 2-0 - Installation Guideline for Automatic Sprinklers
3. FM Global Datasheet 3-26 - Fire Protection Water Demand for Nonstorage Sprinklered Properties

C. Standpipe system shall be designed and installed according to the following standard(s):

1. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems
2. FM Global Datasheet 4-4N - Standpipe and Hose Systems

D. System design and installation shall include all requirements by the Authority Having Jurisdiction, local and state building codes, and Owner's insurance company in addition to the previously listed design standard(s). Those requirements shall take precedence over the contract documents in the case of discrepancies.

E. Systems shall be hydraulically calculated in accordance with the applicable design standard(s). Contractor is responsible for final pipe sizing based on results from hydraulic calculations. Pipe sizing shown on drawings for service entrance and main risers is preliminary and for coordination purposes only.

F. The water supply source for this project is the following:

1. Public waterworks system.
2. Refer to Section 213000 for fire pump performance requirements.
3. The system design shall be based on water supply information provided on the contract drawings. Supply shall be presumed to be at the point of connection to existing water supply infrastructure unless noted otherwise. The Fire Protection Contractor is responsible to verify this information and conduct all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 6 months.

4. System design shall be based on the following water supply information. Supply shall be presumed to be at the point of connection to existing water supply infrastructure unless noted otherwise. The Fire Protection Contractor is responsible to verify this information and conduct all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 6 months.

    a. Date of Test:
    b. Test Conducted By:
    c. Static Pressure: psig
    d. Residual Pressure: psig
    e. Flow at Residual Pressure: GPM

    f. System design shall provide a safety factor when comparing available water supply pressure versus system design pressure at design flow rate (including hose streams). The safety factor shall be the following:

        1) 5 psig

5. System design shall be based on the most recent fire pump test report. The Fire Protection Contractor is responsible to verify this information and conduct all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 6 months.

6. System design shall be based on a new hydrant flow test. Local fire authority or third-party consultant shall be contracted to determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 6 months

G. Coordinate with Plumbing Contractor for installation of a floor drain or floor sink below the backflow preventer.

1.9 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 210500 for required fire protection systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit manufacturers' operation and maintenance data. Include written maintenance data on components of system, servicing requirements, and record drawings.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS - WET PIPE SPRINKLER SYSTEMS

A. Piping - 2" and Under (Steel Pipe):

1. Design Pressure: 175 psig

2. Pipe: Schedule 40, black steel, ASTM A53, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3. Schedule 40 Joints: Threaded or roll grooved (2" and 1.5" only).
4. Lightweight Schedule 40 (Schedule 20) Joints: Threaded or roll grooved (2" and 1.5" only).
5. Fittings:

    a. Threaded:

        1) Cast iron, Class 125, black, UL, ANSI/ASME B16.4ASTM A153.
        2) Malleable iron, Class 150, black, UL, ANSI/ASME B16.3ASTM A153.
        3) Ductile iron, Class 150, black, UL, ANSI/ASME B16.3ASTM A153.

    b. Grooved:

        1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40F to 150F. Carbon steel bolts and nuts.

    c. Flanged:

        1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1ASTM A153.

6. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.

B. Piping - 2-1/2" and Above (Steel Pipe):

1. Design Pressure: 175 psig
2. Pipe: Schedule 10, black steel, ASTM A135, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3. Joints: Roll Grooved.
4. Fittings:

    a. Grooved:

        1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40F to 150F. Carbon steel bolts and nuts.

    b. Flanged:

        1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1ASTM A153.

    c. Saddle Branch Fittings:

        1) In lieu of a TEE fitting for systems using steel piping where connecting a branch line to a main, saddle branch connections utilizing a bolted clamp or a U-bolt support around the main pipe with a ductile iron sealing surface and gasket are permitted based on these size limitations:

            a) Up to 6" Mains: Branch pipe maximum size is nominally one pipe size smaller than main.

b) 8" and Larger Mains: Branch pipe maximum size is nominally two pipe sizes smaller than main.

C. Piping - 3" and Under (CVPC):

1. Design Pressure: 175 psig
2. Tubing: Chlorinated polyvinyl chloride (CPVC), standard dimensional ratio (SDR) of 13.5, NSF certified for use with potable water, UL/FM.

   a. Joints: Solvent Cement, ASTM 493, ASTM F402, NSF certified for use with potable water.
   b. Fittings: Same as tubing. Fittings and tubing shall be a system provided by the same manufacturer. ASTM F437, ASTM F438, ASTM F439. Threaded adapters for threaded valves shall be metal threaded adapter with solvent socket, UL/FM.

3. CPVC shall be listed for use in the following situations:

   a. Light Hazard Occupancies, as defined in NFPA 13.
   b. Residential Occupancies, as defined in NFPA 13R.
   c. Air plenums per the requirements of UL 1887, as defined by NFPA 90A and the International Mechanical Code (IMC).

4. CPVC Compatibility:

   a. CPVC pipe and fittings shall be evaluated for chemical compatibility with internally coated anti-MIC coatings provided in steel piping. All CPVC piping must be compatible with steel pipe containing corrosion inhibitors.
   b. Ancillary products, such as firestopping, thread sealants, cutting oils, etc., coming into contact with both pipe and fittings shall be chemically compatible.
   c. When CPVC is used in combination (e.g., steel and CPVC) systems, the Contractor shall provide a letter stating that all products used in conjunction with the system have been investigated and found to be compatible with CPVC.

D. Piping - 3" and Under (Seamless Copper Tube):

1. Design Pressure: 125 psig.
2. Piping - 3" and Under:

   a. Tubing: Type L drawn temper seamless copper tube, ASTM B88.
   b. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.
   c. Fittings: Wrought copper solder joint, ASME B16.22.

3. Usage: Inside MRI spaces.

2.2 FLEXIBLE FIRE SPRINKLER CONNECTIONS

A. Flexible Connection: Stainless steel hose, 175 psig max working pressure, fully welded non-mechanical fittings, stainless steel braid, maximum of 6' hose length, leak-tested with a minimum 7/8" internal corrugated hose diameter made of 304 stainless steel, end fittings made of carbon or stainless steel. Outlet of end fittings shall be 1/2" or 3/4" to match sprinkler connection. UL.

B. Ceiling Bracket: G90 galvanized steel, direct attachment type, integrated snap-on clip ends, tamper resistance screws, removable attachment hub with set screw for attachment and adjustment of stainless steel hose.

1. Manufacturers:

a. Flexhead Industries
b. Victaulic VicFlex,
c. Sprinkflex
d. or approved equal.

2.3 PIPE AND FITTINGS - DRY PIPE SPRINKLER SYSTEMS

A. Piping - 2" and Under (Steel):

1. Design Pressure: 175 psig
2. Pipe: Schedule 40, galvanized, ANSI/ASTM A135, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3. Joints: Threaded or roll grooved.
4. Fittings:

a. Threaded:

1) Cast iron, Class 125, galvanized, UL, ANSI/ASME B16.4ASTM A153.
2) Malleable iron, Class 150 galvanized, UL, ANSI/ASME B16.3ASTM A153.
3) Ductile iron, Class 150, galvanized, UL, ANSI/ASME B16.3ASTM A153.

b. Grooved:

1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40F to 150F. Carbon steel bolts and nuts. Provide flush gap style gasket. Lubricate gasket according to manufacturer recommendations.

c. Flanged:

1) Cast iron, Class 125, galvanized, UL/FM, ANSI/ASME B16.1ASTM A153.

5. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.

B. Piping - 2-1/2" and Above:

1. Design Pressure: 175 psig
2. Pipe: Schedule 10, galvanized ASTM A135, ASTM A795, UL.
3. Joints: Roll grooved or flanged.
4. Fittings:

a. Grooved:

1) Ductile iron housing ASTM A-536 Grade 65-45-12, UL, galvanized coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40F to 150F. Carbon steel bolts and nuts.

b. Flanged:

1) Cast iron, Class 125, galvanized, UL, ANSI/ASME B16.1ASTM A153.

2.4 PIPE AND FITTINGS - PREACTION SYSTEM

A. Refer to Article 2.2 PIPE AND FITTINGS - DRY PIPE SYSTEMS.

2.5 PIPE AND FITTINGS - WET STANDPIPE SYSTEM

A. Refer to Article 2.1 PIPE AND FITTINGS - WET PIPE SYSTEMS.

2.6 PIPE AND FITTINGS - DRY STANDPIPE SYSTEM

A. Refer to Article 2.2 PIPE AND FITTINGS - DRY PIPE SYSTEMS.

2.7 VALVES

A. Provide handwheels for gate valves. Provide gear operators for butterfly valves.

B. Provide all connections to match pipe joints. Valves shall be same size as pipe.

2.8 BACKFLOW PREVENTERS

A. Provide backflow preventers as required by code and as specified on the drawings.

2.9 EQUIPMENT

A. Equipment shall be as scheduled on the drawings.

2.10 RISER LABELING AND IDENTIFICATION

A. Hydraulic nameplates shall be affixed to each riser and shall include the following minimum information:

1. Installation contractor
2. Date installed
3. Riser location
4. Number of sprinklers
5. Basis of design (density GPM/ft2 and area of coverage ft2
6. Water flow rate (GPM) and residual pressure (psi) at the base of riser
7. Hose stream allowance (GPM).
8. Occupancy classification
9. Commodity classification (If applicable)
10. Maximum storage height (if applicable)

B. A dedicated antifreeze placard is required where a remote antifreeze system is provided. The placard is to be placed on the main valve serving the antifreeze system to document the manufacturer type and brand of the solution and the system volume.

2.11 PIPE LABELING AND IDENTIFICATION

A. All pipe shall be marked along its length by the manufacturer in such a way as to properly identify the type of pipe. The manufacturer pipe marking shall be visible on every piece of pipe over 2 ft (600 mm) long. Manufacturer pipe identification shall include the manufacturer's name, model designation, and/or schedule.

PART 3 - EXECUTION

3.1 INSTALLATION - PIPING

A. General Installation Requirements:

1. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over sprinkler piping and sprinklers.
2. Ream pipe and tube ends to full inside diameter. Remove burrs. Remove scale and foreign material, inside and outside, before assembly.
3. Die cut screw joints with full cut standard taper pipe threads.
4. Coat threads with pipe joint compound or wrap with Teflon tape.
5. Locate piping to minimize obstruction of other work.
6. Route piping in concealed spaces above finished ceiling.
7. Use full and double lengths of pipe wherever possible.
8. Slope all piping for complete drainage. Install auxiliary drains for all trapped piping per NFPA 13.
9. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
10. Comply with manufacturer's installation instructions.

B. Wall/Floor Penetration:

1. Provide sleeves when penetrating floors and walls.
2. Seal pipes passing through exterior walls with a wall seal per Section 210529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe. Sleeves through floors shall extend minimum 1.5" above finished floor.
3. Fire seal all pipe and sleeve penetrations (both wall and floor) to maintain fire separation required without restraining pipe.

C. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment. Fire protection equipment dedicated to the electrical equipment room or space may be installed above equipment if other alternatives are not available.

D. Installation Requirements in MRI (Magnetic Resonance Imaging - Healthcare):

1. Provide non-ferrous semi-recessed chrome plated head and escutcheon.
2. All piping in MRI rooms shall be non-ferrous regardless of materials described in Part 2.

E. Hangers and Supports:

1. Provide hangers and supports as required by NFPA 13 and UL, with the following exceptions:

   a. Do not use powder driven devices, explosive devices, wooden plugs, or plastic inserts.
   b. Do not install fasteners to carry the load in tension, unless absolutely necessary.

F. Exposed Piping:

1. Install chrome plated steel escutcheons where exposed pipes penetrate walls or floors.
2. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

G. Dry Pipe System:

1. All fire protection piping within rooms served by dry pipe valves or preaction systems shall be downstream of dry pipe valve. Wet piping upstream of these devices shall not be installed above these rooms.
2. Refrigerated spaces served by dry pipe valves shall have a 30" easily removable section of pipe located immediately upstream and downstream of pipe entrance to a refrigerated space per NFPA 13. Piping shall be pitched back toward the dry pipe assembly. Air intake for compression devices serving preaction or dry pipe systems shall be from the refrigerated area.

3.2 INSTALLATION - VALVES

A. Install gate valves with stems upright or horizontal, not inverted.

B. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor.
4. Provide monitor switches on all shutoff valves.

C. Dry Pipe Valve:

1. Install dry pipe valve in heated area to prevent mechanical damage.
2. Provide all required trim and accessories for a fully functioning dry pipe valve system.

D. Shutoff Valve:

1. Install buried shutoff valves in valve boxes. Provide post indicators.
2. Provide drain valves at main shutoff valves, low points of piping and apparatus.

3. Provide monitor switches on all shutoff valves.

3.3 INSTALLATION - EQUIPMENT

A. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over system equipment and sprinklers.

B. Fire Department Connection:

1. Locate fire department connection in an accessible location as approved by the local fire department with sufficient clearance from walls, obstructions, and adjacent Siamese connectors to allow full swing of fire department wrench handle.

C. Horn and Strobe:

1. Locate outside horn and strobe on building wall as shown on drawings.
2. Wire all horn and strobes, flow switches and supervisory switches to fire alarm system. All wiring shall be in conduit and meet the requirements of the electrical specifications.

D. Test Valves:

1. Install test valves where required. Pipe to outdoors or drain. Test connection shall have flow equivalent to the smallest K-factor sprinkler.

E. Sprinklers:

1. Locate sprinklers to clear lights, ducts and diffusers. Do not run sprinkler pipes through ducts. Ductwork has priority over sprinkler pipes. Offset pipes as needed.
2. Center sprinklers in two directions in ceiling tiles and provide offsets as required.
3. Do not allow concealed sprinkler cover plates to be painted. Sprinkler cover plates are to be factory painted only. Do not field paint.
4. Apply strippable or paper covers so concealed sprinkler cover plates do not receive field paint finish.

F. Double Interlocked Preaction System:

1. Provide all valves, switches, detectors and all wiring to devices from the alarm control panel.

3.4 INSTALLATION - STANDPIPE AND HOSE SYSTEM

A. Locate and secure hose cabinet plumb.

B. Locate angle valve in cabinet at 60" above floor. Locate fire department connection below angle valve and not closer than 4" from side or bottom of cabinet.

C. Connect wet standpipe system to water source ahead of domestic water connection.

D. Where static pressure exceeds 175 psig at any hose station, provide pressure regulating valves to limit the pressure on hose to 100.

E. Where residual pressure at Class III hose station1-1/2" exceeds 100 psig, provide a pressure regulating valve to limit the residual pressure on the hose to 100 psig.

F. Provide connection for alarm and supervisory control to building alarm system.

G. Provide two-way fire department outlet on roof.

H. Install backflow preventer as required by local Authorities Having Jurisdiction and as indicated on Fire Protection Material List.

3.5 SYSTEMS CLEANING AND TESTING

A. General Requirement:

1. All water used for testing and remaining in the piping system shall be obtained from a potable water source.

B. Underground Piping:

1. Flush all underground piping with minimum flow equal to the system design flow but not less than the following:

   a. 390 gpm for 4" pipes.
   b. 880 gpm for 6" pipes.
   c. 1560 gpm for 8" pipes.
   d. 2440 gpm for 10" pipes.
   e. 3500 gpm for 12" pipes.

2. Branches from existing or new underground mains to sprinkler risers shall be flushed out through two 2-1/2" hoses (with flow through open hose butts) attached to the riser with 4" temporary piping. Flushing through the drain of an alarm check or dry pipe valve is not acceptable.

C. Interior Piping:

1. Verify adequate water flow at the inspector's test connection.
2. Flush all interior piping to remove scale and other foreign material before placing system into service.
3. Hydrostatically test the entire interior piping system at a minimum of 200 psig or 50 psig more than the normal system working pressure for systems subjected to pressures more than 150 psig. Maintain test pressure for 2 hours without loss of pressure. Test shall be performed with dry pipe valves in open position to prevent valve damage.

D. Standpipe and Hose Systems:

1. Hydrostatically test standpipe and hose systems in accordance with NFPA 14 and applicable building code requirements.

E. Dry Piping:

1. On dry-pipe systems, also test the interior piping with an air pressure of 40 psi for 24 hours. Pressure loss shall not exceed 1-1/2 psi in 24 hours with allowance made for temperature change. An odorant, such as oil of wintergreen, may be added to help locate leaks.

F. Fire Alarm System:

1. Test the alarm system by operating the inspector's test connection or the alarm test valves. Verify that the building fire alarm system activates.
2. Adjust all monitor switches for proper operation.

3.6 INSTALLATION - CORROSION PRODUCTS/NITROGEN GENERATOR EQUIPMENT

A. General Installation Requirements:

1. Comply with manufacturer’s installation instructions.

B. System Start-up and Commissioning Protocol:

1. Confirm the operation of system air compressor and connect air compressor and nitrogen generator to the dry pipe system.
2. Determine the operating pressure range for the dry/preaction system and set the system air maintenance device for each zone to the correct setting.
3. Confirm the air maintenance device is taken out of the fast fill (by-pass) setting when the system is placed in service.
4. Confirm the water discharge from the air compressor drain and the Nitrogen Generator drain are piped to a floor drain or building exterior per local requirements.
5. Confirm that back pressure regulator of each dry pipe valve is set to close above the low air pressure alarm of the dry pipe system. The isolation ball valve of each device shall be closed during hydrostatic and/or air pressure testing of the dry pipe system and then placed in the open position for the commissioning and operation of the system.
6. Coordinate with Nitrogen System manufacturer to establish and record the final pressure range settings of the nitrogen generator system to coordinate with the dry pipe system operational pressure ranges.
7. Return in two - four weeks to perform a full system inspection after final commissioning of the Nitrogen Generator. Adjustments to system settings may be required. Verify that dry pipe system nitrogen concentration has reached 98% or greater. The Purge System shall have a connection allowing the portable handheld or manifold to attach and sample the purity of Nitrogen within the dry pipe system to ensure that proper nitrogen purity levels have been obtained.

END OF SECTION

SECTION 220500 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.

B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

D. Scope of Work:

1. Plumbing Work shall include, but is not necessarily limited to:
    a. Furnish and install all items listed in the Plumbing Material List.
    b. Furnish and install a new domestic water service to the building.
    c. Furnish and install water meter and domestic water backflow preventer as required by Code.
    d. Furnish and install a complete domestic water piping system including cold, hot, and hot water circulating piping within the building. Insulate all piping as specified.
    e. Furnish and install water heaters.
    f. Furnish and install complete sanitary sewer and vent system.
    g. Furnish and install site sanitary sewer piping, cleanouts, and manholes.
    h. Furnish and install indirect waste piping from kitchen equipment, appliances, water softeners, backflow preventers, and similar.
    i. Install and make final connections to fixtures and equipment provided by others, for example from the kitchen equipment contractor or laboratory casework provider.
    j. Furnish and install condensate drain piping from plumbing related equipment such as ice machines.
    k. Furnish and install condensate drain piping from cooling related equipment such as air handlers and cooling coil drain pans.
    l. Furnish and install complete gas piping system including all meter requirements.
    m. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
    n. Complete all applicable tests, certifications, forms, and matrices.
2. Heating Work: Refer to Section 230500 "Basic HVAC Requirements".
3. Air Conditioning and Ventilating Work: Refer to Section 230500 "Basic HVAC Requirements".

4. Temperature Control Work: Refer to Section 230500 "Basic HVAC Requirements".
5. Fire Protection Work: Refer to Section 210500 "Basic Fire Suppression Requirements".
6. Testing, Adjusting, and Balancing Work: Refer to Section 230500 "Basic HVAC Requirements".

1.3 COORDINATION DRAWINGS

A. Provide coordination drawings showing the complete, coordinated installation on mechanical, electrical, plumbing, fire protection, and other systems within available building spaces.

B. Definitions:

1. Coordination Drawings: Coordination drawings are defined as composite drawings or models that incorporate work of multiple trades and demonstrate coordinated routing, elevations, and clearances.

    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Provide one complete, composite coordination drawing package for each building area, system, or phase demonstrating fully coordinated conditions.
3. The composite coordination drawing package may be created from multiple trade-specific electronic files; however, the final deliverable shall clearly represent a single coordinated installation.
4. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.

    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
5. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

C. Participation:

1. The Contractor shall be responsible for coordinating all trades and preparing coordination drawings.

2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.

    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

D. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

    a. Scale of drawings:

        1) General plans: 1/4 Inch = 1 '-0" (minimum).
        2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
        3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
        4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).
        5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

E. General:

1. Provide coordination drawing files to the Architect/Engineer for review for identified conflicts. The Architect/Engineer will not act as the project coordinator and is not responsible for coordination of the work. The Architect/Engineer will review only clearly identified conflicts submitted by the Contractor and will not perform clash detection or coordination. The Architect/Engineer will not compile or reconcile multiple trade files and will rely on the Contractor's composite coordination drawing package.
2. The Contractor remains solely responsible for coordination regardless of any review or comment provided by the Architect/Engineer.
3. A plotted set of coordination drawings shall be available at the project site.
4. Coordination drawings are not shop drawings and are not subject to approval. Receipt or review of coordination drawings does not constitute approval of routing, layout, means, methods, sequencing, or constructability.

5. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
6. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
7. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
8. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
9. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
10. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.

11. Complete the coordination drawing process and obtain documented sign-off from all participating trades confirming that coordination drawings have been reviewed and coordinated prior to installation. Sign-off shall consist of signatures on the composite coordination log identifying participating trades and acceptance of the coordinated layout.
12. Do not begin installation of work in an area until coordination drawings for that direction prior to installation. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination. Conflicts identified after installation due to incomplete coordination shall be corrected at no additional cost to the Owner.
13. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.4 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Lowell Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.
4. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
6. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
7. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
8. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for service connections, such as sewer and water and gas.
4. Make application for and pay for all meters and metering systems required by the utility company.

F. Examination of Drawings:

1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.

    a. Any item listed as furnished shall also be installed, unless otherwise noted.
    b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.5 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.6 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

B. Protect equipment, components, and openings with airtight covers and exercise care at every stage of storage, handling, and installation of equipment to prevent airborne dust and dirt from entering or fouling equipment to include, but not limited to:

1. Motor windings and ventilation openings.
2. Bearings.
3. Equipment pipe and accessories connection openings. (e.g. boiler connections, coil connections, etc.)
4. Starter and control cabinets.
5. Heat transfer coils.
6. Pump Seals.
7. Combustion burner and blower equipment (e.g. combustion air intake, combustion vent/flue, etc.)

C. Equipment and components that are visibly damaged or have been subject to environmental conditions prior to building turnover to Owner that could shorten the life of the component (for example, water damage, humidity, dust and debris, excessive hot or cold storage location, etc.) shall be repaired or replaced with new equipment or components without additional cost to the building owner.

D. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

E. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

F. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.7 WARRANTY

A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.8 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the first manufacturer is the basis for job design and establishes the quality.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractor's part or on the part of other Contractors whose work is affected.

E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.

F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locators can be found at the following website (https://call811.com/) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. Utilities Bedding: Lay underground utilities on minimum of 6" sand bedding or CA6 crushed stone. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope Around Utilities to 6" Above Utilities: Place sand or CA6 crushed stone to a height of 6" over utilities in 6" layers. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill From 6" Above Utilities to Earthen Grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep.
4. Backfill From 6" Above Utilities to Below Slabs or Paved Area: Where the sand or CA6 crushed stone fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials:

    a. Sand, CA6: Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
    b. Native Soil: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Native soils shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
    c. Flowable Fill: Cementitious, self-leveling, self-compacting slurry as defined by the ACI with compressive strength of 50-100psi at 28 days; consisting of a mixture of fine aggregate or filler, water and cementitious materials. Filler material consist of sand, fly ash, spent foundry sand, quarry fines, baghouse dust. Cementitious materials consist of Portland cement, pozzolanic materials, and self-cementing materials. Flowable fill may be placed in a pour instead of 6" layers noted above.

6. Water shall not be permitted to rise in unbackfilled trenches.
7. Dispose of excess excavated earth as directed.
8. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
9. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:

a. Pipe insulation is installed and fully sealed.
b. Pipe wall penetrations are sealed.
c. Pipe identification and valve tags are installed.

2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.

4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.
16. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.

D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

E. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Maintenance of equipment.
3. Start-up procedures for all major equipment.
4. Explanation of seasonal system changes.
5. Explanation of Owner’s Responsibilities to operate, maintain, and flush domestic water system (i.e., ASHRAE Standard 188).

F. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM STARTING AND ADJUSTING

A. The plumbing systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

C. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.

D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for troubleshooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

A. The following paragraphs supplement Division 1 requirements.

B. Maintain at the job site a separate and complete set of plumbing drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations of devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.

D. Before completion of the project, a set of reproducible plumbing drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.9 PAINTING

A. This Contractor shall paint the following items:

1. All piping in mechanical room
2. Piping exposed in kitchen

B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

D. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.

F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

G. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.

H. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

I. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:

1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.
3. Color of paint shall be as follows:

    a. All piping in mechanical room:

        1) Domestic Cold Water: Blue pipe/white letters
        2) Domestic Hot Water: Red pipe/white letters
        3) Sanitary Waste: Green pipe/black letters
        4) Natural Gas: Yellow pipe/black letters

    b. Piping exposed in kitchen:

        1) All Piping: White

3.10 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.

D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.11 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.12 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

    a. Minimizing the amount of dust generated.
    b. Reducing solvent fumes and VOC emissions.
    c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
    d. Protect stored on-site and installed absorptive materials from moisture damage.

2. Request that the Owner designate an IAQ representative.
3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
6. Request copies of and follow all of the Owner's IAQ and infection control policies.
7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

3.13 UTILITY REBATE

A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.

1. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

END OF SECTION

SECTION 220503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this Section.

B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

A. UL 263 - Fire Tests of Building Construction and Materials

B. UL 723 - Surface Burning Characteristics of Building Materials

C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops

D. UL 2079 - Tests for Fire Resistance of Building Joint Systems

E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)

F. Intertek / Warnock Hersey - Directory of Listed Products

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops

I. The Building Officials and Code Administrators National Building Code

J. Uniform Building Code

K. International Building Code, Current Adopted Edition

L. NFPA 5000 - Building Construction Safety Code

M. HCAI - Health Care Access and Information (California)

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.

B. Install material prior to expiration of product shelf life.

1.5 PERFORMANCE REQUIREMENTS

A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.

B. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.6 MEETINGS

A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.

1. Review foreseeable methods related to firestopping work.
2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.7 WARRANTY

A. Provide one year warranty on parts and labor.

B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

1. 3M; Fire Protection Products Division.

2. Hilti, Inc.
3. Johns-Manville.
4. Dow Corning Corp.

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.

B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.

C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.

D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.

E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.

F. Provide firestopping systems allowing continuous insulation for all insulated pipes.

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

Penetrating Item	UL System No.
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999

Penetrating Item	UL System No.
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

G. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.

H. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.

B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.

C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.

D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.

B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.

C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:

1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.

B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.

C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.

D. The Contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the Contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The Contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the Contractor's expense.

END OF SECTION

SECTION 220505 - PLUMBING DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mechanical Demolition.

B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

A. Disconnect plumbing systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

C. Existing Plumbing System: Maintain service to all plumbing fixtures until new piping is installed. Obtain permission from Owner at least 48 hours before shutting down system for any reason. Make changeover to new piping with minimum outage. Do not disconnect any roof drainage piping until new piping is in place and operational.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Demolish and extend existing plumbing work under provisions of Division 2 and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned piping to source of supply and/or main lines.

D. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Extend existing installations using materials and methods compatible with existing installations, or as specified.

H. Remove unused sections of domestic water piping back to active mains and cap. Capped pipe length shall be less than 1.5 times the capped pipe diameter to prevent "dead legs".

I. Temporarily cap all openings to the sanitary and vent system to prevent odor from entering the work area and building.

3.4 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to structural plans for additional information.

F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.5 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

3.6 SPECIAL REQUIREMENTS

A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION

SECTION 220529 - PLUMBING SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.

B. Equipment Bases and Supports.

C. Sleeves and Seals.

D. Flashing and Sealing of Equipment and Pipe Stacks.

E. Cutting of Openings.

F. Escutcheon Plates and Trim.

1.2 REFERENCES

A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.

C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices

D. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 220500. Include plastic pipe manufacturers' support spacing requirements.

1.4 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

A. Refer to Section 220550 for additional requirements for seismic restraints.

2.2 HANGER RODS

A. Hanger rods for single rod hangers shall conform to the following:
   1. Steel, Cast Iron, and Glass Pipe:

      a. Hanger Rod Diameter:

1) 2" and smaller: 3/8"
2) 2-1/2" through 3-5/8": 1/2"
3) 4" through 6": 1/2"

2. Copper and Plastic Pipe:

a. Hanger Rod Diameter:

1) 2" and smaller: 3/8"
2) 2-1/2") through 3-5/8": 1/2"
3) 4") through 6": 1/2"

B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.

C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:

2.3 PIPE AND STRUCTURAL SUPPORTS

A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.
3. Copper piping located in an exposed area, including indirect waste piping in kitchens and janitor's closets, shall use split ring standoff hangers for copper tubing. Support shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp. Use electro-galvanized or more corrosion resistant and threaded rod for floor applications. Use anchors applicable to the wall type with corrosion resistant threaded rod for wall applications.

a. Products:

1) nVent/M-Co Model #456
2) Eaton Fig. 3198HCT

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.

a. Products:

1) Eaton Fig B3373 Series
2) nVent 510 Series
3) Anvil Fig. 90

2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

   a. Products:

      1) Mason RBA, RCA or RDA
      2) Mason BR

3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.

   a. Products:

      1) Pipeshields, Inc E1000, E1100, E1200, or E1300 (manufacturer to confirm based on pipe diameter and weight when in service)

4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.
5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp within their temperature limits of -65F to +275F.
3. Vertical cold pipe drops and rough-ins to fixtures shall be supported by insulated pipe clamps to prevent thermal bridging and condensation.
4. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
5. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

   a. Products:

      1) Anvil Fig. 160, 161, 162, 163, 164, 165
      2) Eaton Fig. 3160, 3161, 3162, 3163, 3164, 3165

6. Unless otherwise indicated, hangers shall be as follows:

a. Clevis Type: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches & Smaller

1) Products: Bare Steel Plastic or Insulated Pipe:

a) Anvil Fig. 260
b) Eaton Fig. 3100

2) Products: Bare Copper Pipe Felt or PVC Coated:

a) Eaton Fig. B3104F or B3100CTC
b) Anvil Fig. CT65

b. Roller Type: Service: Insulated Hot Pipe - 4 inches and Larger

1) Products: 4" through 6":

a) Anvil Fig. 181, 271
b) Eaton Fig. 3110
c) Anvil Fig. 324, 327

c. Adjustable Swivel Ring Type: Bare Metal Pipe - 4 inches and Smaller

1) Products: Bare Steel Pipe:

a) Anvil Fig. 69
b) Eaton Fig. B3170NF

2) Products: Bare Copper Pipe:

a) Eaton Fig. B3170CTC
b) Anvil Fig. CT-69

7. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.

a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

8. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

a. Clamp Type: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller

1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.

2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
3) Products: Bare Steel, Plastic or Insulated Pipe:

a) Unistrut Fig. P1100 or P2500
b) Eaton Fig. B2000 or B2400
c) Anvil Fig. AS1200

4) Products: Bare Copper Pipe:

a) Eaton Fig. BVT

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):

1) Products:

a) Anvil Fig. 86
b) Eaton Fig. B3033/B3034
c) nVent Model 300 & 310

b. Steel Structure Clamps: Scissor Type Beam Clamps (for use with bar-joists and wide flange):

1) Products:

a) Anvil Fig. 228, 292
b) Eaton Fig. B3054
c) nVent Model 360

c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):

1) Products:

a) MCL. M1, M2 or M3

d. Concrete: Concrete Inserts, Single Rod Galvanized:

1) Products:

a) Anvil Fig. 282
b) Eaton Fig. B3014
c) nVent Model 355

e. Concrete: Concrete Inserts, Continuous Strip Galvanized:

1) Products:

a) Unistrut Corp P3200 Series
b) Eaton Fig. B22
c) Anvil AS249

f. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
g. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.
h. Steel Structure Welding:

1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.4 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.
3. Refer to Section 220550 for additional requirements for concrete bases in seismic applications.
4. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 6 inches on all sides of the equipment (6 inches larger than factory base), except where pad extension would interfere with working space at equipment control panels and electrical panels.
5. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
6. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days. Provide minimum 1/2" 1/2"New Bases in Existing Buildings: for proper bonding of new equipment bases to existing concrete floors: existing concrete shall be thoroughly cleaned, scarified, and a bonding agent applied, in accordance with manufacturer's instructions, prior to placing new concrete. Bonding agent shall be "Weld-Crete" as manufactured by the Larsen Products Corporation or "Nitobind Acrylic" as manufactured by Fosroc, Inc or approved equivalent.
7. Equipment requiring bases is as follows:
   a. Water Heater

2.5 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

F. Exposed Housing Penetrations: Seal pipes with surface temperature below 150F, penetrating housings with conical stepped, white silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite.

2.6 ROOF PENETRATIONS

A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for pipe penetrations. Refer to drawings for details.

B. Conical Pipe Boot: Seal pipes with surface temperature below 150F, penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: White shall match roofing membrane.

C. Break insulation only at the clamp for pipes between 60F and 150F. Seal outdoor insulation edges watertight.

2.7 SLEEVES AND LINTELS

A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.

F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.

G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.

I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

J. Wall Seals ("Link-Seals"):

1. Underground foundation wall penetrations and where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be at least 2 pipe sizes larger than the service pipe and shall include a waterstop/anchor around the mid section of the sleeve, continuously welded to or integral formed with the sleeve. Sleeve material options based on fluid carrying pipe design temperature:

    a. Any temperature: galvanized steel, painted steel.
    b. Only fluids below 120°FHDPE, PVC.

3. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
4. Sealing element shall be as follows:

		Element	
Model	Service	Material	Temperature Range
S	Standard (Stainless)	EPDM	-40F to 250F
T	High/Low Temperature (Steam)	Silicone	-67F to 400F
T	Fire Seals (1 hour)	Silicone	-67F to 400F
FS	Fire Seals (3 hours)	Silicone	-67F to 400F
OS	Oil Resistant/Stainless	Nitrile	-40F to 210F

5. Manufacturers:

    a. Garlock Pipeline Technologies (GPT) "Link-Seals"
    b. O-Z/Gedney Company
    c. Calpico, Inc.
    d. Innerlynx
    e. Metraflex
    f. Flexicraft
    g. Polywater

2.8 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.9 PIPE PENETRATIONS

A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.10 PIPE ANCHORS

A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

PART 3 - EXECUTION

3.1 PLUMBING SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with Sheet Metal Contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. For attachments to joists that are concentrically loaded on the joist, a max of 100 lbs may be attached to the joist within a chord panel.
2. For attachments to joists that are eccentrically loaded, a max of 25 lbs may be attached to the joist within a chord panel without an additional angle.
3. Multiple attachments are allowed in each chord panel as long as the sum of the loads do not exceed the max load indicated.
4. For loads between 100 lbs - 200 lbs, additional L2x2x3/16" (L51xL51x4.8) ASTM A36 structural steel angles are required and joist must be concentrically loaded.
5. For loading conditions noted above, total sum of loads shall not exceed 200 lbs for an 8 ft segment of joist. For loads greater than 200 lbsand not noted on the drawings, contact engineer prior to installation.
6. No loads shall be supported from joist bridging.
7. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
8. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):

a. Maximum Spacing:

1) 1-1/4" & under: 7'-0"
2) 1-1/2": 9'-0"
3) 2": 10'-0"
4) 2-1/2": 11'-0"
5) 3": 12'-0"
6) 4" & larger: 12'-0"

2. Steel (Std. Weight or Heavier - Vapor Service):

a. Maximum Spacing:

1) 1-1/4" and under: 9'-0"
2) 1-1/2": 12'-0"
3) 2" & larger: 12'-0"

3. Hard Drawn Copper & Brass (Liquid Service):

a. Maximum Spacing:

1) 3/4" and under: 5'-0"
2) 1": 6'-0"
3) 1-1/4": 7'-0"
4) 1-1/2" 8'-0"
5) 2": 8'-0"
6) 2-1/2": 9'-0"
7) 3": 10'-0"
8) 4": 12'-0"

4. Plastic Pipe:

a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

END OF SECTION

SECTION 220550 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Seismic Requirements.

1.2 QUALITY ASSURANCE

A. General:

1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.
2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for seismic restraint.
3. These requirements are beyond those listed in Section 220529 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.
2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

C. Testing Agency: An independent testing agency, acceptable to Authorities Having Jurisdiction, with experience and capability to conduct the testing indicated.

D. Installer: Company specializing in performing the work of this Section.

1.3 REFERENCES

A. International Building Code, Current Adopted Edition.

B. ASHRAE - A Practical Guide to Seismic Restraint.

C. ASCE 7-16, Chapter 13.

D. ASCE 7-22, Chapter 13

E. SMACNA - Seismic Restraint Manual Guidelines for Mechanical Systems.

F. NFPA 13 - Installation of Sprinkler Systems.

G. NFPA 14 - Standpipe and Hose Systems.

1.4 SUBMITTALS

A. Submit under provisions of Section 220500.

B. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a Structural Engineer licensed in the state where the project is located experienced in seismic restraint design and installation.
2. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of mechanical components with other systems and equipment in the vicinity, including other seismic restraints.
3. Manufacturer's Certifications: Professional Structural Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
4. System Supports/Restraints - Submit for each condition requiring seismic bracing:

    a. Calculations for each seismic brace and detail utilized on the project.
    b. Plan drawings showing locations and types of seismic braces on contractor fabrication/installation drawings.
    c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
    d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

5. Equipment - Submit for each piece of equipment supplied:

    a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified.
    b. Specific details of seismic design features of equipment and maximum seismic loads imparted to the structural support.
    c. Engineering calculations and details for equipment anchorage and support structure.
    d.

C. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance to the exception.

1.5 TESTING AND INSPECTION

A. Special Inspection and Testing shall be done in accordance with Chapter 17 of the Building Code.

B. The Contractor shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.

C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.

D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.7 DESIGN REQUIREMENTS

A. This project is subject to the seismic bracing requirements of the International Building Code, current adopted edition.
1. Risk Category: I
2. Seismic Importance Factor: IE = 1.0
3. Seismic Design Category: C
4. Component Amplification Factors (ap) and Component Response Modification Factors (Rp) shall be taken from Table 13.5-1 in ASCE 7-16 for the individual equipment or system being restrained.
5. Component Importance Factors (Ip) shall be taken from Section 13.1.3 in ASCE 7-16 for the individual equipment or system being restrained.
6. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

B. Forces shall be calculated with the above requirements and Equations 13.3-1, -2, and -3 of ASCE 7-16, unless exempted by 13.1.4.

C. Equipment shall met [Internatio**ia**] Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

D. All seismic anchorage and bracing shall comply with FM Global Property Loss Prevention Data Sheet 1-11, Fire Following Earthquakes.

1.8 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.

1.9 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SUPPLIERS

A. Following is a partial list of manufacturer/supplier contact information for seismic restraints:

1. B-Line Systems, Inc. (800) 851-7415, www.b-line.com.
2. Unistrut Corporation http://www.unistrut.us/
3. Kinetics Noise Control (877) 457-2695, www.kineticsnoise.com.
4. Mason Industries, Inc. www.mason-ind.com.
5. Loos & Co., Inc. (800) 321-5667, www.loosnaples.com.
6. Tolco (909) 737-5599, www.tolco.com
7. ISAT 877.523.6060, www.isatsb.com
8. Vibro-Acoustics (416) 291-7371, https://virs.vibro-acoustics.com/

2.2 SEISMIC DESIGN CRITERIA

A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.

B. Definitions:

1. Stay in Place:

a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.

2. Remain Operational:

a. Requirements for "Stay in Place" listed above shall be met.
b. The following systems and associated equipment are intended not to fail externally or internally and are intended to continue operation following a seismic event:

1) Plumbing

2.3 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record; refer to submittal requirements.
2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer's submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.

3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.
5. All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code.

B. Friction from gravity loads shall not be considered resistance to seismic forces.

C. Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14 for the building seismic requirements.

D. Housekeeping Pads:

1. Reinforced housekeeping pads shall be provided to handle shear, tension, and compression forces with proper reinforcement, doweling, and attachments connecting the pad to the structural slab.

2.4 SEISMIC RESTRAINT AND CONSTRUCTION OF EQUIPMENT

A. Equipment supplied for the project shall be designed to meet the requirements of lateral forces calculated using the applicable code and method described above.

B. The following is a partial list of equipment that shall be restrained and that shall be constructed to meet seismic forces described in this section:

1. Air Compressors
2. Pumps
3. Tanks

2.5 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless steel.

2.6 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125, Grade A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.7 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch-thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.

1. Materials for Channel: ASTM A 1011, GR 33.
2. Materials for Fittings and Accessories: ASTM A 635, ASTM A 576, or ASTM A 36.
3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

C. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of piping, ductwork, conduit, equipment, etc.

B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.

C. All rigid floor mounted equipment shall have a resilient media between the equipment mounting hole and the anchor bolt in concrete.

D. All seismic restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

E. Installation of seismic restraints shall not cause any change in position of equipment, piping, or ductwork, resulting in stresses or misalignment.

F. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

G. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified.

H. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Architect/Engineer's attention prior to specific equipment selection.

I. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

J. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.

K. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit.

L. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.

M. Do not install cables over sharp corners.

N. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.

O. Provide reinforced clevis bolts when required.

P. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.

Q. Post-Installed anchors shall be provided to meet seismic requirements.

R. Vertical pipe risers flexibly supported to accommodate thermal motion and/or pipe vibration shall be guided to maintain pipe stability and provide horizontal seismic restraint.

S. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

T. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent piping.

U. Water tanks shall be secured to their saddles by welding or proper concrete attachment, and those saddles shall be properly attached to the structure.

V. Do not brace a system to two different structures such as a wall and a ceiling.

W. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

X. Positively attach all roof mounted equipment to roof curbs. Positively attach all roof curbs to building structure.

Y. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.

Z. Coordinate seismic bracing of architecturally exposed ductwork with the Architect/Engineer.

3.2 SEISMIC RESTRAINT EXCLUSIONS

A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

END OF SECTION

SECTION 220553 - PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Identification of products installed under Division 22.

1.2 REFERENCES

A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

B. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 220500. Include list of items identified, wording, letter sizes, and color coding.

B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 3M

B. Kolbi Industries

C. Marking Services

2.2 MATERIALS

A. All pipe markers shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4"

B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.

E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Valves:

1. All valves (except shutoff valves at equipment) shall have numbered tags.
2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
5. Attach to handwheel or around valve stem.
6. Number all tags and show the service of the pipe.
7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
8. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.

3. Apply markers and arrows in the following locations where clearly visible:

   a. At each valve.
   b. On both sides of walls that pipes penetrate.
   c. At least every 20 feet along all pipes.

d. On each riser and each leg of each "T" joint.
e. At least once in every room and each story traversed.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Provide engraved plastic tags at all hydronic or steam system makeup water meters.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. HIGH TEMP HOT WATER OVER 240F: Black lettering; yellow background
2. CONDENSATE DRAIN: White lettering; green background
3. DOMESTIC COLD WATER: White lettering; green background
4. DOMESTIC HOT WATER - 115F: White lettering; green background
5. DOMESTIC HOT WATER - 140F: White lettering; green background
6. DOMESTIC HOT WATER CIRCULATING - 115F: White lettering; green background
7. DOMESTIC HOT WATER CIRCULATING - 140F: White lettering; green background
8. SANITARY SEWER: Black lettering; yellow background
9. VENT: Black lettering; yellow background
10. NATURAL GAS: Black lettering; yellow background

B. Non-Potable Piping: All piping conveying non-potable water shall be permanently identified by continuously painted or continuous adhesive backed marker along entire length of pipe and branches so the piping is readily distinguishable from piping carrying potable water. Pipe markers shall be located as described above.

1. NON-POTABLE WATER: White lettering; purple background
2. IRRIGATION WATER: White lettering; purple background

END OF SECTION

SECTION 220716 - PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment Insulation.

B. Equipment Insulation Finishes.

1.2 QUALITY ASSURANCE

A. Applicator: Company specializing in insulation application with five years minimum experience.

B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

1.3 REFERENCES

A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ANSI/ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate

C. ANSI/ASTM C534 - Elastomeric Foam Insulation

D. ANSI/ASTM C921 - Properties of Jacketing Materials for Thermal Insulation

E. ANSI/ASTM D1668 - Glass Fabric for Waterproofing

F. ASTM E84 - Surface Burning Characteristics of Building Materials.

G. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

H. NFPA 255 - Surface Burning Characteristics of Building Materials.

I. UL 723 - Surface Burning Characteristics of Building Materials.

PART 2 - PRODUCTS

2.1 INSULATION

A. Type A: Glass Fiber Blanket; ANSI/ASTM C612; 0.40 maximum 'K' value at 300F; 3.0 lb./cu ft.; suitable to 850F, 25/50 flame spread/smoke developed.

B. Type C: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534, Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75F, minimum density 3.0 lb/cu ft. (48kg/m3), listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where thicker values are specified.

2.2 INSULATION FINISHES

A. Type 2: All Service Jacket; ASTM C921; Factory or Field Applied; all-purpose polymer or polypropylene service jacket; Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Seal all joints with manufacturer approved tape and adhesive to maintain vapor barrier. Indoor use only, if used outdoors add type 4 finish.

B. Type 3: Flexible Elastomeric Thermal Insulation; After adhesive has fully cured, apply two coats of latex enamel paint approved by insulation manufacturer for outdoor use.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all materials per manufacturer's instructions, codes and industry standards.

B. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

C. Do not insulate factory insulated equipment.

D. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation. Secure to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier mastic.

F. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.

G. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning; install specially fabricated removable insulation sections. Covers shall have mechanical fasteners and be reusable.

H. Install 26 gauge galvanized sheet metal corner protection angles where insulation extends to the floor. Minimum 2" coverage of insulation.

I. Insulate all equipment surfaces that are not factory insulated and are intended to operate below 60F and/or above 100F. Verify insulation type and thickness with equipment manufacturer and Architect/Engineer.

J. Insulate all supports on equipment operating below ambient temperature.

3.2 INSULATION

A. Type A and B:

1. Apply with edges tightly butted and joints staggered.
2. Secure with welded pins and washers, 4" from each edge and 16" on center, or 1/2" x 0.015" galvanized steel bands, 12" on center.

B. Type C:

1. Apply with edges tightly butted and joints staggered. Install multiple layers if required thickness is greater than 1" thick.
2. Secure with manufacturer approved adhesive. Seal all joints with manufacturer approved adhesive.
3. Exterior Installation: Exterior installations shall contain factory applied 17.5 mils laminated UV resistant cladding with ends sealed and adhesive and similar cover; or Contractor shall paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.

3.3 SCHEDULE

A. Domestic Hot Water Storage Tank (up to 250F): 2" thick Type B; Finish 1 or 2.

END OF SECTION

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping Insulation.

B. Insulation Jackets.

1.2 QUALITY ASSURANCE

A. Applicator: Company specializing in piping insulation application with five years minimum experience.

B. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1.3 REFERENCES

A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ANSI/ASTM C534 - Elastomeric Foam Insulation.

C. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.

D. ASTM C1729 - Standard Specification for Aluminum Jacketing for Insulation.

E. ASTM E84 - Surface Burning Characteristics of Building Materials.

F. NFPA 255 - Surface Burning Characteristics of Building Materials.

G. UL 723 - Surface Burning Characteristics of Building Materials.

H. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

PART 2 - PRODUCTS

2.1 INSULATION

A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75F; non-combustible, minimum density 3.0 lb/cu. ft (48kg/m3). All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534 Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75F, minimum density 3.0 lb/cu. ft (48kg/m3), listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.29 maximum 'K' value at 75F; density 7.3lb/cu.ft; minimum compressive strength 90 psi parallel to rise; moisture resistant, non-combustible; suitable for -100F to +900F. For below grade installations, use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose polymer or polypropylene service jacket for above grade installations.

2.2 VAPOR BARRIER JACKETS

A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

2.3 JACKET COVERINGS

A. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.030" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40F to 150F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

PART 3 - EXECUTION

3.1 PREPARATION

A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

3.2 INSTALLATION

A. General Installation Requirements:

1. Install materials per manufacturer's instructions, building codes and industry standards.
2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.

B. Insulated Piping Operating Below 60F:

1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
2. On piping operating below 60F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
3. All balance valves with fluid operating below 60F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.

C. Insulated Piping Operating Between 60F and 140F:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Insulated Piping Operating Above 140F:

1. Insulate fittings, valves, flanges, and strainers.
2. All balance valves with fluid operating above 140F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.

E. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
3. On exposed piping serving kitchen equipment or plumbing fixtures, the piping shall be insulated unless local code allows it to be uninsulated. In no instance should the uninsulated portion of the piping be more than 4ft in developed length.

3.3 SUPPORT PROTECTION

A. Insulation with pipe size greater than 1-1/2" (38mm) shall be protected from sagging and crushing by one of the following means.

1. High Compressive Strength Insert: On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:

a. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180-degree cylindrical segment the same length as metal shields. Inserts shall be:
b. Cellular glass (Type C) (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
c. Provide metal shields between hangers or supports and the pipe insulation/insert. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

1) Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size

1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5" to 6"	18" long x 16 gauge
8" to 14"	24" long x 14 gauge
16" to 24"	24" long x 12 gauge

d. Where rolled steel plate is noted above, provide minimum 1/4" (6mm) rolled galvanized steel plates in addition to the shield as reinforcement on large pipes as noted above to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength.

2. Premanufactured Insulation Insert/Shield: As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.

a. Products:

1) Buckaroo CoolDry

2) Cooper/B-Line Fig. B3380 through B3384

3) Pipe Shields A1000, A2000

3. Premanufactured Insulation Couplings:

a. Molded thermoplastic slip coupling, -65F to 275F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.

b. PET thermoplastic foam load bearing core with elastomeric foam ends and lap-seal jacket.

c. Horizontal Strut Mounted Insulated Pipe Manufacturers:

1) Klo-Shure or equal
2) Armafix Ecolight

d. Vertical:

1) Manufacturers: Klo-Shure Titan or equal

4. Premanufactured shield/saddle for use with Elastomeric Foam (Type B): Molded thermoplastic rigid pipe saddle sized for insulation outside diameter. Length as required by manufacturer.

B. Rectangular blocks, plugs, or wood material are not acceptable.

C. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

D. Neatly finish insulation at supports, protrusions, and interruptions.

3.4 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
3. Apply insulation with laps on top of pipe.
4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60F, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer's instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Exterior installations shall contain factory applied polymeric, moisture, and UV resistant covering with ends sealed with adhesive and similar cover; or Contractor shall paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
    a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
    b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
    a. Install preformed sections of same material as straight segments of pipe insulation when available.
    b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
    c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

C. Type C Insulation:

1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.
2. Insulate fittings with prefabricated fittings.

3.5 JACKET COVER INSTALLATION

A. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. Use plastic insulation covering on all exposed pipes including, but not limited to:

    a. All exposed piping in finished spaces unless noted otherwise on the drawings.
    b. All exposed piping in locker rooms.
    c. All exposed piping in kitchen areas.
    d. All exposed piping adjacent to cloud ceilings.
    e. All exposed piping in unfinished areas as noted on drawings (e.g., storage rooms, janitor's closets, utility rooms, etc.).
    f. All exposed piping in mechanical or equipment rooms below 8'-0" above floor.
    g. All exposed piping in mechanical rooms that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)
    h. All exposed piping in tunnels designated as passageways, equipment access, or egress.

5. Elastomeric piping insulation may have two coats of latex paint instead of plastic jacket.
6. Use colored plastic covering on the following pipes:

3.6 SCHEDULE

A. Refer to drawings for insulation schedule.

END OF SECTION

SECTION 221000 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Pipe Fittings.

B. Valves.

C. Check Valves.

1.2 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

D. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.3 REFERENCES

A. ANSI/ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.

B. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

C. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

D. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.

E. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.

F. ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.

G. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.

H. ANSI/ASTM B32 - Solder Metal.

I. ANSI/ASTM D2466 - PVC Plastic Pipe Fittings, Schedule 40.

J. ANSI/AWS D1.1 - Structural Welding Code.

K. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3" through 48", for Water and Other Liquids.

L. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.

M. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

N. ANSI/AWWA C153 - Compact Ductile Iron Fittings 3" through 48", for Water and Other Liquids.

O. ASME - Boiler and Pressure Vessel Code.

P. ASSE 1003 - Water Pressure Reducing Valves for Domestic Water Supply Systems.

Q. ASTM A74 - Hub and Spigot Cast Iron Soil Pipe and Fittings.

R. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

S. .

T. ASTM A888 - Hubless Cast Iron Soil Pipe and Fittings.

U. ASTM B88 - Seamless Copper Water Tube.

V. ASTM B306 - Copper Drainage Tube (DWV).

W. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

X. ASTM C1540 - Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.

Y. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

Z. ASTM D1785 - Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.

AA. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

BB. ASTM D2661 - ABS DWV Pipe & Fittings.

CC. ASTM D2665 - PVC DWV Pipe & Fittings.

DD. ASTM D2846 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems

EE. ASTM D3034 - Type PSM (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.

FF. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.

GG. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

HH. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

II. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.

JJ. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

KK. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

LL. ASTM F1412 - Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.

MM. ASTM F2618 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Fittings for Chemical Waste Drainage Systems.

NN. AWS A5.8 - Brazed Filler Metal.

OO. AWWA C651 - Disinfecting Water Mains.

PP. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.

QQ. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.

RR. FM 1680 - Couplings Used in Hubless Cast Iron Systems.

SS. NFPA 54 - National Fuel Gas Code.

TT. NSF - National Sanitation Foundation

1.4 SUBMITTALS

A. Submit shop drawings per Section 220500.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

1.6 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 220500 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 CAST IRON PIPE

A. Cast Iron; Standard Weight; Hub and Spigot Joints:
   1. Pipe: Standard weight hub and spigot cast iron soil pipe, bituminous corrosion protective coating inside and outside, CISPI 301 or ASTM A74.
   2. Design Pressure: Gravity Maximum Design Temperature: 180F.
   3. Joints: Compression gasket, ASTM C564.
   4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 301. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.

5. Adapters: Heavy duty no-hub transition for joining cast iron and PVC pipe. Adapters shall be tested and certified to ASTM C 1460 and be constructed with Type 304 stainless steel shield, thickness 0.015" shield, gasket material to meet ASTM C564, 1-1/2" to 4" will be 3" wide with four 304 stainless steel bands, and 6" to 10" will be 4" wide with six 304 stainless steel bands and 3/8" 305 stainless steel hex head screws torqued to 80 inch pounds.

B. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets:

1. Pipe: Standard weight no-hub cast iron soil pipe, bituminous corrosion protective coating inside and outside, CISPI 301 or ASTM A888.
2. Design Pressure: Gravity Maximum Design Temperature: 180F.
3. Joints: ASTM C1540, FM 1680, and ASTM C-564.

    a. Super Duty, Shielded Stainless Steel Couplings: Neoprene sleeve gasket, 0.015" thick 304 stainless steel shield , stainless steel 3/8" screw type clamps, minimum of four clamps for 1-1/2" to 4" and six clamps for 5" and larger pipe sizes. Clamps shall be tightened to minimum 80 inch pounds or as manufacturer requires. Husky SD-4000 or equal.

4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 310. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
5. Adapters: Transition from cast iron soil pipe to other pipe materials with manufactured adapters specifically for the application. Adapter must meet the same requirements as the joints listed above. ASTM C1460. Sticker identifying transition fitting application must be visible to view. For example, the most commonly used transition fitting from cast iron no-hub to PVC would be the Husky SD-4200 series.

C. Cast Iron; Standard Weight Epoxy Coated; No-Hub Sleeve Gaskets:

1. Pipe and Fittings: Standard weight no-hub cast iron soil pipe, CISPI 301 or ASTM A888, epoxy paint corrosion protective coating inside and outside, EN-877.
2. Joints: ASTM C1540 and FM 1680.

    a. Super Duty, Shielded Stainless Steel Couplings: Neoprene sleeve gasket, 0.015" thick 304 stainless steel shield , stainless steel 3/8" screw type clamps, minimum of four clamps for 1-1/2" to 4" and six clamps for 5" and larger pipe sizes. Clamps shall be tightened to minimum 80 inch pounds or as manufacturer requires. Husky SD-4000 or equal.

3. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 301. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
4. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters specifically for the application. Adapter must meet the same requirements as the joints listed above. ASTM C1460. Sticker identifying transition fitting application must be visible to view.

2.2 COPPER PIPE

A. Copper Pipe; Type L; Solder Joints:

1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
2. Design Pressure: 175 psi; Maximum Design Temperature: 200F.
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.

4. Fittings: Wrought copper solder joint, ANSI B16.22.

B. Copper Pipe; Type K; Solder Joints:

1. Pipe: Type K annealed copper tube, ASTM B88.
2. Design Pressure: 150 psi. Maximum Design Temperature: 200F.
3. Joints: Solder with 100% lead-free solder and flux ASTM B32.
4. Fittings: Wrought copper solder joint, ANSI B16.22.

C. Copper Pipe: Type DWV; Solder Joints:

1. Pipe: Type DWV hard temper seamless copper drainage tube, ASTM B306.
2. Design Pressure: Gravity Maximum Design Temperature: 180F.
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.

2.3 PLASTIC PIPE

A. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints:

1. Pipe: Schedule 40 rigid, PVC-DWV, or ABS-DWV, cell classification 12454 for PVC per ASTM D1784 or 42222 for ABS per ASTM D3965, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
2. Design Pressure/Temperature: Gravity at 140F.
3. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
4. Fittings: PVC-DWV, or ABS-DWV, cell classification 12454 for PVC per ASTM D1784 or 42222 for ABS per ASTM D3965, with solvent-weld socket type ends for Schedule 40 pipe.
5. Limits: Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded. Do not use where exposed to damage. Do not use in return air plenums. Do not use where not allowed by local jurisdiction. Comply with all local jurisdiction special requirements or limitations.
6. Special Requirements: Provide expansion loop(s) and/or expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 220516 for expansion joint requirements.

2.4 VALVES

A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

2. Ball Valves:

a. BA-11: 2" and under, 300 psig water, standard port, screwed or compression. Bronze body and ball of a copper alloy containing less than 15% zinc, chrome plated, Teflon coated, or stainless steel ball. Teflon or Buna-N seats, lead free NSF-372. One piece "T" style cap and stem. A.Y. McDonald 6100 Series, Mueller 300 Series.

2.5 STRAINERS

A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

B. ST-1: Threaded Ends, 4" and under, lead free bronze or 304 stainless steel body, threaded connections, threaded removable cover, 0.045• • • • • • • • 304 stainless steel perforated screen, 125 psi S at 350F, 200 psi CWP at 150F. Apollo Valves, a division of Aalberts-IPS YB-LF (59LF), Metraflex SSFT, Mueller / Watts LF351, Watts LF777, Jomar T-651G, Zurn SXL.

2.6 CHECK VALVES

A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

B. CK-1: Threaded Ends, 2" and under, 125 psi steam at 406F, 200 psi CWP at 150F, threaded connection, lead free bronze body with brass or bronze disc, horizontal swing. Hammond #UP904, Milwaukee #UP509, NIBCO T-413-Y-LF, Jomar T-511G, Apollo Valves, a division of Aalberts-IPS #161T-LF.

2.7 CONNECTIONS BETWEEN DISSIMILAR METALS

A. General:
1. Provide dielectric isolation at all pipe-to-pipe and pipe-to-equipment connections where dissimilar metals are joined, unless specifically noted otherwise below.
2. Dielectric fittings shall:
    a. Prevent direct metal-to-metal contact between dissimilar metals.
    b. Interrupt the electrical path to prevent galvanic current flow.
    c. Be rated for the full operating pressure, temperature, and system test conditions.
    d. Be listed and labeled for the intended service.

B. Materials Requiring Isolation
1. Isolation is required between aluminum, iron, steel, galvanized steel, stainless steel, copper, brass, and bronze, except as follows:
    a. Iron and steel connected to each other.
    b. Brass, copper, and bronze connected to each other.
    c. Brass or bronze valves and specialties installed within closed hydronic systems and connected to steel, iron, or stainless steel piping on both sides.
2. Brass or bronze valves and specialties shall not be used as the sole dielectric separation between different pipe materials.

C. Pipe-to-Equipment Connections
1. Provide dielectric isolation at connections to equipment constructed of a material different than the piping system.

D. Threaded Dielectric Fittings
1. Acceptable for pipe sizes 2 inches and smaller.
2. Minimum pressure rating: 300 psi CWP.
3. Minimum temperature rating: 225F.
4. Provide fittings specifically manufactured as dielectric fittings. Field-fabricated isolators are not permitted.
5. Acceptable manufacturers (threaded configuration):
    a. Elster Group ClearFlow
    b. Victaulic Series 647 (threaded configuration)
    c. Grinnell Series 407 (threaded configuration)
    d. Matco-Norca

PART 3 - EXECUTION

3.1 PREPARATION

A. Install all products per manufacturer's recommendations.

B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

C. Remove scale and dirt, on inside and outside, before assembly.

D. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

E. Connect to equipment with flanges or unions. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

F. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.

G. Roof Penetration (Vent) Flashing:
1. Membrane, Metal or Shingled Roofs: Flash vents with premolded pipe flashing cones for single-ply membrane roofs, metal roofs, or shingled roofs.

H. Existing building sewers or building drains which are shown on the documents to be reused shall be inspected and recorded by closed circuit television for their condition. Report findings back to the Architect, Engineer, and Owner before proceeding with work so any necessary rework can take place if needed.

3.2 SYSTEM, PIPING AND VALVE SCHEDULE

A. The schedule below lists acceptable pipe and valve materials for each plumbing system type. Refer to the paragraph of the same name above in Part 2 for material specifications and limits for usage. This schedule is kept brief to simplify the information but shall not be interpreted to contradict limitations in Part 2. For example, if PVC/ABS is listed for sanitary waste and vent above ground in this schedule, that does not mean it is universally allowed for the entire project. Rather the material is still limited by Part 2 and is not allowed in return air plenum spaces.

B. Cold Water, Hot Water, Tempered Water, Reclaimed Water - Potable and Non-Potable (Above Ground):

1. Copper Pipe; Type L; Solder Joints: All Sizes
2. Shutoff Valves:
3. Check Valves: CK-1, CK-2, CK-3

C. Strainers: ST-1, ST-2Cold Water, Hot Water, Tempered Water, Reclaimed Water - Potable and Non-Potable (Underground):

1. Copper Pipe; Type K; Solder Joints: All Sizes
2. Copper Pipe; Type K; Brazed Joints

D. Sanitary Waste and Vent, Gravity (Above Ground):

1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15" (375mm)
3. Cast Iron; Standard Weight Epoxy Coated; No-Hub Sleeve Gaskets: 1-1/2" to 15"
4. Copper Pipe: Type DWV; Solder Joints: 1-1/4" to 4"
5. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes

E. Sanitary Indirect Drainage (Above Ground):

1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
3. Cast Iron; Standard Weight Epoxy Coated; No-Hub Sleeve Gaskets: 1-1/2" to 15"
4. Copper Pipe: Type DWV; Solder Joints: 1-1/4" to 4"
5. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes

F. Sanitary Waste and Vent, Gravity (Underground - Inside Building):

1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
3. Cast Iron; Standard Weight Epoxy Coated; No-Hub Sleeve Gaskets: 1-1/2" to 15"
4. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes

G. Sanitary Waste and Vent, Gravity (Underground - Outside Building):

1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
3. Cast Iron; Standard Weight Epoxy Coated; No-Hub Sleeve Gaskets: 1-1/2" to 15"

H. Condensate/Equipment Drainage:
1. Copper Pipe: Type DWV; Solder Joints: 1-1/4" to 4"
2. Copper Pipe: Type M; Solder Joints: 1-1/4" to 4"
3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes

3.3 TESTING PIPING

A. Sanitary Drainage, Sanitary Vent:

1. Test all piping with water to prove tight.
2. Test piping before insulation is applied.
3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
4. Hydrostatically test interior downspouts with 10 feet head of water for 15 minutes with no leaks.
5. Test force mains with water at 105% of the operating pump discharge pressure for 15 minutes.
6. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.

B. Hot Water - Potable and Non-Potable, Cold Water - Potable and Non-Potable:

1. Test pipes underground or in chases and walls before piping is concealed.
2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.

3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen. Exception: Inert gas test shall not be used to test plastic piping.
4. Hold test pressure for at least 2 hours.
5. Test to be witnessed by the Architect/Engineer's representative, if requested by the Architect/Engineer.

C. All Other Piping:

1. Test piping at 150% of normal operating pressure.
2. Piping shall hold this pressure for one hour with no drop in pressure.
3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.
4. Drain and clean all piping after testing is complete.

3.4 CLEANING PIPING

A. Air Blow:

1. Blow out pipe and components with clean compressed air. Instrument air, argon, nitrogen and sulfuric acid lines shall be blown out with dry, oil free air or nitrogen gas. "Oil Free" is defined as air compressed in a centrifugal, Teflon ring, carbon ring or water pumped air compressor. Where air supply is judged to be inadequate to continually attain cleaning velocity, alternate pressurization and sudden relief procedure may be used until discharge at all blow out points is clean. Use 80-90 psig pressure unless otherwise indicated.
2. Air blow applies to the following systems:

    a. Acetylene
    b. Carbon Dioxide
    c. Nitrogen (use oil free air or nitrogen gas)
    d. Argon (use oil free air or nitrogen gas)
    e. Instrument Air (use oil free air or nitrogen gas)
    f. Distilled Water (use maximum of 50 psig pressure)
    g. Chemical Feed
    h. Air Compressor Intakes
    i. Sulfuric Acid (use oil free air or nitrogen gas)

B. All Water Piping:

1. Flush all piping using faucets, flush valves, etc. until the flow is clean.
2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

3.5 INSTALLATION

A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Install bell and spigot piping with bells upstream.
7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

8. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.
9. All vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

C. Valves/Fittings and Accessories:

1. Install shutoff valves that permit the isolation of equipment/fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement. Exception: Back-to-back rooms in no more than two adjacent rooms.
2. Provide clearance for installation of insulation and access to valves and fittings.
3. Provide access doors for concealed valves and fittings.
4. Install valve stems upright or horizontal, not inverted.
5. Provide one plug valve wrench for every ten plug valves 2" and smaller, minimum of one. Provide each plug valve 2-1/2" and larger with a wrench with set screw.
6. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

D. Underground Piping:
1. Install buried water piping outside the building with at least insert3feet of cover.Refer to Section 220500 for Excavation, Fill, Backfill and Compaction requirements
2. Install buried borosilicate glass pipe with the protective polystyrene covering intact. Lay the pipe on bedding and backfill per manufacturer instructions.
3. Direct buried, uninsulated steel pipe shall have a factory applied external protective coating consisting of two coats with an intermediate layer of 18 mil fibrous glass mat. Coating thickness shall total not less than 3/32". The outer coating shall be further protected by a wrapping of heavy Kraft paper. This external protection shall extend and be exposed for a minimum of 1 foot beyond the buried or concealed portion of the pipe.

4. As an option, the Contractor may provide factory applied protective coatings consisting of a polyethylene plastic film bonded to the pipe surface by a hot applied thermo-plastic adhesive.

5. Exercise care in handling, storing and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.
6. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
7. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of the Architect/Engineer's representative with an electronic holiday detector. Any defects in the protective coatings shall be repaired in accordance with requirements for original coatings.
8. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.

E. Sanitary and Storm Piping:

1. Install all sanitary and storm piping inside the building with a slope as shown on the drawings.
2. Install horizontal offset at all connections to roof drains to allow for pipe expansion.
3. Slope sanitary and storm piping outside the building to meet invert elevations shown on drawings and to maintain a minimum velocity of 2 feet per second.
4. Sway Bracing: Where horizontal sanitary and/or storm pipes 4 inches and larger change flow direction greater than 45 degrees, rigid bracing or thrust restraints shall be installed to resist movement of the upstream pipe in the direction of pipe flow. The rigid bracing or thrust restraint shall be connected to structure. A change of flow direction from horizontal into a vertical pipe does not require the upstream pipe to be braced.
5. All sanitary and storm piping shall have at least 36"of cover when leaving the building.
6. Starter fittings with internal baffles are not permitted.

3.6 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all horizontal water lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.

B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.

C. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.

D. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.

E. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.

F. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.

G. All vent and drain piping shall be of same materials and construction for the service involved.

3.7 PLUMBING VENTS

A. Vent as shown on the drawings and in accordance with all codes having jurisdiction.

B. Extend the high side of the soil and waste stacks at least 12" above roof.

C. Flash pipes at roof with premolded EPDM pipe flashing cones adhered to roof membrane by General Contractor. Secure top of cone with stainless steel clamp and seal watertight.

D. Increase vent pipes through the roof two pipe sizes with long increasers located at least 12" below the roof.

E. In no case shall the vent through the roof be less than 4" in diameter.

F. Vent pipes through the roof shall be located a minimum of 10 feet from any air intake opening on the roof.

3.8 BRANCH CONNECTIONS

A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.

B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.

3.9 JOINING OF PIPE

A. Solder Joints (Copper Pipe):

1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470F melting point solder. Remove discs and seals during soldering if they are not suitable for 470F.

B. Brazed Joints (Copper Pipe):

1. Make up joints with silver alloy brazing filler metal conforming to ASTM B260 "Brazing Filler Metal" BAg-1 or BAg-2. Cut copper tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to brazing. Apply non-corrosive flux of the type recommended by filler alloy manufacturer, evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly using oxygen-acetylene torch with tip size recommended by fitting manufacturer. Wipe and brush joint clean after alloy has set.
2. Remove discs from solder end valves during brazing.

C. Mechanical Joints (Ductile Iron Pipe):

1. Joints shall conform to ANSI A21.11 "Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings". Gasket material shall be neoprene. The standard bolts and nuts of the pipe manufacturer shall be used and shall be coated at the factory with rust preventive lubricant after threading and tapping.
2. Final tightening of bolts shall be with a torque wrench to insure equal tension in all bolts.

D. Hub and Spigot Joints - Sanitary Pipe and Storm Pipe (Cast Iron and Stainless Steel Pipe):
1. Compression Gasket Joints: Joint shall be one-piece double seal compression type gasket made specifically for joining cast iron soil pipe. Gasket shall be neoprene, permitting joint to flex as much as 5 degrees without loss of seal. Gasket shall be extra heavy weight class, conforming to ASTM C-564.

E. Solvent Weld Joints (PVC):

1. Make joints with a two-step process. Use primer conforming to ASTM F656 and solvent cement conforming to ASTM D2564.
2. All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualifications procedures described in ASME B31.3, Chapter VII for bonding of plastic piping.

F. No-Hub Sleeve Gaskets (No-Hub) (Cast Iron Pipe):

1. Gasket shall be heavy weight class, conforming to ASTM C564.
2. The gasket shall have an internal center stop.
3. The gasket shall be covered by a stainless steel band secured with a minimum of four stainless steel bands per fitting/joint.
4. Sleeve gaskets shall be installed in accordance with the manufacturer's installation instructions.

G. Couplings: Assemblies with combinations of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

H. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

I. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

3.10 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfection of the domestic water piping shall be completed within three (3) weeks prior to building occupancy. Contractor is responsible for disinfecting water piping if used by workers during construction; disinfection during construction does not eliminate the requirement for final disinfection prior to occupancy. Flushing of piping shall be completed within two (2) weeks prior to building occupancy.

B. Provide necessary connections at the start of individual sections of mains for adding chlorine.

C. Before starting work, verify system is complete, flushed and clean.

D. Follow the disinfection of potable water procedure outlined in this project’s applicable plumbing code. For example: IPC 610.1, UPC 609.10, CPC 609.10, and Illinois 890.1180. Where local codes do not outline a disinfection procedure, follow the International Plumbing Code procedure 610.1.

E. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.

F. Take water samples, no sooner than 24 hours after flushing, from 2% of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651, Section 5 - Verification.

END OF SECTION

SECTION 221023 - NATURAL GAS AND PROPANE PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Pipe Fittings.

B. Valves.

C. Natural Gas Piping System.

1.2 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.

B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

1.3 REFERENCES

A. ANSI/AWS D1.1 - Structural Welding Code.

B. ANSI AGA-LC1 - Standards for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing.

C. ASME B1.20.1 - Pipe Threads, General Purpose.

D. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.

E. ASME B16.5 - Pipe Flanges and Flanged Fittings.

F. ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.

G. ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.

H. ASME B16.39 - Malleable Iron Threaded Pipe Unions.

I. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.

J. ASME B18.2.2 - Square and Hex Nuts, Inch Series.

K. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

L. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.

M. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.

N. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

O. NFPA 54 - National Fuel Gas Code.

1.4 SUBMITTALS

A. Test Reports: Provide results of piping system pressure test.

B. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.

B. Deliver and store valves in shipping containers with labeling in place.

1.6 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 22 05 00 for the required natural gas piping system electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 NATURAL GAS (0 to 125 PSI)

A. Design Pressure: 125 psi. Maximum Design Temperature: 350F.

B. Piping - 2" and Under:

1. Pipe: Standard weight black steel, threaded and coupled, ASTM A53.
2. Joints: Screwed. (NOTE: For below ground, all sizes to have welded joints.)
3. Fittings: 150# steam - 300# CWP, black malleable iron, banded, ASTM A197, ANSI B16.3.
4. Unions: 250# - 500# CWP, black malleable iron, ANSI B16.39, ground joint with brass seat.

C. Piping - 2-1/2" and Over:

1. Pipe: Standard weight black steel, beveled ends, ASTM A53.
2. Joints: Butt welded or flanged.
3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade I, ANSI B16.9.
4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Flange face seal weld (backweld) is required for slip-on flanges.

D. Shutoff Valves/Throttling Valves:

1. BA-13: 2" and under, threaded, full port, 600 psi CWP; UL listed for 250# LP, flammable liquid, heating oil, natural and manufactured gases, 150 psi steam, chrome plated brass ball, Teflon seats and packing.

a. Body: Bronze.

1) Manufacturers:

a) Apollo #80-100
b) Nibco #T580-70-UL or #T585-70-UL

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

D. Connect to all equipment with flanges or unions.

E. After completion, fill, clean, and treat systems. Refer to Section 232500 for treatment.

3.2 TESTING PIPING

A. Low Pressure - Up to 1 psi:

1. Test piping with 20 psi air pressure. System must hold this pressure without adding air for two hours.

B. High Pressure - Above 1 psi:

1. Test piping with compressed air at twice the operating gas pressure, but at least 20 psi. System must hold this pressure without adding air for two hours.

C. A non-combustible odorant, such as oil of wintergreen, may be added to help locate leaks.

3.3 CLEANING PIPING

A. Assembly:

1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.

4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

3.4 INSTALLATION

A. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.

B. Install piping to conserve building space, and not interfere with other work.

C. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Install thrust blocking and restraints on all buried piping at elbows and other changes in pipe direction.

G. Provide clearance for access to valves and fittings.

H. Provide access doors where valves are not exposed.

I. Prepare pipe, fittings, supports, and accessories for finish painting.

J. Install valves with stems upright or horizontal, not inverted.

K. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.

L. Provide shutoff valves to isolate part of systems and vertical risers.

M. Provide shutoff valves to boilers and water heaters in readily accessible location, maximum 6 feet above finished floor, within 6 feet of boiler connection per ASME CSD-1.

N. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

O. Reducers are generally not shown. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.

P. Refer to Section 230500 for Excavation, Fill, Backfill and Compaction requirements.

Q. All vertical pipe drops to equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.

3.5 BONDING AND GROUNDING

A. Each above ground portion of a gas piping system, other than corrugated stainless steel tubing systems, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than corrugated stainless steel tubing, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.

B. Gas piping shall not be used as a grounding conductor or electrode.

C. Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems.

3.6 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.

B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.

D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.

F. Use full and double lengths of pipe wherever possible.

G. Cut all pipe to exact measurement and install without springing or forcing.

H. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

3.7 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage.

B. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install gas pipes with bottom of pipe and eccentric reducers in a continuous line.

C. Provide drip legs at low points and at the base of all risers in gas pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

3.8 BRANCH CONNECTIONS

A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.

B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

C. Use of forged weld-on fittings is also limited as follows:

1. Must have at least same pressure rating as the main.
2. Header or main must be 2-1/2" or over.
3. Branch line is at least two pipe sizes under header or main size.

D. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

E. All branch piping connections for natural gas shall take off on the top or on the side of the main.

3.9 JOINING OF PIPE

A. Threaded Joints:

1. Ream pipe ends and remove all burrs and chips.
2. Protect plated pipe and valve bodies from wrench marks when making up joints.
3. Apply gas-rated Teflon tape or thread compound to male threads.

B. Welded Joints:

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

3.10 PAINTING EXPOSED PIPE

A. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

3.11 SERVICE CONNECTIONS

A. Provide new gas service complete with gas meter and regulators. Verify gas service pressure with the Utility Company.

END OF SECTION

SECTION 221030 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cleanouts.

B. Traps.

C. Trap Seals and Primers.

D. Floor Drains and Sinks

E. Hub Drains and Standpipes

F. Backflow Preventers.

G. Strainers.

H. Unions.

I. Balancing Valves.

J. Water Hammer Arresters.

K. Dielectric Fittings (Connections Between Dissimilar Metals).

L. Drain Valves.

M. Relief Valves.

1.2 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

B. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.3 REFERENCES

A. ANSI A112.21.1 - Floor Drains.

B. ANSI A112.21.2 - Roof Drains.

C. ASSE 1010 - Water Hammer Arresters.

D. ANSI A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers.

E. ANSI 1012 - ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers; American Society of Sanitary Engineering; 1.

F. ASSE 1019 - AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.

G. PDI WH-201 - Water Hammer Arresters.

1.4 SUBMITTALS

A. Include sizes, rough-in requirements, service sizes, and finishes.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Provide cleanouts as shown and specified on the drawings as well as required by code.

B. Coordinate floor cleanout cover with surrounding floor finish. Provide either solid, recessed for tile or terrazzo or carpet marker as applicable.

C. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.

D. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.

2.2 YARD CLEANOUTS

A. Provide yard cleanouts as shown and specified on the drawings as well as required by code.

B. Cleanout shall be same size as pipe up to 6" and 6" for larger pipes.

2.3 TRAPS

A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be of the same material as specified for waste system.

B. All traps shall have accessible, removable cleanouts, except where installed on floor drains with removable strainers.

C. Deep seal pattern traps shall be provided where required by code.

D. Each trap shall be completely filled with water at the end of construction but before building turnover to the Owner. All floor drains, floor sinks, trench drains, etc. shall be filled with water.

2.4 TRAP SEALS AND PRIMERS

A. Provide trap seals as specified on the drawings.

B. Provide trap primers as shown and specified on the drawings.

C. Where trap primers are shown on drawings, coordinate with corresponding floor drains to ensure they include a side inlet connection for the trap primer line.

2.5 FLOOR DRAINS

A. Floor drains shall be in the form of a receptor with grate/strainer set flush with the surrounding floor.

B. Provide floor drains and sinks as shown and specified on the drawings as well as required by code.

2.6 HUB DRAINS AND STANDPIPES

A. A hub drain shall be in the form of a hub or pipe without a grate/strainer extending through the floor for receiving indirect waste. A hub drain has a flood level rim above the finished floor.

B. Provide hub drains as shown and specified on the drawings as well as required by code.

2.7 BACKFLOW PREVENTERS

A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

2.8 STRAINERS

A. Furnish pipe nipple with shutoff valve to blow down all strainer screens.

B. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

2.9 BALANCING VALVE

A. Rated for 125 psi working pressure and 250F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.

B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.

C. Furnish one meter kit equivalent to Bell & Gossett Model RO-5 meeting the following requirements:

1. Carrying case with handle.
2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.
4. Coordinate with the Mechanical Contractor if a meter kit is also required in Section 232100. It is not our intent to require two identical kits, rather it will be acceptable to provide only one kit to the owner which can be used with both plumbing and hydronic piping systems.

D. Flow rate of 0.5 GPM or larger: Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design "Accusetter", Preso "B+", Armstrong "CVB", Bell & Gossett "Circuit Setter Plus", Griswold "Quickset", Gerand "Balvalve Venturi", Nibco Globe Style or Hays MV7-005 balancing valve.

E. Flow rate less than 0.5 GPM: Valves in copper piping shall be brass or bronze. Cv value shall be less than 1.0 when valve is completely open, and minimum balanceable flow rate shall not exceed 0.1 GPM with a meter reading of at least 2.5 feet. Acceptable manufacturers: Bell & Gossett "Circuit Setter RF", Flow Design, Preso, Armstrong, Griswold, Gerand, or Nibco balancing valve.

F. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.10 WATER HAMMER ARRESTERS

A. Provide water hammer arresters as shown and specified on the drawings as well as required by code.

B. ANSI A112.26.1; sized and located in accordance with PDI WH-201, precharged for operation between -100F and 300F and maximum 250 psig working pressure.

2.11 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron, steel, and stainless steel connected to each other.
2. Brass, copper, and bronze connected to each other.
3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.

D. Dielectric protection is required at connections to equipment of a material different than the piping.

2.12 DRAIN VALVES

A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Coordinate construction to receive drains at required invert elevations.

B. Install all items per manufacturer's instructions.

C. Water Hammer Arresters:

1. Install water hammer arresters in accessible locations. Provide access doors as required. Coordinate type with Architect/Engineer/Owner.

2. Water hammer arrestors shall be installed in cold and hot water lines upstream of all plumbing fixtures or equipment, with a quick acting valve or multiple quick acting valves. Quick acting valves shall be defined as solenoid actuated valves, manual flush valves, sensor activated faucets and flush valves, squeeze handle spray faucets, and other similar type valves.
3. Install multiple water hammer arrestors in toilet group branch piping greater than 20 feet in developed length from the cold and hot water mains.

D. Cleanouts:

1. Provide cleanouts where shown on the drawings and as required by code, but in no case farther apart than 50 feet .
2. Provide cleanouts at bases of all sanitary and storm risers as shown on the drawings and as required by code.
3. Provide a cleanout at the upstream end of a horizontal waste pipe in a plumbing chase serving multiple plumbing fixtures; for example a bank of water closets or lavatories.
4. Provide cleanouts on the branch line connected to individual plumbing fixtures as required by code; for example just below a sink, lavatory or urinal.
5. Extend underfloor cleanouts up to the floor with long sweep elbows.
6. Install a full size, two-way cleanout within 5 feet of the foundation inside or outside of building.
7. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
8. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12" above the finished floor.

E. Yard Cleanouts:

1. Install cleanouts on maximum 90 foot centers (including riser) for pipes 8" and smaller.
2. Extend cleanout to grade. Encase cleanout in 5" thick concrete pad extending 6" beyond cleanout, set low enough not to interfere with lawn mowers.

F. Floor Drains and Floor Sinks:

1. Drains in upper floors shall have a flashing of EPDM or similar membrane sheet. The sheet shall be at least 36" X 36" square with the drain in the center. Clamp membrane in auxiliary clamping ring of floor drain.
2. Use alternate sealing method when installing drains in existing floor slabs.
3. Coordinate sloping requirements with the architectural plans and specifications.
4. Top of floor drain and sink grate/strainer shall not extend above the finished floor elevation. Grate/strainer shall be installed flush with surrounding finished floor. Should the Plumbing Contractor believe this presents a conflict with code, the issue should be evaluated before installation of the floor drain or sink begins. Proceeding with installing a floor drain or sink raised above the finished floor without prior approval will result in the Contractor being required to remove the drain or sink in question and reinstall it at the approved elevation.

G. Hub Drains and Standpipes:

1. The top of a hub drain/standpipe shall extend above the finished floor elevation. Refer to drawings for dimensions above the finished floor.
2. Access shall be provided to drains and standpipes for rodding.

H. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor in a location that is accessible for annual testing and maintenance.

I. Balancing Valves:

1. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

END OF SECTION

SECTION 221429 - SUMP PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Sump Pumps.

1.2 SUBMITTALS

A. Submit shop drawings under provisions of Section 220500.

B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.

C. Pumps with motors operating above the RPM the pump curves are based on shall have impellers trimmed to deliver GPM and head scheduled.

D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

PART 2 - PRODUCTS

2.1 GENERAL

A. Statically and dynamically balance rotating parts.

B. Construction shall permit complete servicing without breaking piping or motor connections.

C. Pumps shall operate at 1750 rpm unless specified otherwise.

D. Pump connections shall be flanged, whenever available.

E. The discharge pipe sizes shall meet or exceed the scheduled pump.

2.2 SUMP PUMPS

A. Provide pumps as specified on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings and accessories.

C. Support piping so weight of piping is not supported by pumps.

D. Mount control panel on adjacent wall within required distance for cables and wiring. Provide unistrut mounting frame for the control panel if wall space is not available. Properly anchor frame to floor.

E. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.

F. Pumps shall be factory aligned. If alignment is not satisfactory, as determined by the Architect/Engineer, manufacturer shall provide a factory trained representative to field align the shafts.

G. Sump pumps that discharge to storm shall be installed with the top of the sump basin 2" above floor level. A 2" high x 4" wide concrete curb around the perimeter of the basin lid may be used in lieu of raising the entire sump basin.

H. Set submersible sump pumps on basin/pit floor. Make direct connections to storm drainage piping.

I. Install sump pump basins and connect to drainage piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

END OF SECTION

SECTION 223000 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Water Heaters.

1.2 QUALITY ASSURANCE

A. Products and installation of specified products shall conform to recommendations and requirements of the following organizations:

1. American Gas Association (AGA).
2. National Sanitation Foundation (NSF).
3. American Society of Mechanical Engineers (ASME).
4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
5. National Electrical Manufacturers' Association (NEMA).
6. Underwriters' Laboratories (UL).

B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1 when tested in accordance with DOE 10 CFR, ANSI Z21.10.1 and ANSI Z21.10.3.

C. Conform to ASME Section VIII for construction of water heaters and heat exchangers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

1.3 REFERENCES

A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ANSI/ASME Section 8D - Pressure Vessels.

C. ANSI Section 21.10.1 or Section ANSI 21.10.3 - Gas Water Heaters Ratings 75,000 BTU per Hour and Less.

D. ANSI/NFPA 30 - Flammable and Combustible Liquids Code.

E. ANSI/NFPA 54 - National Fuel Gas Code.

F. ANSI/NFPA 70 - National Electrical Code.

G. ANSI/UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters.

H. ASSE 1005 - Water Heater Drain Valves, 3/4" Iron Pipe Size.

1.4 SUBMITTALS

A. Submit shop drawings under provisions of Section 220500.

B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.

C. Include heat exchanger dimensions, size of tappings, and performance data.

D. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

E. For equipment connected to an electric power source, submit short circuit rating (SCCR) of integrated unit.

F. Submit manufacturer's installation instructions including control and electrical power/controls wiring diagrams.

G. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.

H. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

I. Submit a current water analysis from the actual water source serving the existing building for softening equipment verification before sending shop drawings to the Architect/Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.6 REGULATORY REQUIREMENTS

A. Water heaters shall conform to AGA, ANSI/NFPA 54, ANSI/NFPA 70, ANSI/UL 1453 as applicable.

B. Conform to ANSI/ASME Section 8 Division 1 for fabrication of steel pressure vessels.

C. Conform to ANSI/ASME Section 10 for manufacture of fiber-reinforced plastic pressure vessels.

PART 2 - PRODUCTS

2.1 WATER HEATERS

A. All water heaters shall be as scheduled on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all items in accordance with manufacturer's instructions.

3.2 WATER HEATER INSTALLATION

A. Install water heaters on concrete bases. Coordinate sizes and locations of concrete bases.

B. Install water heaters level and plumb, according to drawings, manufacturer's instructions, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend drain piping full size from relief valve and discharge by positive air gap onto closest floor drain. Discharge pipe material shall be same as domestic water piping.

D. Install gas water heaters according to NFPA 54.

END OF SECTION

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. All plumbing fixtures.

1.2 REFERENCES

A. ANSI A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

B. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

C. ANSI A112.19.1M - Enameled Cast Iron Plumbing Fixtures.

D. ANSI A112.19.2M - Vitreous China Plumbing Fixtures.

E. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

F. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.

G. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

H. ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.

I. AHRI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.

J. ASSE 1002 - Water Closet Flush Tank Ball Cocks.

K. Americans with Disabilities Act (ADA), Title III.

L. The Energy Policy Act (EPAct) of 2005.

1.3 SUBMITTALS

A. Submit product data under provisions of Section 220500. Submittals shall include fixture carriers for record purposes only. Architect/Engineer does not review or approve carriers except for manufacturer.

B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. For fixtures and trim requiring electrical connections, submit product data indicating general assembly, components, electrical power/controls wiring diagrams, and service connections.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All fixtures shall be as shown on the drawings and as scheduled in the plumbing material list. Additional requirements below:

B. All vitreous china fixtures shall be from the same manufacturer where possible.

C. All lavatory and sink trim shall be from the same manufacturer where possible.

D. All fixtures shall be lead free. Faucets, traps, stops, and other fixture accessories shall not contain more lead than allowed per the latest State or Federal Act.

E. P-Traps and Tailpieces:

1. Lavatories:

    a. Accessible Type: 1-1/4" chrome plated 17-gauge cast brass offset tailpiece and p-trap with cleanout on bottom of trap.
    b. Non-Accessible Type: Offset not required for tailpiece, otherwise same.

2. Sinks:

    a. Accessible Type: 1-1/2" chrome plated 17-gauge cast brass offset tailpiece and p-trap with cleanout on bottom of trap.
    b. Non-Accessible Type: Offset not required for tailpiece, otherwise same.

F. Insulation Covers and Enclosures for Accessible Lavatories and Sinks:

1. Premanufactured cover for P-trap, stop valves, and supply lines.

    a. 1/8" thick vinyl construction, paintable, tool free installation,

2. Premanufactured rigid enclosure for concealing lavatory P-trap, stop valves, and supply lines,

    a. Rigid, high impact PVC, paintable, stainless steel fasteners for anchoring and removal.

3. Premanufactured rigid enclosure for concealing sink P-trap, stop valves, supply lines, garbage disposal, etc.

    a. Rigid, high impact PVC, white or beige (Color by architect), paintable, 36" or 42" widths, stainless steel fasteners for anchoring and removal.

G. Wall Hung Fixture Carriers:

1. Material: All Metal, ASME/ANSI A112.6.1M.
2. Lavatory carrier shall be rated to support 250 lbs unless noted otherwise on the drawings.
3. Water closet carrier shall be rated to support 500 lbs unless noted otherwise on the drawings

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
2. Install each fixture with trap easily removable for servicing and cleaning. Use screwed tailpiece couplings. Connect fixture waste to stack with slip fitting.
3. Provide fixtures with supply lines, stop valves, reducers, escutcheons, and any other items required for a complete and operational plumbing fixture assembly.
4. Install components level and plumb.
5. Caulk joint between finish floor and floor mounted fixtures and between finish walls and wall mounted fixtures with silicone caulk. Caulk the joint, between rim and fixture where a fixture builds into a counter top, with caulking compound. Color to match fixture.
6. Refer to Plumbing Material List for fixture mounting heights.
7. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.

B. Wall-Mounted Fixture Requirements:

1. All wall-mounted fixtures shall have compatible carriers designed for their intended service and suitable for the space available and configuration of fixtures. All carriers shall extend to the floor and be anchored to the slab as intended by the carrier manufacturer.

C. Floor-Mounted Fixture Requirements:

1. Where floor mounted fixtures are installed on a sloped floor, the open void below the fixture shall be grouted, leveled, and caulked to eliminate stress on the fixture and to prevent water migration to the floor below.

D. Exposed or Inside Accessible Cabinets Traps, Valve and Pipe Requirements:

1. All water or waste piping for plumbing fixtures that is exposed or inside cabinets shall be chrome plated.
2. All exposed flush valves for water closets and urinals shall have a chrome plated hanger to anchor the piping to the wall.
3. All exposed water supply piping and fittings in a finished space to a shower valve, hose bibb, or other water outlet shall be chrome plated.

E. ADA Accessible Exposed Sink and Lavatory Trim:

1. All exposed sink and lavatory traps, piping and angle stops installed at accessible sink and lavatory locations shall include offset style drain tailpiece, p-trap installed near and parallel with back wall, and insulation kit specially manufactured for this installation. Armaflex with duct tape is not acceptable.

F. ADA Accessible Water Closet Requirements:

1. Handicapped accessible water closet flush valve or flush tank handles shall be on the left hand or right hand side of the fixture, whichever is nearer to the center of the stall.
2. Coordinate flush valves in handicap accessible locations with grab bars installed by the General Contractor. Make modifications as necessary to flush valve piping to avoid conflict with grab bars. Common solutions include shortened or offset vacuum breaker tailpieces.

3.2 ADJUSTING AND CLEANING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

B. At completion, clean plumbing fixtures, equipment, and faucet aerator screens.

3.3 FIXTURE ROUGH-IN SCHEDULE

A. Rough-in fixture piping connections in accordance with table on plumbing drawings of minimum sizes for particular fixtures.

END OF SECTION

SECTION 230500 - BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to all Division 23 Sections. Also refer to Division 01 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.

B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

D. Scope of Work:

1. Heating Work shall include, but is not necessarily limited to:
    a. Furnish and install refrigerant piping, accessories, and final charge of refrigerant.
    b. Furnish and install condensate drain piping from cooling related equipment such as air handlers and cooling coil drain pans.
    c. Furnish and install seismic restraint and equipment designed for use in seismic conditions described in Section 230550.
    d. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
    e. Complete all applicable tests, certifications, forms, and matrices.

2. Air Conditioning and Ventilating Work shall include, but is not necessarily limited to:

    a. Furnish and install package rooftop air handling units complete with curbs.
    b. Furnish and install air-cooled condensing units and curbs.
    c. Furnish and install complete supply air ductwork systems including all fittings, insulation, and outlets.
    d. Furnish and install complete return air ductwork systems including all fittings, insulation, and inlets.
    e. Furnish and install all terminal air boxes and reheat coils.
    f. Furnish and install combustion air louver, damper, and ductwork.
    g. Furnish and install complete exhaust ductwork systems including all fittings, insulation, inlets, and fans.
    h. Furnish and install mechanical room ventilation systems including louvers, ductwork, insulation, and fans.
    i. Furnish and install gas flues, stacks, and breechings.
    j. Furnish and install all temperature control systems.
    k. Furnish and install all fire dampers.

l. Furnish and install seismic restraint and equipment designed for use in seismic conditions described in Section 230550.
m. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
n. Complete all applicable tests, certifications, forms, and matrices.

3. Temperature Control Work shall include, but is not necessarily limited to:

a. Furnish and install a complete temperature control system as specified in Section 230900.
b. Temperature control system shall consist of a full Direct Digital Control (DDC) system including all accessories, sensors, and programming.
c. Furnish automatic control valves and dampers for installation by others.
d. Furnish and install seismic restraint and equipment designed for use in seismic conditions described in Section 230550.
e. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.

4. Fire Protection Work: Refer to Section 210500 "Basic Fire Suppression Requirements".
5. Testing, Adjusting, and Balancing Work shall include, but is not necessarily limited to:

a. Furnish complete testing, adjusting, and balancing as specified in Section 230593, including, but not limited to, air systems, hydronic systems, plumbing systems, and verification of control systems.
b. Complete all applicable tests, certifications, forms, and matrices

1.3 OWNER FURNISHED PRODUCTS

A. This Contractor shall make all mechanical system connections shown on the drawings or as required for fully functional units.

B. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

1.4 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours will be required.

1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:

a. Plumbing Contractor.
b. Heating Contractor.
c. Air Conditioning and Ventilating Contractor.
d. Temperature Control Contractor.
e. Fire Protection Contractor.
f. Testing, Adjusting, and Balancing Contractor.

2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.

    a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.

6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.

4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:

    a. Light fixtures.
    b. Gravity flow piping, including steam and condensate.
    c. Electrical busduct.
    d. Sheet metal.
    e. Electrical cable trays, including access space.
    f. Sprinkler piping and other piping.
    g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:

    a. Condensing Units.
    b. Makeup Air Units.
    c. Gas Trains.
    d. Packaged Rooftop Units.

2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:

    a. Wiring of all devices needed to make the Temperature Control System functional.
    b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
    c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.

6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Provide coordination drawings showing the complete, coordinated installation of mechanical, electrical, plumbing, fire protection, and other systems within available building spaces.

B. Definitions:

1. Coordination Drawings: Coordination drawings are defined as composite drawings or models that incorporate work of multiple trades and demonstrate coordinated routing, elevations, and clearances.

    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Provide one complete, composite coordination drawing package for each building area, system, or phase demonstrating fully coordinated conditions.
3. The composite coordination drawing package may be created from multiple trade-specific electronic files; however, the final deliverable shall clearly represent a single coordinated installation.
4. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.

    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.

5. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

C. Participation:

1. The Contractor shall be responsible for coordinating all trades and preparing coordination drawings.

2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.

    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

D. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

    a. Scale of drawings:

        1) General plans: 1/4 Inch = 1'-0" (minimum).
        2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
        3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
        4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
        5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

E. General:

1. Provide coordination drawing files to the Architect/Engineer for review of identified conflicts. The Architect/Engineer will not act as the project coordinator and is not responsible for coordination of the work. The Architect/Engineer will review only clearly identified conflicts submitted by the Contractor and will not perform clash detection or coordination. The Architect/Engineer will not compile or reconcile multiple trade files and will rely on the Contractor's composite coordination drawing package.
2. The Contractor remains solely responsible for coordination regardless of any review or comment provided by the Architect/Engineer.
3. A plotted set of coordination drawings shall be available at the project site.
4. Coordination drawings are not shop drawings and are not subject to approval. Receipt or review of coordination drawings does not constitute approval of routing, layout, means, methods, sequencing, or constructability.

5. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
6. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
7. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
8. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
9. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
10. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.

11. Complete the coordination drawing process and obtain documented sign-off from all participating trades confirming that coordination drawings have been reviewed and coordinated prior to installation. Sign-off shall consist of signatures on the composite coordination drawing package or a coordination log identifying participating trades and acceptance of the coordinated layout.
12. Do not begin installation of work in an area until coordination drawings for that area are complete and trade sign-offs have been obtained.
13. Submit unresolved coordination conflicts to the Architect/Engineer for direction prior to installation. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination. Conflicts identified after installation due to incomplete coordination shall be corrected at no additional cost to the Owner.
14. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.7 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Arkansasinsert Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for service connections, such as gas.
4. Make application for and pay for all meters and metering systems required by the utility company.

F. Examination of Drawings:

1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.

    a. Any item listed as furnished shall also be installed, unless otherwise noted.
    b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.8 WEB-BASED PROJECT SOFTWARE

A. The General Contractor shall provide a web-based project software site for the purpose of hosting and managing project communication and documentation until completion of the warranty phase.

B. The web-based project software shall include, at a minimum, the following features: construction schedule, submittals, RFIs, ASIs, construction change directives, change orders, drawing management, specification management, payment applications, contract modifications, meeting minutes, construction progress photos.

C. Provide web-based project software user licenses for use by the Architect/Engineer. Access will be provided from the start of the project through the completion of the warranty phase.

D. At project completion, provide digital archive of entire project in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

1.9 SUBMITTALS

A. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:

1. Transmittal: Each transmittal shall include the following:

    a. Date
    b. Project title and number
    c. Contractor's name and address
    d. Division of work (e.g., plumbing, heating, ventilating, etc.)
    e. Description of items submitted and relevant specification number
    f. Notations of deviations from the contract documents
    g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

    a. Date
    b. Project title and number
    c. Architect/Engineer
    d. Contractor and subcontractors' names and addresses
    e. Supplier and manufacturer's names and addresses
    f. Division of work (e.g., plumbing, heating, ventilating, etc.)
    g. Description of item submitted (using project nomenclature) and relevant specification number
    h. Notations of deviations from the contract documents
    i. Other pertinent data
    j. Provide space for Contractor's review stamps

3. Composition:

    a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
b. Unstamped submittals will be rejected.
c. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.
2) Addenda items have been incorporated.
3) Catalog numbers and options match those specified.
4) Performance data matches that specified.
5) Electrical characteristics and loads match those specified.
6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
7) Dimensions and service clearances are suitable for the intended location.
8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
b. The Contractor shall clearly indicate the size, finish, material, etc.
c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.

    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.

16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

B. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

    a. Submittal file name: 23 XX XX.description.YYYYMMDD
    b. Transmittal file name: 23 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:

1. Air Cooled Condensers
2. Condensing Units
3. Fire Seal Systems
4. Seismic Restraints and Equipment Bracing

5. Vibration Isolation

B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.

C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

B. Protect equipment, components, and openings with airtight covers and exercise care at every stage of storage, handling, and installation of equipment to prevent airborne dust and dirt from entering or fouling equipment to include, but not limited to:

1. Motor windings and ventilation openings.
2. Bearings.
3. Equipment pipe and accessories connections openings. (e.g. boiler connections, coil connections, etc.)
4. Equipment duct and accessories connections openings. (e.g. AHU/RTU duct connections; terminal air boxes, etc.)
5. Starter and control cabinets.
6. Heat transfer coils.
7. Pump seals.
8. Combustion burner and blower equipment (e.g. combustion air intake, combustion vent/flue, etc.)

C. Equipment and components that are visibly damaged or have been subject to environmental conditions prior to building turnover to Owner that could shorten the life of the component (for example, water damage, humidity, dust and debris, excessive hot or cold storage location, etc.) shall be repaired or replaced with new equipment or components without additional cost to the building owner.

D. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

E. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, they shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

F. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.14 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractor's part or on the part of other Contractors whose work is affected.

E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.

F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.16 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 and 23 08 01 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:

a. Pipe insulation is installed and fully sealed.
b. Pipe and duct wall penetrations are sealed.
c. Pipe identification and valve tags are installed.
d. Main, branch and flexible ducts are installed.
e. Diffusers, registers and grilles are installed and connected to ductwork.
f. Terminal air box reheat coil piping or wiring is complete.
g. Terminal air box control wiring is complete and all control boxes are closed.

2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.3 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 01.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents includimarked-up drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Inspection by State Boiler Inspector.
5. Start-up reports on all equipment requiring a factory installation inspection or start-up.
6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; receipt by Architect/Engineer required prior to final payment approval.

3.4 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

    a. O&M file name: O&M.div23.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Refer to Section 230900 for additional requirements for Temperature Control submittals.
5. Copy of final approved test and balance reports.
6. Copies of all factory inspections and/or equipment startup reports.
7. Copies of warranties.
8. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
9. Dimensional drawings of equipment.
10. Capacities and utility consumption of equipment.
11. Detailed parts lists with lists of suppliers.
12. Operating procedures for each system.
13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
14. Repair procedures for major components.
15. List of lubricants in all equipment and recommended frequency of lubrication.
16. Instruction books, cards, and manuals furnished with the equipment.

3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Explanation of all air handling systems.
3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
4. Maintenance of equipment.
5. Smoke control systems.
6. Stairwell pressurization systems.
7. Start-up procedures for all major equipment.
8. Explanation of seasonal system changes.
9. Description of emergency system operation.

E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

F. Minimum hours of instruction for each item shall be:

1. <>Refrigeration System - 4 hours.
2. Air Handling System(s) - 4hours.
3. Heat Pump System - 4 4 hours.
4. Exhaust System(s) - 4t 4 hours.
5. Temperature Controls - As defined in Section 230900.

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.6 SYSTEM STARTING AND ADJUSTING

A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

C. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 60% RH.

D. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.

E. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

F. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for troubleshooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.7 RECORD DOCUMENTS

A. The following paragraphs supplement Division 01 requirements.

B. Maintain at the job site a separate and complete set of mechanical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

D. Refer to Section 230900 for additional requirements for Temperature Control documents.

E. Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

F. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

G. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

H. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.8 PAINTING

A. This Contractor shall paint the following items:

1. All piping in mechanical room
2. Piping exposed in kitchen

B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

D. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.

F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

G. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.

H. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

I. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:

1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.
3. Color of paint shall be as follows:

a. All piping in mechanical room:
   1) Natural Gas: Yellow pipe/black letters

b. Piping exposed in kitchen:

   1) All Piping: White

3.9 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed bare metal ductwork, piping, hangers, and accessories.

D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.11 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

   a. Minimizing the amount of dust generated.
   b. Reducing solvent fumes and VOC emissions.
   c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
   d. Protect stored on-site and installed absorptive materials from moisture damage.

2. Request that the Owner designate an IAQ representative.
3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.

4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
6. Request copies of and follow all of the Owner's IAQ and infection control policies.
7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".
10. If permanently installed air handlers are used to serve both construction and occupied areas, all return grilles throughout construction areas shall be sealed to prevent air from construction areas being supplied to occupied areas.
11. If permanently installed air handlers are used during construction to serve only construction areas and do not supply air to adjacent occupied areas, MERV 8 filtration media shall be used to protect each return air grille or opening. The intent of this will be to prevent construction dust and debris from entering any return or supply air ductwork in the facility. All filtration media shall be replaced immediately prior to occupancy.
12. Construction areas shall be maintained at a negative pressure at all times during construction. When areas are under construction, HEPA filtered exhaust fan(s) shall be installed in sufficient quantities as required to maintain construction areas at sufficient negative pressure as called for in the Owner's Infection Control Risk Assessment (ICRA). HEPA filtered exhaust fan discharge shall be ducted either outdoors or back into designated hospital areas as called for in the Owner's ICRA.
13. For each area under construction, the Contractor shall install a negative pressure indicator equivalent to Lamiflow Model L-102F as manufactured by Lamiflow Technologies. Contractor shall regularly monitor and record the negative pressure condition of the construction areas as called for in the Owner's ICRA.

3.12 MAINTAINING CLEAN DUCTWORK THROUGHOUT CONSTRUCTION

A. Throughout the duration of construction, all ductwork shall be capped or sealed with sheet metal caps, polyethylene film, or other airtight protective to keep dust, dirt, and construction debris out of ducts. Similar means shall be used to seal air-side connections of HVAC equipment to include, but not limited to, air handling units, fans, terminal air boxes, fan coil units, cabinet heaters, blower coils, and the like.

B. When air terminal devices are installed, contractors shall seal all supply, return, and exhaust grilles with polyethylene film or other airtight protective to keep dust, dirt, and construction debris out of ducts.

C. Should HVAC equipment be started during construction, Contractor shall remove airtight protectives and shall install one-inch thick MERV 8 filter media over all return and exhaust grilles to prevent dust, dirt, and construction debris from entering ductwork. Filter media shall cover the entire grille face and shall be secured such that air cannot bypass filter media.

D. Should filter media become laden with dust and dirt, Contractor shall replace filter media with new media to prevent damage to air distribution system and equipment.

E. The following steps shall be taken during testing, adjusting, and balancing of each air system:

1. All construction activities in all spaces served by the air system shall stop.
2. All airtight protectives and temporary filter media shall be removed from all portions of the air system.

3. Testing, adjusting, and balancing work shall not commence until all construction activity is stopped and all airtight protectives and temporary filter media is removed.
4. Once testing, adjusting, and balancing work is complete for the air system, airtight protectives or temporary filter media shall be installed over all ductwork openings and air terminals on the air system prior to resuming construction activities in any spaces served by the air system.

F. The Owner shall agree the building is sufficiently clean prior to the removal of any filtration media and airtight protectives from air terminal devices.

3.13 UTILITY REBATE

A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.

B. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

END OF SECTION

SECTION 230503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this Section.

B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

A. UL 263 - Fire Tests of Building Construction and Materials

B. UL 723 - Surface Burning Characteristics of Building Materials

C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops

D. UL 2079 - Tests for Fire Resistance of Building Joint Systems

E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)

F. Intertek / Warnock Hersey - Directory of Listed Products

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops

I. The Building Officials and Code Administrators National Building Code

J. Uniform Building Code

K. International Building Code, Current Adopted Edition

L. NFPA 5000 - Building Construction Safety Code

1.4 SUBMITTALS

A. Submit under provisions of Section 230500 .

B. Submit Firestopping Installers Certification for all installers on the project.

C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.

D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:

1. Types of penetrating items.
2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.

E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.

B. Install material prior to expiration of product shelf life.

1.6 PERFORMANCE REQUIREMENTS

A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.

B. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.7 MEETINGS

A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the , General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.

1. Review foreseeable methods related to firestopping work.

2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.8 WARRANTY

A. Provide one year warranty on parts and labor.

B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

1. 3M; Fire Protection Products Division.
2. Hilti, Inc.
3. Johns-Manville.
4. Dow Corning Corp.

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.

B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.

C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.

D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.

E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.

F. Provide firestopping systems allowing continuous insulation for all insulated pipes.

G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:

a. F Rating = Floor/Wall Rating
b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

a. F Rating = Wall Rating
b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

a. F Rating = Wall/Floor Rating
b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.

I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.

B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.

C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.

D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.

B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.

C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:

1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.

B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.

C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.

D. The Contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the Contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The Contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the Contractor's expense.

END OF SECTION

SECTION 230505 - HVAC DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mechanical demolition.

B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

C. Existing Heating System: Maintain existing system in service until new system is complete and ready for service. Drain system only to make switchovers and connections. Obtain permission from the Owner at least 48 hours before partially or completely draining system. Minimize outage duration.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Demolish and extend existing mechanical work under provisions of Division 2 and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned ducts and piping to source of supply and/or main lines.

D. Remove exposed abandoned pipes and ducts, including abandoned pipes and ducts above accessible ceilings. Cut ducts flush with walls and floors, cap duct that remains, and patch surfaces. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.

H. Remove unused sections of supply and return air ductwork back to mains. Patch opening with sheet metal and seal airtight. Patch existing insulation to match existing. Where existing ductwork is to be capped and reused, locate the end cap within 6" of the last branch. End caps shall be 3" pressure class and seal class "A".

I. Extend existing installations using materials and methods compatible with existing installations, or as specified.

J. Properly reclaim and dispose of all refrigerant in demolished equipment and as required for extension of existing equipment.

3.4 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 230529 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to structural plans for additional information.

F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.5 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. MECHANICAL ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

END OF SECTION

SECTION 230513 - MOTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single Phase and Three Phase Electric Motors.

1.2 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.

E. ANSI/NEMA MG 1 - Motors and Generators.

F. ANSI/NFPA 70 - National Electrical Code.

G. Energy Independence and Security Act of 2007.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 230500. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.

B. Submit shop drawings for all three phase motors.

C. Submit motor data with equipment when motor is installed by the manufacturer at the factory.

D. Submit shaft grounding rings or brushesfor all motors as required.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

PART 2 - PRODUCTS

2.1 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. Design motors for continuous operation in 40ºC environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.

D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

E. Unless otherwise indicated, motors 1/2HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.

F. Unless otherwise indicated, motors 3/4 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.

G. Each contractor shall set all motors furnished by him.

H. All motors shall have a minimum service factor of 1.15.

I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.

J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.

K. Aluminum end housings are not permitted on motors 15 HP or larger.

L. Motor Driven Equipment:

1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.

2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.

M. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.

N. Motors for fans and pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of varying motor speed.

2.2 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Electronically Commutated Motors (ECMs) shall be motors in which rotation and speed are controlled by integral electronic motor controllers utilizing electronic commutation.

B. ECMs shall utilize Permanent Magnet (PM), Synchronous Reluctance (SynRM), or Ferrite-Assisted Synchronous Reluctance (FASR) motor constructions.

C. ECMs shall be AC-powered motors with internal electronic conversion of AC power to DC for motor control. Motor input power shall be AC, at the scheduled voltage and phase. Field wiring shall be AC. Internal conversion to DC for electronic commutation shall be provided by the motor manufacturer. Motor shall be pre-wired for scheduled voltage and phase.

D. Motors shall be variable-speed, suitable for continuous operation over the scheduled operating range, and matched by the manufacturer with an integral electronic motor control module.

E. Electronics shall be factory-mounted and factory-matched to the motor. Control electronics shall include soft-start functionality, electronic current limiting, and motor protection functions as recommended by the motor manufacturer. Electronics shall be protected against moisture and contaminants in accordance with the application and motor enclosure rating.

F. ECMs shall be suitable for direct-drive applications unless otherwise indicated. Motors shall be permanently lubricated and provided with ball bearings suitable for the connected driven equipment.

G. Motors shall be permanently lubricated; utilize ball bearings to match with the connected driven equipment.

H. Operational mode shall be as scheduled and shall be one of the following:

1. Constant Flow
2. Constant Temperature
3. Constant Pressure

2.3 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

A. All motors, unless exempted by EPAct legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
HP	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0
20.0	92.4	93.0	91.0	91.7	93.0	91.0
25.0	93.0	93.6	91.7	93.0	93.6	91.7
30.0	93.6	94.1	91.7	93.0	93.6	91.7
40.0	94.1	94.1	92.4	94.1	94.1	92.4
50.0	94.1	94.5	93.0	94.1	94.5	93.0
60.0	94.5	95.0	93.6	94.5	95.0	93.6
75.0	94.5	95.0	93.6	94.5	95.4	93.6
100.0	95.0	95.4	93.6	95.0	95.4	94.1
125.0	95.0	95.4	94.1	95.0	95.4	95.0
150.0	95.4	95.8	94.1	95.8	95.8	95.0
200.0	95.4	95.8	95.0	95.8	96.2	95.4
250.0	95.4	95.8	95.0	95.8	96.2	95.8
300.0	95.4	95.8	95.4	95.8	96.2	95.8
350.0	95.4	95.8	95.4	95.8	96.2	95.8
400.0	95.8	95.8	95.8	95.8	96.2	95.8
450.0	96.2	96.2	95.8	95.8	96.2	95.8
500.0	96.2	96.2	95.8	95.8	96.2	95.8

B. Motor nameplate shall be noted with the above ratings.

2.4 MOTORS ON VARIABLE FREQUENCY DRIVES

A. All motors driven by VFDs shall be premium efficiency type.

B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.

C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.

D. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushesas a means to protect bearings from adverse shaft currents.

1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.
2. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

2.5 SHEAVES

A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.

B. When replacing sheaves, use sheaves of at least the originally supplied sizes.

C. Contractor responsible for motor shall also be responsible for replacement sheaves. Coordinate with testing and balancing of the equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION

SECTION 230529 - HVAC SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.

B. Equipment Bases and Supports.

C. Sleeves and Seals.

D. Flashing and Sealing of Equipment and Pipe Stacks.

E. Cutting of Openings.

F. Escutcheon Plates and Trim.

1.2 REFERENCES

A. ANSI/ASME B31.9 - Building Services Piping.

B. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

C. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.

D. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

E. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 230500. Include plastic pipe manufacturers' support spacing requirements.

1.4 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

A. Refer to Section 230550 for additional requirements for seismic restraints.

2.2 HANGER RODS

A. Hanger rods for single rod hangers shall conform to the following:
   1. Steel Pipe:

a. Hanger Rod Diameter:

1) 2" and smaller: 3/8"
2) 2-1/2" through 3-5/8": 1/2"
3) 4" through 6": 1/2"
4) 8": 5/8"
5) 10": 3/4"
6) 12": 7/8"
7) 14" and 16": 1"
8) 18" and 24": 1-1/4")

2. Copper, Plastic and Fiberglass Reinforced Pipe:

a. Hanger Rod Diameter:

1) 2" and smaller: 3/8"
2) 2-1/2" through 3-5/8": 1/2"
3) 4") through 6": 1/2"
4) 8": 5/8"
5) 10": 3/4"
6) 12": 7/8"
7) 14" and 16": 1"
8) 18" and 24": 1-1/4"

B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.

C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.3 PIPE AND STRUCTURAL SUPPORTS

A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.

a. Products:

1) Eaton Fig B3373 Series
2) nVent 510 Series

3) Anvil Fig. 90

2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

   a. Products:

      1) Mason RBA, RCA or RDA
      2) Mason BR

3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.

   a. Products:

      1) Pipeshields, Inc E1000, E1100, E1200, or E1300 (manufacturer to confirm based on pipe diameter and weight when in service)

4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.
5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp within their temperature limits of -65F to +225F.
3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
4. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

   a. Products:

      1) Anvil Fig. 160, 161, 162, 163, 164, 165
      2) Eaton Fig. 3160, 3161, 3162, 3163, 3164, 3165
      3) nVent Model 630, 631, 632, 633, 634, 635

5. Unless otherwise indicated, hangers shall be as follows:

   a. Clevis Type: Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and Smaller:

      1) Products: Bare Steel, Plastic or Insulated Pipe:

a) Anvil Fig. 260
b) Eaton Fig. 3100
c) Roller Type: Service: Insulated Hot Pipe - 4 inches and Larger:

2) Products: 4" through 6":

a) Anvil Fig. 181, 271
b) Eaton Fig. 3110
c) nVent Model 610

3) Products: 8" and Above:

a) Anvil Fig. 171, 271
b) Eaton Fig. 3114, 3117
c) nVent Model 605

b. Continuous Channel with Clevis Type: Service: Plastic Tubing, Flexible Hose, Soft Copper Tubing:

1) Products:

a) Eaton Fig. B3106, with Fig. B3106V
b) nVent Model 104, with Model 104V
c) Anvil Fig. 1V

c. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller:

1) Products: Bare Steel Pipe:

a) Anvil Fig. 69
b) Eaton Fig. B3170NF
c) nVent Model 115

2) Products: Bare Copper Pipe:

a) Eaton Fig. B3170CTC
b) nVent 102A0 Series
c) Anvil Fig. CT-69

6. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.

a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

7. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

a. Clamp Type: Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller:

1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.
2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
3) Products: Bare Steel, Plastic or Insulated Pipe:

a) Unistrut Fig. P1100 or P2500
b) Eaton Fig. B2000 or B2400
c) Anvil Fig. AS1200
d) nVent USC

4) Products: Bare Copper Pipe:

a) Eaton Fig. BVT
b) nVent CADDY Cushion Clamp

b. Roller Type: Service: Insulated Hot Pipe - 4 inches and larger:

1) Products: 4" through 6":

a) Unistrut Fig. P2474
b) Eaton Fig. B218
c) Anvil Fig. ROL-12
d) nVent ROL12

2) Products: 8" and Above:

a) Unistrut Fig. P2474-1
b) Eaton Fig. B219
c) nVent Fig. ROL-13
d) Anvil AS1902

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):

1) Products:

a) Anvil Fig. 86
b) Eaton Fig. B3033/B3034
c) nVent Model 300 & 310

b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):

1) Products:

a) Anvil Fig. 228, 292
b) Eaton Fig. B3054
c) nVent Model 360

c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):

1) Products:

a) MCL. M1, M2 or M3

d. Concrete: Inserts Continuous Strip Galvanized:

1) Products:

a) Anvil AS249

e. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-20. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

f. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

g. Steel Structure Welding:

1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

h. Wood Anchors: Tension wood rod hanger for suspending 3/8" threaded rod. Zinc plated carbon steel.

1) Minimum allowable tension loads for Douglass Fir/Southern Pine:

a) 3/8" diameter rod; 2-1/2" shank: 600 lb/590 lb.
b) Load values are based on full shank penetration into wood member. Minimum edge distance 3/4". Minimum end distance 3-1/4".

2) Limitations:

a) Truss: Do not hang from wood trusses without truss manufacturer or Structural Engineer’s approval.
b) Sheetrock/Gypsum Ceiling: When drilling through non-wood materials (e.g., sheet rock, gypsum, etc.), increase shank length by depth of non-wood materials.
c) Plywood Flooring/Roofing: Do not hang from plywood floor or roofing.
d) Spacing: Refer to wood structure spacing of hangers.

3) Products:

a) Simpson RWV
b) DeWALT
c) ITI Sammys GT25

2.4 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Refer to Section 230550 for additional requirements for concrete bases in seismic applications.
2. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 6 inches on all sides of the equipment (6 inches larger than factory base), except where pad extension would interfere with working space at equipment control panels and electrical panels.
3. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days (be 20 MPa strength). Provide minimum 1/2" 45 degree angled or 1/2" radius chamfer on exposed horizontal edges.
5. New Bases in Existing Buildings: For proper bonding of new equipment bases to existing concrete floors: Existing concrete shall be thoroughly cleaned, scarified, and a bonding agent applied, in accordance with manufacturer's instructions, prior to placing new concrete. Bonding agent shall be "Weld-Crete" as manufactured by the Larsen Products Corporation or "Nitobind Acrylic" as manufactured by Fosroc Inc. or approved equivalent.
6. Equipment requiring bases is as follows:

C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.5 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

F. Exposed Housing Penetrations: Seal pipes with surface temperature below 150F, penetrating housings with conical stepped, white silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite.

2.6 ROOF PENETRATIONS

A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for pipe and duct penetrations. Refer to drawings for details.

B. Conical Pipe Boot: Seal pipes with surface temperature below 150F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: shall match roofing material.

C. Break insulation only at the clamp for pipes between 60F and 150F. Seal outdoor insulation edges watertight.

2.7 SLEEVES AND LINTELS

A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.

F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.

G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.

I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

J. Wall Seals ("Link-Seals"):

1. Underground foundation wall penetrations and where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be at least 2 pipe sizes larger than the service pipe and shall include a waterstop/anchor around the mid section of the sleeve, continuously welded to or integral formed with the sleeve. Sleeve material options based on fluid carrying pipe design temperature.
3. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
4. Sealing element shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40F to 250F
T	High/Low Temperature (Steam)	Silicone	-67F to 400F
T	Fire Seals (1 hour)	Silicone	-67F to 400F
FS	Fire Seals (3 hours)	Silicone	-67F to 400F
OS	Oil Resistant/Stainless	Nitrile	-40F to 210F

5. Manufacturers:

a. Garlock Pipeline Technologies (GPT) "Link-Seals"
b. O-Z/Gedney Company
c. Calpico, Inc.
d. Innerlynx
e. Metraflex
f. Flexicraft
g. Polywater

2.8 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.9 PIPE PENETRATIONS

A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.10 PIPE ANCHORS

A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.11 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 HVAC SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with Sheet Metal Contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.

5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. For attachments to joists that are concentrically loaded on the joist, a max of 100 lbs may be attached to the joist within a chord panel.
2. For attachments to joists that are eccentrically loaded, a max of 25 lbs may be attached to the joist within a chord panel without an additional angle.
3. Multiple attachments are allowed in each chord panel as long as the sum of the loads do not exceed the max load indicated.
4. For loads between 100 lbs - 200 lbs, additional L2x2x3/16" (L51xL51x4.8) ASTM A36 structural steel angles are required and joist must be concentrically loaded.
5. For loading conditions noted above, total sum of loads shall not exceed 200 lbs for an 8 ft segment for joist. For loads greater than 200 lbs and not noted on the drawings, contact engineer prior to installation.
6. No loads shall be supported from joist bridging.
7. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
8. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):

a. Maximum Spacing:

1) 1-1/4" & under: 7'-0"
2) 1-1/2": 9'-0"
3) 2": 10'-0"
4) 2-1/2": 11'-0"
5) 3": 12'-0"
6) 4" & larger: 12'-0"

2. Steel (Std. Weight or Heavier - Vapor Service):

a. Maximum Spacing:

1) 1-1/4" and under: 9'-0"
2) 1-1/2": 12'-0"
3) 2" & larger: 12'-0"

3. Hard Drawn Copper & Brass (Liquid Service):

a. Maximum Spacing:

1) 3/4" and under: 5'-0"
2) 1": 6'-0"
3) 1-1/4": 7'-0"
4) 1-1/2" 8'-0"
5) 2": 8'-0"
6) 2-1/2": 9'-0"
7) 3": 10'-0"
8) 4": 12'-0"
9) 6": 12'-0"

4. Hard Drawn Copper & Brass (Vapor Service):

a. Maximum Spacing:

1) 3/4" & under: 7'-0"
2) 1": 8'-0"
3) 1-1/4": 9'-0"
4) 1-1/2": 10'-0"
5) 2": 11'-0"
6) 2-1/2" & larger: 12'-0"

5. Plastic Pipe:

a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

6. Ultra-Flexible Pipe, Flexible Hose, and Soft Copper Tubing:

    a. Continuous channel with hangers maximum 8'-0" OC.

I. Wood Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):

    a. Maximum Spacing:

        1) 1-1/4" & under: 7'-0"
        2) 1-1/2": 9'-0"
        3) 2": 10'-0"
        4) 2-1/2": 11'-0"
        5) 3": 12'-0"
        6) 4" through 6": 12'-0"8": 9’-0"10": 6’-0"12": 4’-0"

2. Steel (Std. Weight or Heavier - Vapor Service):

    a. Maximum Spacing:

        1) 1-1/4" and under: 9'-0"
        2) 1-1/2": 12'-0"
        3) 2" & larger: 12'-0"
        4) 2-1/2": 11'-0"
        5) 3": 12'-0"
        6) 4" through 8": 12'-0"
        7) 10": 9’-0"
        8) 12": 6’-0"

3. Hard Drawn Copper & Brass (Liquid Service):

    a. Maximum Spacing:

        1) 3/4" and under: 5'-0"
        2) 1": 6'-0"
        3) 1-1/4": 7'-0"
        4) 1-1/2" 8'-0"
        5) 2": 8'-0"
        6) 2-1/2": 9'-0"
        7) 3": 10'-0"
        8) 4": 12'-0"
        9) 6": 12'-0"

4. Hard Drawn Copper & Brass (Vapor Service):

    a. Maximum Spacing:

        1) 3/4" & under: 7'-0"
        2) 1": 8'-0"
        3) 1-1/4": 9'-0"

4) 1-1/2": 10'-0"
5) 2": 11'-0"
6) 2-1/2" & larger: 12'-0"

5. Plastic Pipe:

a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

6. Ultra-Flexible Pipe, Flexible Hose, and Soft Copper Tubing:

a. Continuous channel with hangers maximum 8'-0" OC.

J. Wood Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):

a. Maximum Spacing:

1) 1-1/4" & under: 7'-0"
2) 1-1/2": 9'-0"
3) 2": 10'-0"
4) 2-1/2": 11'-0"
5) 3": 12'-0"
6) 4" through 6": 12'-0"

2. Steel (Std. Weight or Heavier - Vapor Service):

a. Maximum Spacing:

1) 1/2" and under: 6'-0"
2) 3/4" to 1": 8'-0"
3) 1-1/4" and under: 9'-0"
4) 1-1/2": 10'-0"
5) 2" & larger: 10'-0"
6) 3": 12'-0"
7) 4" through 8": 12'-0"

3. Hard Drawn Copper & Brass (Liquid Service):

a. Maximum Spacing:

1) 3/4" & under: 5'-0"
2) 1": 6'-0"
3) 1-1/4": 6'-0"
4) 1-1/2": 6'-0"
5) 2": 8'-0"
6) 2-1/2": 9'-0"
7) 3": 10'-0"
8) 4": 10'-0"

4. Hard Drawn Copper & Brass (Vapor Service):

a. Maximum Spacing:

1) 3/4" & under: 6'-0"
2) 1": 6'-0"
3) 1-1/4": 6'-0"
4) 1-1/2": 6'-0"
5) 2": 10'-0"

K. Installation of hangers shall conform to MSS SP-58, 69, and 89.

END OF SECTION

SECTION 230530 - ROOF SUPPORT AND WIND BRACING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wind Restraint of Rooftop Equipment

B. Rooftop Access and Service Platforms

C. Rooftop Duct Support

D. Rooftop Pipe Support

E. Rooftop Equipment Support

1.2 QUALITY ASSURANCE

A. General:

1. The Contractor shall retain a specialty consultant or equipment manufacturer to develop a wind restraint and support system and perform wind restraint calculations in accordance with these specifications, state, and local codes.
2. These requirements are beyond those listed in Section 230550 of these specifications. Where a conflict arises between the wind restraint of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this section.
2. Equipment: Each company providing equipment that must meet wind restraint requirements shall provide certification included in project submittals that the equipment supplied for the project meets or exceeds the wind restraint of the project.

C. Installer: Installed by Contractor.

1.3 REFERENCES

A. International Building Code, Current Adopted Edition

B. HCAI - Health Care Access and Information (California)

C. ASCE 7-16, Chapter 29

1.4 SUBMITTALS

A. Submit under provisions of Section 230500.

B. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a Structural Engineer licensed in the state where the project is located and experienced in wind restraint design and installation.
2. Coordination Drawings: Plans and sections drawn to scale, coordinating wind restraint bracing of mechanical components with other systems and equipment in the vicinity, including other wind restraint restraints.
3. Manufacturer's Certifications: Structural Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
4. System Supports/Restraints - Submit for each condition requiring wind restraint bracing:

    a. Calculations for each wind restraint brace and detail used on the project.
    b. Plan drawings showing locations and types of wind restraint braces on contractor fabrication/installation drawings.
    c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
    d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

5. Equipment - Submit for each piece of equipment supplied:

    a. Certification that the equipment supplied for the project meets or exceeds the wind restraint requirements specified.
    b. Specific details of wind restraint design features of equipment and maximum wind restraint loads imparted to the structural support.
    c. Engineering calculations and details for equipment anchorage and support structure.

C. A wind restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If wind restraint restraints are not provided for a system that requires wind restraint bracing, the wind restraint designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, used for each item. Wind restraint designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance with the exception.

1.5 TESTING AND INSPECTION

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.7 DESIGN REQUIREMENTS

A. This project is subject to the wind loading requirements of the International Building Code, current adopted edition.

B. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

1.8 COORDINATION

A. Coordinate layout and installation of anchoring with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

1.9 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SUPPLIERS

A. Miro Industries

2.2 DESIGN CRITERIA

A. The following design criteria applies to all equipment noted below.

B. General Information:

1. Adopted Building Code:
2. Building Occupancy Risk Category: II

C. Wind Design Criteria:

1. Mean Roof Height: 25 feet
2. Basic Wind Speed: 107 MPH @ 3-second gust
3. Exposure Category: C

D. Seismic:

1. Refer to Section 230550 "Seismic Requirements For Equipment And Supports" for additional seismic requirements.

2.3 ACCESS AND SERVICE STAIRS AND PLATFORMS

A. Provide prefabricated OSHA 1910 compliant structure over obstructions and access to equipment installed on the roof as shown on the drawings. Supports include stanchioned supports anchored to the roof structure. Refer to drawings for stairs and/or service platform size, layout, and roofing material.

B. Roof equipment support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain access and service stair and platforms for uplift and lateral loading.

C. Frame and Railing: Support frame and platform shall be hot dipped galvanized steel minimum 12-gauge channel or tube steel. Manufacturer shall determine final design.

D. Decking: Support decking shall be minimum 1" thick, non-slip hot dipped galvanized bar grating.

E. Minimum clear height above obstructions shall be 24 inches .

F. Acceptable Manufacturer:

1. Miro Industries Stanchioned Crossover Stairs

2.4 ROOF DUCT SUPPORTS

A. Roof duct support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop duct system for uplift and lateral loading.

B. Refer to drawings for duct size, layout, structural framing, roofing material, and wind and seismic loading information.

C. Provide adjustable pre-fabricated roof duct supports for all duct installed on the roof. Supports include a combination of non-penetrating pillow block duct supports and stanchioned supports anchored to the roof structure.

D. Supports shall be constructed from hot dipped galvanized steel minimum 12-gauge channel or tube steel. Manufacturer shall determine final design.

E. Pillow block base shall be UV resistant polycarbonate rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.

F. Acceptable Manufacturer:

1. Miro Industries DS and Stanchioned DS

2.5 ROOF PIPING SUPPORTS

A. Non-Penetrating Pillow Block Supports:

1. Provide pre-fabricated non-penetrating pillow block roof pipe supports for all piping installed on the roof.
2. Pillow block base shall be UV resistant polycarbonate rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
3. Acceptable Products:

    a. Anvil International HBS-Base Series
    b. Cooper B-Line Dura-Blok
    c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load)
    d. Miro Industries 1.5, 3-R, 4-R or 5-R (to match pipe)

B. Premanufactured Anchored Roof Pipe Supports:

1. Roof duct support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop piping system for uplift and lateral loading.
2. Refer to drawings for pipe size, layout, structural framing, roofing material, and wind and seismic loading information.
3. Provide adjustable pre-fabricated pipe supports for all pipe installed on the roof. Supports include a combination of non-penetrating pillow block pipe supports and stanchioned supports anchored to the roof structure.

a. Supports shall be constructed from hot dipped galvanized steel minimum 12-gauge channel or tube steel. Manufacturer shall determine final design.

4. Pillow block base shall be UV resistant polycarbonate rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
5. Acceptable Manufacturer:

a. Miro Industries DS and Stanchioned DS

2.6 ROOF EQUIPMENT SUPPORTS

A. Premanufactured Equipment Roof Support Frames:

1. Roof equipment support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop equipment for uplift and lateral loading.
2. Refer to drawings for equipment size, layout, structural framing, roofing material, and wind speed.
3. Provide adjustable prefabricated roof equipment supports for all equipment installed on the roof. Supports include stanchioned supports anchored to the roof structure.
4. Frame: Support frame shall be hot dipped galvanized steel minimum 12 gauge channel or tube steel. Manufacturer shall determine final design.
5. Decking: Support decking shall be minimum 1" thick, non-slip hot dipped galvanized bar grating.
6. Equipment requiring support frames is as follows:

a. Condensing units
b. VRF outdoor units
c. Split system outdoor units

7. Minimum clear height above roof shall be 24 inches .
8. Acceptable Manufacturer:

a. Miro Industries LD/HD

B. Equipment Roof Curbs and Rails:

1. Equipment requiring curbs or rails with this section is as follows:

a. Condensing units

2. Provide prefabricated curbs or rails as follows:

a. Roof Mounting Curb: Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.
b. 14 or 18 gauge galvanized sheet metal, as required for the equipment weight.
c. Internal reinforcing.
d. Pressure treated wood nailer.
e. 18 gauge counter flashing completely covering nailer.
f. Factory insulated with rigid fiberglass.

3. Refer to drawings for curb and rail heights.

4. Match units to the building roof with either a raised cant to match roof insulation (for built-up roofs) or with no cant (for single-ply roofs).
5. Where legs of equipment rest on rails, provide 1/4" bent plates 18" long.
6. Manufacturers:

    a. Thy
    b. Pate
    c. United
    d. Roof Products Systems
    e. Portals Plus

C. Rooftop Air Handling Units:

1. Standard Curb: Rooftop equipment such as packaged air handling units shall be provided with curbs by the unit manufacturer. Refer to individual equipment sections for curb description.
2. External Vibration Isolation Curb: Refer to Vibration Isolation section for vibration isolation curbs equipment. Rooftop equipment such as large air handling units shall be provided with vibration isolation curbs. Equipment provided with vibration isolation curbs:
3. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.
4. This section shall provide anchoring such as Z-clip wind restraint brackets, guy wires, tethers or straps to limit wind disruption.
5. Roof equipment support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop equipment for uplift and lateral loading.

D. Exhaust Fans, Roof Hoods, Etc.:

1. Curb provided with equipment. Rooftop equipment such as roof hoods and rooftop exhaust fans shall be provided with curbs by the unit manufacturer. Refer to individual equipment sections for curb description.
2. This section shall provide anchoring such as guy wires, tethers, or straps to limit wind disruption.
3. Roof equipment support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop equipment for uplift and lateral loading.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all items per manufacturer's instructions.

B. All wind restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

C. Installation of wind restraints shall not cause any change in position of equipment, piping, or ductwork resulting in stresses or misalignment.

D. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

E. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast-in-place inserts.

F. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only. Do not install cables over sharp corners.

G. Provide reinforced clevis bolts when required.

H. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.

I. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent piping.

J. Positively attach all roof-mounted equipment to roof curbs. Positively attach all roof curbs to building structure.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

L. Supports shall extend directly to building structure.

M. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the drawings as being by others.

N. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.

O. Roof Supports: Install per manufacturer's requirements. Coordinate with Roofing Contractor.

3.2 ROOF PIPING SUPPORTS

A. Roof Supports: Install per manufacturer's requirements. Coordinate with Roofing Contractor.

B. Install roof pipe supports to resist wind movement per manufacturer's recommendations. Method of securing base to roof shall be compatible with roofing materials.

C. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

D. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories, to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.

E. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.

F. Support piping at equipment and valves so it can be disconnected and removed without further supporting the piping.

G. Piping shall not introduce strains or distortion to connected equipment.

H. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, and at equipment connections and heavy fittings.

I. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

J. Spacing: Refer to Supports and Anchors section for pipe spacing requirements.

3.3 INSPECTION

A. Special inspection and testing shall be done in accordance with Chapter 17 of the Building Code.

B. The Owner shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.

C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.

D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

END OF SECTION

SECTION 230548 - HVAC VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Bases.

B. Vibration Isolation.

C. Flexible Connectors.

1.2 SUBMITTALS

A. Submit shop drawings per Section 230500 and the Vibration Isolation Submittal Form at the end of this section.

B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.

C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.

D. Isolator submittals shall include:

1. Equipment served
2. Type of Isolator
3. Load in Pounds per Isolator
4. Recommended Maximum Load for Isolator
5. Spring Constants of Isolators (for Spring Isolators)
6. Load vs. Deflection Curves (for Neoprene Isolators)
7. Specified Deflection
8. Deflection to Solid (at least 150% of calculated deflection)
9. Loaded (Operating) Deflection
10. Free Height
11. Loaded Height
12. Kx/Ky (horizontal to vertical stiffness ratio - for spring isolators)
13. Materials and Coatings
14. Spring Diameters

E. Make separate calculations for each isolator on equipment where the load is not equally distributed.

F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.

G. Submit certification that equipment, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.3 EQUIPMENT SUPPLIERS' INSPECTION

A. The vibration isolation vendor shall inspect and approve the installation of the vibration isolators and shall submit a report to the Engineer and Owner which verifies that all of the M2-M4 mountings and H1-H3 hangers have been properly installed and that the installation is in full conformance with the specification. The report shall record the vibration isolator identification and model or type. For isolators containing steel springs the report shall also record the size and uncompressed height, design static deflection, and measured static deflection of the isolators provided.

PART 2 - PRODUCTS

2.1 BASIC CONSTRUCTION AND REQUIREMENT

A. Vibration isolation for this project is subject to seismic restraint requirements of Section 230550.

B. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

C. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.

D. The lateral to vertical stiffness ratio (Kx/Ky) of spring isolators shall be between 0.8 and 2.0.

E. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

F. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.

G. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.

H. Provide motor slide rails for belt-driven equipment per Section 230513.

I. All isolators, except M1, shall have provision for leveling.

2.2 MOUNTINGS

A. Type M2:

1. Double deflection neoprene with minimum static deflection of 0.15" at calculated load and 0.35" at maximum rated load.
    a. All metal shall be neoprene covered. Mounting shall have friction pads both top and bottom.
2. All units shall have bolt holes and be bolted down.
3. Use steel rails above the mountings to compensate for the overhang of equipment such as small vent sets and close coupled pumps.
4. Manufacturers:

    a. Mason Industries "ND" or "DNR"
    b. VMC/Amber-Booth "RVD"
    c. Kinetics "RD"
    d. Vibration Mountings and Controls "RD"
    e. Vibration Eliminator Co. "T22" or "T44"

B. Type M3:

1. Free standing, laterally stable spring isolators without housings and complete with 1/4" neoprene friction pads.
2. Units shall have bolt holes but need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators. Bolt holes shall not be within the springs.
3. All mountings shall have leveling bolts.
4. Manufacturers:

    a. Mason "SLFH"
    b. Kinetics "FDS"
    c. VMC/Amber-Booth SW-3 4"
    d. Vibration Eliminator Co. "OST"

C. Type M4:

1. Use restrained spring mountings for equipment with operating weight different from the installed weight such as chillers and boilers, and equipment exposed to the wind such as cooling towers.
2. Spring isolators shall be free-standing with 1/4" neoprene acoustical friction pads.
3. All units shall have bolt holes and be bolted down. Prevent short circuiting with neoprene bushings and washers between bolts and isolators.
4. All mountings shall have leveling bolts.
5. Housings with vertical resilient limit stops shall prevent spring extension when weight is removed. Housings shall serve as blocking during erection and the installed and operating heights shall be the same.
6. Maintain a minimum clearance of 1/2" around restraining bolts and between the housings and the springs so as not to interfere with the spring action.
7. Limit stops shall be out of contact during normal operation.
8. Select isolators for equipment subjected to wind loads in conformance with ASCE 7-02.
9. Manufacturers:

    a. Mason "SLRS"
    b. Kinetics "FLS"

c. Aeroflex "AWRS"
d. Vibration Eliminator Co. "KW"

2.3 VIBRATION ISOLATION CURBS

A. Spring Isolated Curbs:

1. Provide factory fabricated vibration isolated curb consisting of an upper floating section resting on a rigid rectangular steel tube structure containing adjustable steel vibration isolation springs.
2. Roof Mounting Curb: Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.
3. Vibration Isolation:

    a. Isolators shall consist of free standing, unhoused laterally stable steel springs.
    b. Springs shall be zinc electroplated.
    c. Springs shall rest on a minimum of 1/4" neoprene pad.
    d. Springs shall provide a minimum of 1-1/2" deflection calculated based on final assembled loads.

4. Provide continuous wood nailing strip and counter flashing along entire perimeter of the curb.
5. Provide continuous air and water seal, such as an EPDM bellows, around the entire curb.
6. Curb assembly shall withstand 125#/sf lateral wind loading against the supported equipment.
7. The curb shall be designed with lateral restraint to meet seismic requirements specified in Section 230550.
8. Coordinate internal structural cross framing with ductwork and piping routed in the curb.
9. Manufacturers:

    a. Mason Industries, Inc. - Type RSC
    b. Vibration Elimination Company - BERC
    c. ThyCurb - Vibro Curb II
    d. Kinetics - SSR.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Provide vibration isolation as indicated on the drawings and as described herein.

C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.

D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.

F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as rectangular ducts or pipes supported on a strut rack.

3.2 VIBRATION ISOLATION OF DUCTWORK

A. The first three hangers on all fan systems shall be Type H1 with at least 0.20" minimum static deflection.

B. Provide flexible duct connections as described in Section 233300 at all fan inlets and outlets and on the mechanical room side of all locations where ducts penetrate mechanical room walls.

3.3 VIBRATION ISOLATION SCHEDULE

A. Packaged HVAC Unit (less than 10 HP):

1. Base Type: NA
2. Isolator Type: M3 or H2 or H3
3. Static Deflection: 0.75"
4. Flexible Connections: Per Section 233300

B. Packaged HVAC Unit (greater than 15 HP, less than 4" static pressure):

1. Base Type: NA
2. Isolator Type: M3 or H2 or H3
3. Static Deflection: Refer to ASHRAE Table
4. Flexible Connections: Per Section 233300

C. Condensing Unit (Roof Mounted):

1. Base Type: NA
2. Isolator Type: M4
3. Static Deflection: 0.75"
4. Flexible Connections: NA

END OF SECTION

SECTION 230550 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Seismic Requirements.

1.2 QUALITY ASSURANCE

A. General:

1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.
2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for seismic restraint.
3. These requirements are beyond those listed in Section 230529 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.
2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

C. Testing Agency: An independent testing agency, acceptable to Authorities Having Jurisdiction, with experience and capability to conduct the testing indicated.

D. Installer: Company specializing in performing the work of this Section.

1.3 REFERENCES

A. International Building Code, Current Adopted Edition.

B. ASHRAE - A Practical Guide to Seismic Restraint.

C. Technical Manual 5-809-10, NAVFAC P-355, Air Force Manual 88-3, Chapter 13.

D. ASCE 7-02, Chapter 9.

E. ASCE 7-05, Chapter 13.

F. ASCE 7-10, Chapter 13.

G. ASCE 7-16, Chapter 13.

H. SMACNA - Seismic Restraint Manual Guidelines for Mechanical Systems.

I. NFPA 13 - Installation of Sprinkler Systems.

J. NFPA 14 - Standpipe and Hose Systems.

1.4 SUBMITTALS

A. Submit under provisions of Section 230500.

B. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a Structural Engineer licensed in the state where the project is located experienced in seismic restraint design and installation.
2. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of mechanical components with other systems and equipment in the vicinity, including other seismic restraints.
3. Manufacturer's Certifications: Structural Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
4. System Supports/Restraints - Submit for each condition requiring seismic bracing:

    a. Calculations for each seismic brace and detail utilized on the project.
    b. Plan drawings showing locations and types of seismic braces on contractor fabrication/installation drawings.
    c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
    d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

5. Equipment - Submit for each piece of equipment supplied:

    a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified.
    b. Specific details of seismic design features of equipment and maximum seismic loads imparted to the structural support.
    c. Engineering calculations and details for equipment anchorage and support structure.

C. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance to the exception.

1.5 TESTING AND INSPECTION

A. Special Inspection and Testing shall be done in accordance with Chapter 17 of the Building Code.

B. The Owner shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.

C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.

D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.7 DESIGN REQUIREMENTS

A. This project is subject to the seismic bracing requirements of the International Building Code, current adopted edition.

B. The following criteria are applicable to this project:

1. Risk Category: II
2. Seismic Importance Factor: $I_E = 1.0$
3. Seismic Design Category: C
4. Component Amplification Factors (ap) and Component Response Modification Factors (Rp) shall be taken from Table 13.5-1 in ASCE 7-16 for the individual equipment or system being restrained.
5. Component Importance Factors (Ip) shall be taken from Section 13.1.3 in ASCE 7-16 for the individual equipment or system being restrained.
6. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

C. Forces shall be calculated with the above requirements and Equation 13.3-1, -2, and -3 of ASCE 7-16, unless exempted by 13.1.4.Equipment shall meet International Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

1.8 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.

1.9 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SUPPLIERS

A. Following is a partial list of manufacturer/supplier contact information for seismic restraints:

1. B-Line Systems, Inc. (800) 851-7415, www.b-line.com.
2. Unistrut Corporation http://www.unistrut.us/
3. Kinetics Noise Control (877) 457-2695, www.kineticsnoise.com.
4. Mason Industries, Inc. www.mason-ind.com.
5. Loos & Co., Inc. (800) 321-5667, www.loosnaples.com.
6. Tolco (909) 737-5599, www.tolco.com
7. ISAT 877.523.6060, www.isatsb.com
8. Vibro-Acoustics (416) 291-7371 , https://virs.vibro-acoustics.com/

2.2 SEISMIC DESIGN CRITERIA

A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.

B. Definitions

1. Stay in Place:

a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.

2.3 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record; refer to submittal requirements.
2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer's submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.
3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.
5. All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code.

B. Friction from gravity loads shall not be considered resistance to seismic forces.

C. Housekeeping Pads:

1. Reinforced housekeeping pads shall be provided to handle shear, tension, and compression forces with proper reinforcement, doweling, and attachments connecting the pad to the structural slab.
2. New Bases for Existing Buildings: In addition to forces noted above, proper bonding of new equipment bases to existing concrete floors shall include: Existing concrete shall be throughly cleaned, scarified, and a bonding agent applied, in accordance with manufacturer's instructions, prior to placing new concrete. Bonding agent shall be "Weld-Crete" as manufactured by the Larsen Products Corporation or "Nitobond Acrylic" as manufactured by Fosroc Inc. or approved equivalent.

2.4 SEISMIC RESTRAINT AND CONSTRUCTION OF EQUIPMENT

A. Equipment supplied for the project shall be designed to meet the requirements of lateral forces calculated using the applicable code and method described above.

B. The following is a partial list of equipment that shall be restrained and that shall be constructed to meet seismic forces described in this section:

1. Air Handling Units

2.5 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless steel.

2.6 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125, Grade A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.7 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch-thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.

1. Materials for Channel: ASTM A 1011, GR 33.
2. Materials for Fittings and Accessories: ASTM A 635, ASTM A 576, or ASTM A 36.
3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.

1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
2. Wire Rope Cable: Comply with ASTM A 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.

D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of piping, ductwork, conduit, equipment, etc.

B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.

C. All rigid floor mounted equipment shall have a resilient media between the equipment mounting hole and the anchor bolt in concrete.

D. All seismic restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

E. Installation of seismic restraints shall not cause any change in position of equipment, piping, or ductwork, resulting in stresses or misalignment.

F. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

G. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified.

H. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Architect/Engineer's attention prior to specific equipment selection.

I. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

J. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.

K. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit.

L. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.

M. Do not install cables over sharp corners.

N. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.

O. Provide reinforced clevis bolts when required.

P. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.

Q. Post-Installed anchors shall be provided to meet seismic requirements.

R. Vertical pipe risers flexibly supported to accommodate thermal motion and/or pipe vibration shall be guided to maintain pipe stability and provide horizontal seismic restraint.

S. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

T. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent piping.

U. Water tanks shall be secured to their saddles by welding or proper concrete attachment, and those saddles shall be properly attached to the structure.

V. Brace all terminal units with water coils as required by the building code and provide flexible connection to the coil if bracing is required.

W. Independently brace duct mounted equipment (terminal units, in-line fans, etc.) and the associated suspended ductwork.

X. Do not brace a system to two different structures such as a wall and a ceiling.

Y. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

Z. Positively attach all roof mounted equipment to roof curbs. Positively attach all roof curbs to building structure.

AA. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.

BB. Coordinate seismic bracing of architecturally exposed ductwork with the Architect/Engineer.

3.2 SEISMIC RESTRAINT EXCLUSIONS

A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

END OF SECTION

SECTION 230553 - HVAC IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Identification of products installed under Division 23.

1.2 REFERENCES

A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

B. ASTM B-1, B-3, and B-8 for copper conductors.

C. ASTM D-1248 for Polyethylene Extrusion Materials, ICEA S-70-547 Weatherproof Resistant Polyethylene Conductors, ICEA S-61-402/NEMA WC5 Thermoplastic Insulated Wire & Cable, ICEA S-95-658/NEMA WC70 Non-Shielded 0 - 2kV Cables.

D. CGA Pamphlet C-9, Standard Color-Marking of Compressed Gas Cylinders for Medical Use.

E. NFPA-99 - Health Care Facilities.

F. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 230500. Include list of items identified, wording, letter sizes, and color coding.

B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 3M

B. Kolbi Industries

C. Seton

D. Marking Services.

2.2 MATERIALS

A. General:

1. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

2. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
3. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
4. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

B. Pipe Markers:

1. All pipe markers shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4"

2. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
3. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.
4. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.
5. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item.
6. Tracer Wire:

    a. Single copper conductors shall be solid or stranded annealed or hard uncoated copper per UL83 and ASTM requirements. Tracer tape or copper-coated steel wire is not acceptable.
    b. Conductor shall be insulated with HMWPE as specified and applied in a concentric manner. The minimum at any point shall not be less than 90% of the specified average thickness in compliance with UL 83.
    c. Tracer wire shall be continuously spark tested at 7500 Volts DC. Other electrical and mechanical tests shall be in accordance with UL 1581.

C. Ductwork Markers:

1. Ductwork systems shall be provided with preprinted, color-coded lettering indicating service, equipment serving, and arrow showing flow direction. Refer to Part 3 for installation information.
2. Self-Adhesive Vinyl Duct Labels: Colored vinyl with permanent Contact-type permanent pressure-sensitive adhesive backing suitable for indoor and outdoor application compatible with label and with substrate. Stencil painted markers are not permitted on ductwork systems.
3. Maximum Temperature: Able to withstand temperatures up to 160F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch 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 1-1/2 inches high beyond 72 inches viewing distance. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
7. Ductwork systems containing hazardous materials shall be provided with minimum 2" x 4" ANSI Z535.2 biohazard warning labels with custom labeling describing hazard. Refer to Part 3 for system and label description.

D. Ceiling Markers:

1. Label Style:

a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves. An arrow can be used to point to the tile needing removal.
b. The label tape shall be approximately 1/2" wide with all capitalized letters approximately 3/16” tall.
c. Ceiling grid labels shall be made with a label maker with durable adhesive labels having a clear background and black letters.
d. Equipment labels shall be as designated on the drawings (e.g., FCU-606B, etc.).
e. Valve labels shall be designated by the size, service, and the valve tag number (e.g., 1-1/4" CW #123, 2" HWS #234, etc.). A single longer label can be used to identify multiple valves using spaces between the descriptors if the valves are located close together and have the same service (e.g., HWS and HWR valves serving the same equipment or CW, HW, and HWC lines serving the same restroom, etc.).
f. Fire, fire/smoke and smoke dampers shall be labeled consistent with the type (e.g., Fire Damper, Fire/Smoke Damper, etc.).

2. "Dot" Style:

a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves.

b. The marker shall be a self-adhesive color dot approximately 1/2" in diameter.

c. The equipment and accessories to be marked and dot color shall be coordinated with the Architect/Engineer and Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Valves:

1. All valves (except shutoff valves at equipment) shall have numbered tags.
2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.

3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
5. Attach to handwheel or around valve stem.
6. Number all tags and show the service of the pipe.
7. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Stencil Painted Pipe Markers:

    a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
    b. Apply primer on non-insulated pipes before painting.
    c. Use background and letter colors as scheduled later in this section.

4. Apply markers and arrows in the following locations where clearly visible:

    a. At each valve.
    b. On both sides of walls that pipes penetrate.
    c. At least every 20 feet along all pipes.
    d. On each riser and each leg of each "T" joint.
    e. At least once in every room and each story traversed.

5. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

E. Ductwork Markers:

1. Apply ductwork markers on ductwork systems in the following locations where clearly visible:

    a. On both sides of walls that ducts penetrate.
    b. At least every 20 feet along all ducts.
    c. On each riser and each leg of each branch connection.
    d. At least once in every room and each story traversed.
    e. At all ductwork access doors.
    f. At all fans and equipment serving ductwork system. Markers shall be clearly visible from the normal maintenance access path to the equipment. Coordinate placement location with Owner.

F. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.

2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

G. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.
2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

H. Tracer Wire:

1. Tracer wire shall be installed on top of all non-metallic buried utilities.
2. Tracer wire shall be taped directly to plastic water or drain pipe.
3. Tracer wire shall not be fastened directly or indirectly to gas piping.
4. Tracer wire when attached shall be secured to the pipe a minimum of every 10 feet and at all changes of direction.
5. Tape shall be Polyken "930-35", Protecto-Wrap "310", or approved equal.
6. Tracer wire shall be continuous between boxes and shall be tested for continuity.
7. Splices in tracer wire shall be made with a water proof splice kit to prevent corrosion. Wire nuts shall not be used.
8. The tracer wire shall daylight to grade through a 2" PVC conduit, at the point of the utility entrance to building. PVC conduit shall be capped and labeled as future contact point to locate the utility.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:
1. NATURAL GAS: Black lettering; yellow background
2. REFRIGERANT LIQUID: White lettering; purple background
3. REFRIGERANT SUCTION: White lettering; purple background
4. REFRIGERANT HOT GAS: White lettering; purple background
5. Tracer Wire - Natural Gas Pipe Lines: Black lettering; yellow background
6. Tracer Wire - All other buried types: White lettering; green background

B. Ductwork and Fan Systems: All fans, filters housings, and access doors shall be labeled with text as follows:
1. SUPPLY AIR: White lettering; green background
2. RETURN AIR: White lettering; green background
3. GENERAL EXHAUST AIR: Black lettering; yellow background
4. VENTILATION AIR: White lettering; green background
5. RELIEF Black lettering; yellow background

C. Ceiling Markers:

1. TAB-##
2. FCU-##
3. FSD
4. FD
5. SD
6. SMOKE DETECTOR

7. MOTOR OPERATED DAMPERS
8. CONTROL VALVES
9. CLEAN OUT
10. BRANCH SELECTOR (VRF System)

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Testing, adjusting, and balancing of air systems.

B. Testing, adjusting, and balancing of plumbing systems.

C. Measurement of final operating condition of HVAC systems.

1.2 QUALITY ASSURANCE

A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years' experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, or TABB Certified Supervisor.

B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

1.3 REFERENCES

A. AABC - National Standards for Total System Balance, Seventh Edition.

B. ADC - Test Code for Grilles, Registers, and Diffusers.

C. AMCA - Publication 203-90; Field Performance Measurement of Fan Systems.

D. ASHRAE - 2019 HVAC Applications Handbook; Chapter 39, Testing, Adjusting and Balancing.

E. ASHRAE/ANSI - Standard 111-2008; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.

F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Ninth Edition, 2019.

G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing (latest edition).

H. TABB - International Standards for Environmental Systems Balance.

1.4 SUBMITTALS

A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.

B. Electronic Copies:

1. Submit a certified copy of test reports to the Architect/Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
3. All text shall be searchable.
4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.

1.5 REPORT FORMS

A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.

B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.

C. Refer to PART 4 for required reports.

1.6 WARRANTY/GUARANTEE

A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.

B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.7 SCHEDULING

A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Architect/Engineer prior to performing each test.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.

B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g. submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.

C. Recorded data shall represent actual measured or observed conditions.

D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.

E. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.

G. The Balancing Contractor shall measure terminal air box air flow, and the TCC shall adjust DDC readout to match. Refer to Section 230900 for additional information.

H. Installations with systems consisting of multiple components shall be balanced with all system components operating.

3.2 EXAMINATION

A. Before beginning work, verify that systems are complete and operable. Ensure the following:

1. General Equipment Requirements:

    a. Equipment is safe to operate and in normal condition.
    b. Equipment with moving parts is properly lubricated.
    c. Temperature control systems are complete and operable.
    d. Proper thermal overload protection is in place for electrical equipment.
    e. Direction of rotation of all fans and pumps is correct.
    f. Access doors are closed and end caps are in place.

2. Duct System Requirements:

    a. All filters are clean and in place. If required, install temporary media.
    b. Duct systems are clean and free of debris.
    c. Fire/smoke and manual volume dampers are in place, functional and open.
    d. Air outlets are installed and connected.
    e. Duct system leakage has been minimized.

3. Pipe System Requirements:

    a. Coil fins have been cleaned and combed.
    b. Hydronic systems have been cleaned, filled, and vented.
    c. Strainer screens are clean and in place.
    d. Shutoff, throttling and balancing valves are open.

B. Report any defects or deficiencies to Architect/Engineer.

C. Promptly report items that are abnormal or prevent proper balancing.

D. If, for design reasons, system cannot be properly balanced, report as soon as observed.

E. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.

B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.4 INSTALLATION TOLERANCES

A. Adjust supply, return, and exhaust air-handling systems to +10% / -5% of scheduled values.

3.5 ADJUSTING

A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.

B. Once balancing of systems is complete, at least one damper or valve must be 100% open.

C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.

D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.

E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. Coordinate with contractor.

3.6 SYSTEM PERFORMANCE REPORT

A. After the conclusion of balancing operations, utilize the building DDC system or install portable data loggers to simultaneously record temperatures and humidity during summer and winter conditions for a seven-day period, continuous over a weekend, and including at least one period of operation at outside conditions within 5F wet bulb temperature of maximum summer design condition and within 10F dry bulb temperature of minimum winter design condition.

B. Design Conditions:

1. Summer: 100 F DB 73.6 F WB
2. Winter: 0 F DB

C. Architect/Engineer will direct all test locations.

D. Report of test results shall include original recording and three reproductions.

3.7 SUBMISSION OF REPORTS

A. Fill in test results on appropriate forms.

PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

4.1 GENERAL REQUIREMENTS

A. Title Page:

1. Project name.
2. Project location.
3. Project Architect.
4. Project Engineer (IMEG Corp.).
5. Project General Contractor.
6. TAB Company name, address, phone number.
7. TAB Supervisor's name and certification number.
8. TAB Supervisor's signature and date.
9. Report date.

B. Report Index

C. General Information:

1. Test conditions.
2. Nomenclature used throughout report.
3. Notable system characteristics/discrepancies from design.
4. Test standards followed.
5. Any deficiencies noted.
6. Quality assurance statement.

D. Instrument List:

1. Instrument.
2. Manufacturer, model, and serial number.
3. Range.
4. Calibration date.

4.2 AIR SYSTEMS

A. Duct Leakage Test:

1. Air system and fan.
2. Leakage class.
3. Test pressure.
4. Construction pressure.
5. Flow rate (cfm): specified and actual.
6. Leakage (refer to Section 233100 in the specifications): specified and actual.
7. Statement that fire dampers, reheat coils and other accessories were included in the test.
8. Pass or Fail.
9. Test performed by.

10. Test witnessed by.

B. Air Moving Equipment:

1. General Requirements:

a. Drawing symbol.
b. Location.
c. Manufacturer, model, arrangement, class, discharge.
d. Fan RPM.
e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
f. Final frequency of motor at maximum flow rate (on fans driven by VFD).

2. Flow Rate:

a. Supply flow rate (cfm): specified and actual.
b. Return flow rate (cfm): specified and actual.
c. Outside flow rate (cfm): specified and actual.
d. Exhaust flow rate (cfm): specified and actual.

3. Pressure Drop and Pressure:

a. Filter pressure drop: specified and actual.
b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
c. Inlet pressure.
d. Discharge pressure.

C. Fan Data:

1. Drawing symbol.
2. Location.
3. Manufacturer and model.
4. Flow rate (cfm): specified and actual.
5. Total static pressure: specified and actual. (Indicate measurement locations).
6. Inlet pressure.
7. Discharge pressure.
8. Fan RPM.

D. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

E. Duct Traverse:

1. System zone/branch/location.
2. Duct size.
3. Free area.
4. Velocity: specified and actual.
5. Flow rate (cfm): specified and actual.
6. Duct static pressure.

7. Air temperature.
8. Air correction factor.

F. Air Terminal (Inlet or Outlet):

1. Drawing symbol.
2. Room number/location.
3. Terminal type and size.
4. Velocity: specified and actual.
5. Flow rate (cfm): specified and actual.
6. Percent of design flow rate.

G. Air Terminal Unit (Terminal Air Box) Data:

1. General Requirements:

a. Drawing symbol.
b. Location.
c. Manufacturer and model.
d. Size.
e. Type: constant, variable, single, dual duct.

2. Flow Rate:

a. Cooling maximum flow rate (cfm): specified and actual.
b. Heating maximum flow rate (cfm): specified and actual.
c. Minimum flow rate (cfm): specified and actual.

3. Temperature:

a. Entering air temperature: specified and actual.
b. Leaving air temperature (in minimum airflow/heating mode): specified and actual.

4. Pressure Drop and Pressure:

a. Inlet static pressure during testing cooling maximum airflow rate (maximum and minimum).

H. Air Flow Measuring Station:

1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Size.
6. Flow rate (cfm): specified and actual.
7. Pressure drop: specified and actual.

I. Fume Hood:

1. Drawing symbol.
2. Location.
3. Manufacturer and Model.

4. Total flow rate (cfm): specified and actual.
5. Test velocities.
6. Hood opening dimensions.

J. Positive Air Flow Test:

1. Occupied Supply Air (Max./Min.) Flow rate (cfm): specified and actual.
2. Occupied Return Air (Max./Min.) Flow rate (cfm): specified and actual.
3. Unoccupied Supply Air (Max./Min.) Flow rate (cfm): specified and actual.
4. Unoccupied Return Air (Min./Max.) Flow rate (cfm): specified and actual.

4.3 PLUMBING SYSTEMS

A. Pump Data:

1. Drawing symbol.
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: operating and shutoff.
8. Discharge Pressure: operating and shutoff.

B. Gas Fired Water Heater:

1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Capacity (Btuh): specified, nameplate, and actual.
6. Entering water temperature: specified and actual.
7. Leaving water temperature: specified and actual.
8. Pressure Drop: specified and actual.
9. Control Setting: specified and actual.

END OF SECTION

SECTION 230713 - DUCTWORK INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Ductwork Insulation.

B. Insulation Jackets.

1.2 QUALITY ASSURANCE

A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer's certificate indicating qualifications.

B. Materials:

1. Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
2. Fungal Resistance: No growth when tested in accordance with ASTM G21 (antifungal test).
3. Rated velocity on coated air side for air erosion in accordance with UL 181 at 5,000 fpm minimum.

C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

1.3 REFERENCES

A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ANSI/ASTM C553 - Mineral Fiber Blanket and Felt Insulation.

C. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.

D. ASTM E84 - Surface Burning Characteristics of Building Materials.

E. ASTM E136 - Standard Test Method for the Behavior of Materials in a Vertical Tube Furnace at 750C.

F. ASTM E814 - Fire Tests of Through Penetrations Firestops.

G. ASTM E2336-04 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.

H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

I. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

J. NFPA 96 - Standard for the Installation of Equipment for Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.

K. NFPA 255 - Surface Burning Characteristics of Building Materials.

L. UL - XHEZ - Through Penetration Firestop Systems.

M. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

N. UL 263 - Full Scale External Fire Tests with Hose Stream.

O. UL 723 - Surface Burning Characteristics of Building Materials.

P. UL 1479 - Fire Tests of Through Penetrations Firestops.

1.4 SUBMITTALS

A. Submit shop drawings per Section 230500. Include product description, list of materials and thickness for each service, and location.

B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both "Out of Package" and "Installed-Compressed 25%" K and R-values.

B. Type B: Semi-rigid Fiberglass Board Wrap - Outside Application; ANSI/ASTM C612, Class 1; 0.25 maximum 'K' value at 75F; foil scrim Kraft facing, 3 lb./cu. ft. density.

C. Type C: Flexible Fiberglass Liner; ANSI/ASTM C1071; 0.28 maximum 'K' value at 75F; 1.5 lb/cu ft minimum density; coated air side for 5000 fpm air velocity.

D. Type E: Double wall ductwork insulation; fiberglass; 0.27 maximum 'K' value at 75F mean temperature; 1.5 lb/cu ft density.

E. Type G: Preformed rigid fiberglass acoustical liner. ANSI/ASTM C1071; 0.23 maximum 'K' value at 75F mean temperature; Noise Reduction Coefficient (NRC) per ASTM C423 Type "A" mounting of 0.70 for 1" thickness, 0.90 for 1.5" thickness, min density 3 lb./cu. ft (48 kg/m3). Liner shall be factory coated with an anti-microbial agent to prevent fungus and bacteria growth per ASTM G-21 and G-22. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

F. Type I: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534, Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75F, minimum density 3.0 lb/cu.ft (48kg/m3), listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Coated air side for 5000 fpm air velocity.

2.2 JACKETS

A. Vapor Barrier Jackets: Kraft reinforced foil scrim vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 25 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

2.3 JACKET COVERINGS

A. Laminated flexible aluminum, self-adhering, protective jacketing, vapor barrier and weather proofing membrane with having high-performance adhesive capable of installation with no additional mechanical attachment. Owner/Architect shall select from manufacturer's standard finishes.

1. Acceptable Manufacturers:

    a. VentureClad 1577CW
    b. Polyguard Alumaguard

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.

B. Install materials after ductwork has been tested.

C. Clean surfaces for adhesives.

D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.

E. Exterior Duct Wrap - Flexible, Type A:

1. Apply with edges tightly butted.
2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
3. Seal joints with adhesive backed tape.
4. Apply so insulation conforms uniformly and firmly to duct.
5. the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.
6. Provide high-density insulation inserts on rectangular ducts at trapeze duct hangers to prevent crushing of insulation. Provide high-density insulation inserts with clamp-on round ducts requiring two (2) rods or straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.
8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
9. Staples may be used, but must be covered with tape.
10. Vapor barrier must be continuous.
11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.

F. Semi Rigid Fiberglass Board Wrap - Type B (Indoor Use):

1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.
2. Space pins as needed to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK facing tape.
4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.

G. Semi Rigid Fiberglass Board Wrap - Type B (Outdoor Use):

1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.
2. Space pins as required to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of the same facing tape with adhesive.
4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.
5. Install vapor barrier jacket. Cover with laminated jacket covering with seams on the bottom of horizontal ductwork.
6. Seal all butt joints with metal draw bands screwed to jacket and filled with sealant. Seal all joints watertight.
7. Provide positive slope on top of all horizontal surfaces to prevent ponding of water.

H. Interior Insulation - Flexible Duct Liner, Type C:

1. Observation of Duct Lining:

    a. After installation of ductwork, Architect/Engineer may select random observation points in each system.

        1) At each observation point, cut and remove an 18" x 18" section of ductwork and liner for verification of installation.
        2) Random observation points based on one opening per 75 lineal ft. of total duct run.

    b. When any of the observation points shows non-compliance, additional points will be designated by the Architect/Engineer, and observation repeated.
    c. If 20% of points observed do not comply, remove and replace all lined ducts and repeat tests. Where replacement is not required, correct all non-compliances.
    d. At end of observation, repair all duct lining and observation holes by installing standard, insulated, hinged access doors per Section 233300.
    e. Paint or finish to match adjacent duct surfaces.

2. Impale on spindle anchors welded or mechanically fastened to the duct. Adhesive or glue fastened anchors are not acceptable. Maximum anchor spacing per SMACNA Duct Construction Standards or manufacturer's recommendations, whichever is more restrictive. Locate pins less than 3" from corners and at intervals not over 6" around the perimeter at leading and trailing edges. Locate pins within 3" of transverse joints and at intervals not over 16" long the length of the duct. Pins must be long enough to prevent compressing the insulation.

3. In addition to anchors, secure liner with UL listed adhesive covering over 90% of the duct surface.
4. Install per the latest edition of the SMACNA Manual.
5. Leading edges shall be covered as follows:

    a. For duct velocities below 3000 fpm, coat leading edges with adhesive. Neatly butt liner without gaps at transverse joints. Cut liner flush with end of the duct section for tight joints with no exposed duct. If adhesive is shop installed, field apply additional adhesive to the end of each duct section for complete adhesion of the liner. Protect edges from dirt and debris.
    b. For duct velocities above 3000 fpm, cover leading edges with metal nosing. Use nosing on upstream edges of each section of duct. If the duct can be installed in either direction, provide nosing on each end or clearly mark the duct to allow visual verification after installation. Verify duct velocities based on the scheduled air flow rates and determine where metal nosing is required.
    c. Install metal nosing in the following locations (regardless of velocity):

        1) The first three fittings downstream of all fans.
        2) At all duct liner interruptions. This includes fire dampers, access doors, branch connections, and all other locations where the edge of the liner is exposed.
        3) Trailing edges of transverse joints do not require metal nosings.

6. Overlap liner at longitudinal joints. Make longitudinal joints at corners of the duct unless the duct size does not allow this. Coat longitudinal joints with adhesive at velocities over 2500 fpm.
7. Seal all damaged duct liner with adhesive and glass cloth. Do not damage duct liner surface coatings.
8. Duct dimensions given are net inside dimensions. Increase sheet metal to allow for insulation thickness.

I. Double-Wall Ductwork Insulation - Type E:

1. Install insulation per manufacturer's recommendations.
2. Duct dimensions given are net inside dimensions of inner wall.

J. Preformed Fiberglass Acoustical Liner, Rigid - Type G:

1. Cut and secure duct liner inside duct.
2. Install insulation pins or adhesives in locations as recommended by the manufacturer.
3. Seal all damaged duct liner and fill all gaps with manufacturer approved sealant. Do not damage duct liner surface coatings.
4. Where edges show evidence of delamination, the damaged areas shall be secured by manufacturer approved sealant.
5. Duct dimensions given are net inside dimensions. Increase sheet metal to allow for insulation thickness.

K. Exterior Duct Wrap - Type I:

1. On ducts with any sides having a dimension 20" and greater: Impale insulation on spindle anchors welded or mechanically fastened to the duct and secured with speed clips. Clip pins off close to speed clips. Adhesive or glue fastened anchors are not acceptable. Maximum anchor spacing per SMACNA Duct Construction Standards or manufacturer's recommendations, whichever is more restrictive. Locate pins within 4" from edges and at intervals not over 16" in all directions. Pins shall be long enough to prevent compressing the insulation.

L. Continue insulation with vapor barrier through penetrations unless code prohibits.

M. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.

3.2 SCHEDULE

A. Refer to Ductwork Application Schedule on Drawings for scheduling of insulation.

END OF SECTION

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment Insulation.

B. Equipment Insulation Finishes.

1.2 QUALITY ASSURANCE

A. Applicator: Company specializing in insulation application with five years minimum experience.

B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

1.3 REFERENCES

A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ANSI/ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate

C. ANSI/ASTM C195 - Mineral Fiber Thermal Insulation Cement.

D. ANSI/ASTM C534 - Elastomeric Foam Insulation

E. ANSI/ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

F. ANSI/ASTM C553 - Mineral Fiber Blanket Thermal Insulation.

G. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.

H. ANSI/ASTM C921 - Properties of Jacketing Materials for Thermal Insulation

I. ANSI/ASTM D1668 - Glass Fabric for Waterproofing

J. ASTM E84 - Surface Burning Characteristics of Building Materials.

K. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

L. NFPA 255 - Surface Burning Characteristics of Building Materials.

M. UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Submit shop drawings per Section 230500. Include product description, list of materials and thickness for equipment scheduled.

PART 2 - PRODUCTS

2.1 INSULATION

A. Type A: Rigid Mineral Fiber Blocks; ANSI/ASTM C612; 0.625 maximum 'K' value 800F. Suitable to 1900F, 25/50 flame spread/smoke developed when tested in accordance with ASTM E84 (UL 723).

B. Type B: Cellular Glass Board; ANSI/ASTM C552; 0.35 maximum 'K' value at 200F; 8.0 lb/cu ft.; suitable to 900F, 25/50 flame spread/smoke developed when tested in accordance with ASTM E84 (UL 723).

C. Type C: Glass Fiber Blanket; ANSI/ASTM C1393 Type IIIA Cat2; 0.40 maximum 'K' value at 300F; 2.5 lb/cu ft.; suitable to 850F, with all service jacket (ASJ) vapor retarder jacket having 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).

D. Type D: Glass Fiber Board; ANSI/ASTM C612; 0.28 maximum 'K' value at 200F; 6.0 lb/cu ft; suitable to 850F, 25/50 flame spread/smoke developed when tested in accordance with ASTM E84 (UL 723).

E. Type E: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534, Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75F, minimum density 3.0 lb/cu.ft (48kg/m3) listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where thicker values are specified.

F. Type F: Semi-Rigid Mineral Wool Fiberboard; ANSI/ASTM C612; 0.30 maximum 'K' value at 200F; suitable to 1200F.

2.2 INSULATION FINISHES

A. Type 1: Glass Fabric; ASTM D1668, woven glass fabric with two coats of mastic approved for insulation type. Use vapor barrier mastics that are approved for both indoor and outdoor use on insulation systems covering surfaces having temperatures less than 70F and having maximum 0.013 perms/inch rating at 0.043 inch dry-film thickness when tested in accordance with ASTM E-96 Procedure B (Foster 30-80 or approved equivalent). Use breather mastics that are approved for both indoor and outdoor use on insulation systems covering surfaces having temperatures 70F or greater (Foster 35-00 or approved equivalent).

B. Type 2: All Service Jacket; ASTM C921; Factory or Field Applied; all-purpose polymer or polypropylene service jacket; Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Seal all joints with manufacturer approved tape and adhesive to maintain vapor barrier. Indoor use only, if used outdoors add type 4 finish.

C. Type 3: Flexible Elastomeric Thermal Insulation; After adhesive has fully cured, apply two coats of latex enamel paint approved by insulation manufacturer for outdoor use.

D. Type 4: Aluminum Jacket; ASTM B209; 0.016" thick stucco embossed finish; install with 3/4" aluminum bands 12" on center.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all materials per manufacturer's instructions, codes and industry standards.

B. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

C. Do not insulate factory insulated equipment.

D. Apply insulation as close as possible to equipment by grooving, scoring, and bevelling insulation. Secure to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier mastic.

F. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.

G. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning; install specially fabricated removable insulation sections. Covers shall have mechanical fasteners and be reusable.

H. Install 26 gauge galvanized sheet metal corner protection angles where insulation extends to the floor. Minimum 2" coverage of insulation.

I. Insulate all equipment surfaces that are not factory insulated and are intended to operate below 60F and/or above 100F. Verify insulation type and thickness with equipment manufacturer and Architect/Engineer.

J. Insulate all supports on equipment operating below ambient temperature.

3.2 INSULATION

A. Type A and G:

1. Apply with edges tightly butted and joints staggered.
2. Secure with 1/2" x 0.015" galvanized steel bands, 12" on center.

B. Type B:

1. Apply with edges tightly butted and joints staggered
2. Seal all joints with manufacturer approved adhesive.
3. Secure with 1/2" x 0.015 galvanized steel bands, 12" on center.

C. Type C, D and F:

1. Apply with edges tightly butted and joints staggered.

2. Secure with welded pins and washers, 4" from each edge and 16" on center, or 1/2" x 0.015" galvanized steel bands, 12" on center.

D. Type E:

1. Apply with edges tightly butted and joints staggered. Install multiple layers if required thickness is greater than 1" thick.
2. Do not wrap sheet insulation around square corners, but cut and overlap insulation at corners to provide full insulation thickness on all sides. Seal all overlapping insulation surfaces with manufacturer approved adhesive.
3. Secure with manufacturer approved adhesive in accordance with installation instructions. Where applied to underside surfaces or on surfaces with temperatures 140F and above, cover all surfaces with full application of adhesive. Seal all joints and seams with manufacturer approved adhesive.
4. Exterior Installations: Exterior installations shall contain factory applied 17.5 mils laminated UV resistant cladding with ends sealed with adhesive and similar cover; or Contractor shall paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.

3.3 SCHEDULE

END OF SECTION

SECTION 230905 - SMALL EQUIPMENT CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Complete System of Automatic Controls.

B. Control Devices, Components, Wiring and Material.

C. Instructions for Owners.

D. Remodeling.

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years' experience.

B. TCC: Company specializing in the work of this section with minimum three years temperature control experience.

C. Technician: Minimum three years' experience installing commercial temperature control systems.

D. TCCs are limited to firms regularly employing a minimum of one full-time temperature control technician within 100 miles of the job site.

E. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under this section.

1.3 REFERENCES

A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ANSI/ASHRAE Standard 135-2016: BACnet® - A Data Communication Protocol for Building Automation and Control Networks, including all amendments.

D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 volts Maximum).

E. ANSI/NFPA 70 - National Electrical Code.

F. ANSI/NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.

G. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.

H. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.

I. IEEE 802.15.4 - Standard for Low Rate Wireless Networks

J. FCC CFR 47 - Radio Frequency Devices.

K. Federal Information Processing Standards (FIPS) Publication 197 - AES-128 Advanced Encryption Standard.

L. Federal Information Processing Standards (FIPS) Publication 198 - HMAC Keyed Hash Message Authentication Code.

1.4 SUBMITTALS

A. Equipment Coordination:

1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
2. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.

B. Shop Drawings:

1. Submit shop drawings per Section 230500. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.
2. Cross-reference **all** control components and point names in a single table located at the beginning of the submittal with the **identical** nomenclature used in this section.
3. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.
5. Diagrams shall include:

a. Wiring diagrams and layouts for each control panel showing all termination numbers.
b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
c. Identification of all control components connected to emergency power.
d. Schematic diagrams for all field sensors and controllers.
e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
h. All installation details and any other details required to demonstrate that the system will function properly.

i. All interface requirements with other systems.

6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.
7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. **The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.**
8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.
9. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:

    a. Damper Identification Tag.
    b. Location.
    c. Damper Type.
    d. Damper Size.
    e. Duct Size.
    f. Arrangement.
    g. Blade Type.
    h. Velocity.
    i. Pressure Drop.
    j. Fail Position.
    k. Actuator Identification Tag.
    l. Actuator Type.
    m. Mounting.

10. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.
11. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL) or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version that meets BTL testing and listing requirements if problems are found during BTL testing is required.

12. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.
13. Clearly identify work by others in the submittal.
14. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

C. Operation and Maintenance Manual:

1. In addition to the requirements of Section 230500, submit an electronic copy of the O&M manuals in PDF format.
2. Provide three complete sets of manuals.
3. Each O&M manual shall include:

    a. Table of contents with indexed tabs dividing information as outlined below.
    b. Definitions: List of all abbreviations and technical terms with definitions.
    c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
    d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
    e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
    f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.
    g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
    h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.

D. Training Manual:

1. Provide a course outline and training manuals for each training class. Provide login information and access to a web application where the current training manuals can be downloaded at no additional cost.

E. Record Documents:

1. Submit record documentation per Section 230500.
2. Provide a complete set of "as-built" drawings and application software on CDs. Provide drawings as AutoCAD™ or Visio™ compatible files. Provide two copies of the "as-built" drawings with revisions clearly indicated in addition to the documents on compact disk. Provide all product data sheets in PDF format.
3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
4. Provide all completed testing and commissioning reports and checklists.

5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the A/E verifying completion and proper operation of all points.

1.5 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.6 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Automatic Dampers.

1.7 AGENCY AND CODE APPROVALS

A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.

1. UL-916; Energy Management Systems.
2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "Signal Equipment."
3. EMC Directive 89/336/EEC (European CE Mark).
4. FCC, Part 15, Subpart J, Class A Computing Devices.

1.8 ACRONYMS

A. Acronyms used in this specification are as follows:

1. B-AAC - BACnet Advanced Application Controller
2. B-ASC - BACnet Application Specific Controller
3. BTL - BACnet Testing Laboratories
4. DDC - Direct Digital Controls
5. FMCS - Facility Management and Control System
6. GUI - Graphic User Interface
7. IBC - Interoperable BACnet Controller
8. IDC - Interoperable Digital Controller
9. LAN - Local Area Network
10. NAC - Network Area Controller
11. ODBC - Open DataBase Connectivity
12. WNAC - Wireless Network Area Controller
13. OOT - Object Oriented Technology
14. OPC - Open Connectivity via Open Standards
15. PICS - Product Interoperability Compliance Statement
16. TCC - Temperature Control Contractor
17. TCS - Temperature Control System
18. WAN - Wide Area Network
19. WBI - Web Browser Interface

1.9 SUMMARY

A. Provide new standalone FMCS for this project.

B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using direct digital controls as shown on the drawings and as described herein.

C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.

D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

1.10 SYSTEM DESCRIPTION

A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to an NAC. Temperature Control System products shall be as specified below.

B. The FMCS shall include network area controller or controllers (NAC) within each facility. The NAC shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard web browsers, via the Internet, and/or via local area network.

C. The FMCS will include all related programming, with a fully operational web-based management system using a cloud server program and including a network of commercial internet programmable thermostats that use IEEE 802.15.4 mesh wireless communication protocol to reach a wireless network area controller (WNAC). The WNAC shall connect to the Owner's local or wide area network, depending on configuration, over a TCP/IP connection. Access and control of the FMCS is via a web-based management tool that resides on a cloud server and must be accessible either locally or remotely via the Internet.

D. Provide materials and labor necessary to connect factory-supplied control components.

E. Provide central and remote hardware, software, and interconnecting wire and conduit where required.

F. The FMCS shall include automated alarming software capable of calling email-compatible cellular telephones and pagers. The email alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.

G. For each touchscreen display, mobile application, and web user interface provided, furnish one legal copy of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be readily available in the market. Contractor shall convey to the Owner all software tools and their legal licenses at project closeout.

1.11 SOFTWARE LICENSE AGREEMENT

A. The Owner shall be the named license holder of all software and applications associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job-specific configuration documentation, data files, configuration tools, and application-level software developed for the project. This shall include, but is not limited to, all custom, job-specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN/WAN/intranet and/or Internet connected routers and devices. Provide the Owner with all required IDs and passwords for access to any component or software program. The Owner shall determine which organizations shall be named in the SI organization ID (**"orgid"**) of all software licenses. Owner shall be free to direct the modification of the **"orgid"** in any software license, regardless of supplier.

1.12 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

1.13 WARRANTY

A. Refer to Section 230500 for warranty requirements.

B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.

C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.

D. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

1.14 WARRANTY ACCESS

A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS (BACnet Protocol)

A. Carrier: iVU

B. Honeywell: LCBS

C. Johnson Controls: Verasys

D. Trane: Concierge

2.2 SYSTEM ARCHITECTURE

A. General:

1. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall consist of a network of interoperable, standalone digital controllers, touchscreen display, mobile application, web user interface, network devices, dampers, sensors, and other devices as specified herein.
2. The installed system shall provide secure password or PIN access to all features, functions and data contained in the overall FMCS.

B. Open, Interoperable, Integrated Architectures:

1. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data are not acceptable.
2. The supplied system must be able to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. Systems requiring proprietary user interface programs are not acceptable.

2.3 NETWORKS

A. The local area network (LAN) shall be a minimum 100 megabits/sec Ethernet network supporting BACnet. Provide support for multiple network area controllers (NACs).

B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE Standard 802.3.
2. Cable; 100 Base-T, UTP-8 wire, Category 6.
3. Minimum throughput; 100 Mbps.

C. Communication conduits shall not be installed closer than six feet from 110VAC or higher transformers or run parallel within six feet of electrical high-power cables. Route the cable as far from interference generating devices as possible. Where communication wire must cross 110VAC or higher wire, it must do so at right angles.

D. Ground all shields (earth ground) at one point only to eliminate ground loops. Provide all shield grounding at the controller location, with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.

E. There shall be no power wiring more than 30 VAC rms run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, run all communication wiring and signal wiring using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

2.4 REMOTE NETWORK ACCESS

A. For local area network installations, provide access to the LAN from a remote location via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 line or via the customer's intranet to a corporate server providing access to an internet service provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

B. The controls manufacturer shall provide secure remote access to the FMCS.

1. Secure remote access to the FMCS shall be available anywhere, anytime, using a compatible client device (PC/tablet/phone)
2. Secure remote access to the FMCS shall be maintained by controls manufacturer.
3. Secure remote access to the FMCS shall not require additional software to be installed on the client device (e.g., VPN client).
4. Secure remote access to the FMCS shall not require any inbound ports on a firewall to be "exposed" or "forwarded".

2.5 NETWORK AREA CONTROLLER (NAC)

A. The TCC shall supply one or more network area controllers (NAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.

B. Each system controller shall perform communications to a network of custom application and application specific controllers using BACnet/MSTP (RS485) as defined by the BACnet standard. Each NAC shall provide the interface between the LAN or WAN and the field control devices, and shall provide global supervisory control functions over the control devices connected to the NAC. It shall execute application control programs to provide:

1. Calendar functions.
2. Scheduling.
3. Alarm monitoring and routing.
4. Time synchronization.
5. Integration of all controller data.
6. Network management functions.

C. The network area controller shall provide the following hardware features as a minimum:

1. One Ethernet Port - 10/100 Mbps.
2. One RS-485 port.
3. Battery backup.
4. Flash memory for long-term data backup. (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with at least 1 gigabyte storage capacity.)
5. The NAC must be capable of operation over a temperature range of 32F to 122F.
6. The NAC must be capable of withstanding storage temperatures of between 0F and 158F.
7. The NAC must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.

D. The NAC shall support standard Web browser access via the Internet or an intranet.

E. Event Alarm Notification and Actions:

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:

    a. Alarm
    b. Normal

4. Provide for the creation of a minimum of eight alarm classes with different routing and acknowledgement properties, e.g., security, HVAC, fire, etc.
5. Provide timed (scheduled) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

F. Treat control equipment and network failures as alarms and annunciated.

G. Annunciate alarms in any of the following manners as defined by the user:

1. Touchscreen message.
2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

    a. Day of week.
    b. Time of day.
    c. Recipient.

3. Pagers via paging services that initiate a page on receipt of email message.
4. Graphic with flashing alarm object(s).

H. The FMCS shall record the following for each alarm:

1. Time and date.
2. Location (building, floor, zone, office number, etc.).
3. Equipment tag.
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

I. Give defined users proper access to acknowledge any alarm.

J. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

2.6 WIRELESS NETWORK AREA CONTROLLER (WNAC)

A. The TCC shall supply one or more wireless network area controllers (WNAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.

B. Each system controller shall perform communications to a network of custom application and application specific controllers using ANSI/ASHRAE Standard 135-2016 (BACnet® / ZigBee®). It shall execute application control programs to provide:

1. Calendar functions.
2. Scheduling.
3. Alarm monitoring and routing.
4. Time synchronization.
5. Integration of all controller data.
6. Network management functions.

C. The WNAC shall be capable of similar performance to a wired, equally quantified network by responding to controls requests within 10% timing comparison to provide a similar user experience for facility managers and occupants.The WNAC shall support standard web browser access via the Internet or an intranet.

D. The WNAC shall be capable of similar performance to a wired, equally quantified network by responding to controls requests within 10% timing comparison to provide a similar user experience for facility managers and occupants.

E. The WNAC shall be secured using Advanced Encryption Standard AES-128 (FIPS Pub 197) and HMAC (FIPS Pub 198). A trust center will create a randomly generated 128-bit network security key for each ZigBee network.

F. The WNAC shall use IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.

G. Indoor design range for wireless transmission and receiving shall be a minimum of 200 feet; open range shall be 2500 feet with less than 2% packet error rate to minimize the need for repeaters and to optimize network reliability. TCC shall field test locations identified on the drawings for connectivity prior to installing components. Report findings to the Mechanical Engineer along with proposed recommendations for device relocation.

H. The WNAC shall employ two-way communications to maintain robust communication, self-healing, and redundant mesh networking, and to optimize the wireless network reliability.

I. The WNAC shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.

J. The WNAC shall include FCC CFR47 - Radio Frequency Devices - Section 15.247 and Subpart E certifications.

K. WNAC functionality for equipment with variable speed fans shall include the following:

1. The WNAC shall provide an air systems application program that coordinates rooftop units (RTU) and variable air volume terminal equipment.
2. Start up and shut down the air handler safely. Ensure the VAV boxes are open sufficiently when the air handler is running to prevent damage to the ductwork and VAV boxes due to high air pressure.
3. Calibrate VAV boxes to ensure proper air damper/actuator operation.

4. Fan Pressure Optimization (ASHRAE 90.1): Minimize energy usage by controlling system static pressure to the lowest level while maintaining zone airflow requirements. System static pressure controlled to keep the "most open" zone damper between 65% and 75% open.
5. The fan pressure optimization application shall have the ability to identify and display the discharge air setpoint of the air handler and the VAV box that serves the critical zone (i.e., the zone with the most open VAV box damper). This information shall dynamically update with changes in the location of the critical zone.
6. During commissioning and with the Engineer/Owner, the Controls Contractor shall confirm the performance of fan pressure optimization by conducting a field functional test that demonstrates critical zone reset.
7. Enable/disable optimization strategies (duct static optimization and ventilation optimization).
8. The following is a list of the air system points that shall be displayed on the operator touchscreen display:

    a. Rooftop Unit - Fan Status
    b. Rooftop Unit - Discharge Air Temperature
    c. Rooftop Unit - Discharge Air Temperature Setpoint Active
    d. VAV Air System - Duct Static Pressure (if used in system)
    e. VAV Air System - Duct Static Pressure Setpoint (if used in system)
    f. VAV Air System - Space Temperature Average (if used in system)
    g. VAV Box - Space Temperature Active
    h. VAV Box - Space Temperature Setpoint

L. Event Alarm Notification and Actions:

1. The WNAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The WNAC shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:

    a. Alarm
    b. Normal

4. Provide timed (scheduled) routing of alarms by class, object, group, or node.
5. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

M. Treat control equipment and network failures as alarms and annunciated.

N. Annunciate alarms in any of the following manners as defined by the user:

1. Touchscreen message.
2. Email the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

    a. Day of week.
    b. Time of day.
    c. Recipient.

3. Pagers via paging services that initiate a page on receipt of email message.
4. Graphic with flashing alarm object(s).

O. The FMCS shall record the following for each alarm:

1. Time and date.
2. Location (building, floor, zone, office number, etc.).
3. Equipment tag.
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

P. Give defined users proper access to acknowledge any alarm.

Q. A log of all alarms shall be maintained by the WNAC and/or a server (if configured in the system) and shall be available for review by the user.

R. WNAC Configuration:

1. Software Setup Utility:

a. The WNAC shall be capable of being set up from the touchscreen interface.

2. Network Communication and System Setup:

a. The WNACs shall be addressed by methods other than software settings, such as rotary switches, for ease in troubleshooting communication issues.
b. Communicating WNAC devices shall be automatically discovered by the coordinating system panel.
c. Equipment shall be combined to form systems from the local display.

2.7 BACNET FMCS

A. The intent of the FMCS is to integrate the mechanical equipment associated with this project into one system for global monitoring, control and alarming compliant with ANSI/ASHRAE Standard 135-2001 BACnet. System must be fully integrated and coordinated with mechanical equipment DDC controllers furnished and installed in the equipment manufacturer's factory.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices in the system. Adherence to industry standards including the latest ANSI/ASHRAE Standard 135 (BACnet) to assure interoperability between all system components is required. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP) and/or RS-485 (BACnet MSTP).

C. All mechanical equipment that is intended to be integrated into the FMCS shall be controlled by custom application or application specific controllers that meet the interface requirements as detailed in the communications section of this specification.

D. Interoperable BACnet Controller (IBC):

1. Controls shall be microprocessor based interoperable BACnet controllers (IBC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide IBCs for unit ventilators, fan coils, heat pumps, terminal air boxes (TAB), and other applications. The application control program shall reside in the same enclosure as the input/output circuitry that translates the sensor signals.
2. The IBCs shall be listed by the BACnet testing laboratory (BTL) as follows:

a. BACnet Building Controller(s) (B-BC).
b. BACnet Advanced Application Controller(s) (B-ACC).
c. BACnet Application Specific Controller(s) (B-ASC).

3. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
4. The Contractor supplying the IBCs shall provide documentation for each device, with the following information at a minimum:

a. BACnet Device; MAC address, name, type and instance number.
b. BACnet Objects; name, type and instance number.

2.8 TERMINAL AIR BOX (TAB) CONTROLLERS

A. FMCS Volume Controller: Electronic, furnished and installed by TCC. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c.. Provide velocity and static sensor at box inlet for use by unit controller. Set boxes for maximum and minimum settings shown on the drawings. Refer to Section 233600 for additional information.

B. The controller shall support various digital and analog inputs and outputs as needed for damper control, control valves, electric coils, airflow sensors, remote heating, occupancy sensors, etc. and shall be capable of independent occupancy scheduling.

C. Controller shall provide continuous zone temperature histories internal to device for up to 24 hours and perform its own limit and status monitoring and alarms to limit unnecessary communications.

D. Operator interface to any ASC point data or programs shall be through network resident programs or portable operator's terminal connected to the specific controller.

E. Store all system setpoints, proportional bands, control algorithms, and other programmable parameters such that a power failure of any duration does not necessitate reprogramming of the controller.

F. BACnet TAB controllers shall either be B-AAC devices or B-ASC devices as required to meet the performance and BTL listing.

2.9 OPERATOR INTERFACES

A. Web User Interface Application:

1. The system shall be capable of supporting an unlimited number of clients using a standard web browser such as Edge, Firefox, or Chrome. Systems requiring additional software to enable a standard web browser to reside on the client machine, or manufacturer-specific browsers, are not acceptable. Interface shall be plug-in free.
2. The web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the graphic user interface. Systems that require different views or that require different means of interacting with objects, such as schedules or logs, are not permitted.
3. The web browser interface shall provide:

a. Context sensitive online help and training system to assist in the operation and configuration of the system.
b. Graphics pages for all equipment and system applications. These pages shall allow a servicer to obtain information relevant to the operation of the equipment and/or application.
c. The following interface capabilities:

1) Animated equipment graphics for each piece of equipment.
2) Alarm indication for all equipment and system applications.
3) Historical data logs. Data logs shall be begin recording at system startup.
4) Fault detection and diagnostics (FDD) data and alarms including:

a) Sensors and the ability to display the values for outside air, supply air, and return air (for differential economizer operation when required).
b) Indicate the following conditions: (1) free cooling available; (2) economizer enabled; (3) compressor enabled; (4) heating enabled, if the system is capable of heating; (5) mixed-air low limit cycle active.
c) Faults reported via the FMCS that automatically provides notification to facility personnel for the following faults: (1) air temperature sensor failure/fault; (2) not economizing when it should; (3) economizing when it should not; (4) damper not modulating; (5) excess outdoor air.

5) Demand response controls certified by the manufacturer capable of responding to a demand response signal from a certified OpenADR 2.0b Virtual End Node by automatically implementing the functions requested by the virtual end node from equipment down to the zone level.

B. Mobile Application:

1. A mobile application that enables access to the control system shall be included. The mobile application shall support the latest versions of both iOS and Android. The mobile application shall allow the user to accomplish the following tasks:

a. Control the setpoints for multiple pieces of equipment with a single touch.
b. Setpoint adjustment by the occupant shall be bound by editable limits.
c. Occupant override of the system/equipment operating mode shall be possible with a single touch.
d. FDD fault detection and diagnostics data and alarms.

2.10 ZONE AND BYPASS CONTROL DAMPERS

A. Rectangular Control Dampers - Standard Construction:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Hat-shaped channel, minimum 12 gauge extruded aluminum, and minimum 4" deep. Caulk or weld seams to prevent leakage.
4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, and overlapping blades and blade seals (overlapping blade seals only is unacceptable).
5. Shaft: Non-cylindrical, solid aluminum or zinc plated steel with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.

6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
7. Blade Seals: Extruded silicone gaskets secured in an integral slot within the blade.
8. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
9. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
10. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
11. Maximum Leakage: Class 1A at 1" w.c. pressure differential for a 24" x 24" damper.
12. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8000 CFM through a 24"x24" damper (2000 fpm).
13. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8000 CFM through a 24"x24" damper (2000 fpm).

B. Round Galvanized Steel Control Dampers:

1. Test leakage and pressure drop per AMCA 500.
2. Frame: Minimum 20 gauge galvanized steel, 10" long.
3. Bearings: Provide thrust bearings for vertical damper applications.
4. Blades: Two-layer galvanized steel, equivalent 14 gauge thickness with neoprene or polyethylene foam seal enclosed in two-piece blade construction up to 24", 10 gauge steel over 24".
5. Linkage: Stainless steel, minimum 1/2" diameter shaft through 24", 3/4" shaft over 24" size. Stainless steel bearings. Shaft shall be securely keyed to blades and of sufficient length to mount direct-coupled actuator. Install damper with the shaft horizontal to the floor. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
6. Maximum Leakage: 8 CFM maximum at 1" w.c. pressure differential for a 24" x 24" damper.
7. Maximum Pressure Drop: 0.10" for 6280 CFM through a 24" damper (2000 fpm).

2.11 DAMPER ACTUATORS

A. Damper Actuators - Electronic:

1. Actuator shall be UL 873 or 60730 listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation. Mount actuator by means of a V-bolt dual nut clamp with a V-shaped toothed cradle, directly couple and mount to the valve bonnet stem, or ISO-style direct-coupled mounting pad. Actuators shall be capable of being mechanically and electrically paralleled to increase torque, if required.
2. Actuators shall be warranted for a period of five (5) years from the date of production, with the first two (2) years unconditional.
3. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
4. Fail-Safe Dampers: Where shown on the drawings or sequences, fail-safe mechanism shall operate the damper to the fail position following power interruption.

    a. Mechanical/Spring: Mechanical spring return mechanism to drive controlled drive to an end position (open or close) on loss of power.

b. Electronic: Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the capacitors. The power fail position shall be proportionally adjustable between 0 to 100% in 10 percent increments with a 10 second operational delay.

5. Feedback: Where shown on drawings or sequences, provide analog feedback signal for positive position indication.
6. Damper End Switches: Where shown on the drawings or sequences, provide end switches to prove damper reaches open/closed position.

2.12 ZONE SENSORS

A. Temperature Sensors:

1. Room Temperature Sensor:

a. Sensor with Setpoint Adjustment and Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45F to 90F operating range, ± 0.50F accuracy, with exposed single setpoint adjustment (no numeric temperature scale - provide with a warmer/cooler or red/blue visual scale), occupied/unoccupied override button with LED.
b. Sensors shall include the following functions:

1) A signal strength on the space sensor display.
2) Error codes shall be displayed on the digital display. Error codes shall include: not associated, address to 000, improper software configuration, input voltage too high, or general sensor failure. Codes shall be indicated on inside of sensor back cover.
3) Provide an LCD display readable in low light conditions, and text display shall be a minimum font size of 12 points.
4) Space/wall sensors shall be supplied with batteries having a minimum life of 15 years.

2. Duct Temperature Sensor:

a. Thermistor or RTD type. Pneumatic transmitters with transducers are not acceptable.

B. Humidity Measuring Devices:

1. Humidity Sensors:

a. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be ± 5% of reading.

2. Humidistats:

a. Room Humidistats: Wall-mounted, proportioning type, with adjustable 2% RH throttling range, operating range from 30% to 80% at temperatures up to 110F, cover with concealed setpoint.
b. Duct Humidistats: Proportioning insertion type, with adjustable 2% RH throttling range and operating range from 20% to 80% at temperatures up to 150F.

C. Pressure Measuring Devices:

1. Pressure Transmitters/Transducer:

   a. Air-to-Air:

      1) Provide transducer having the following minimum performance for measuring duct static pressure for VFD control or measuring differential pressure across filter banks:

         a) Accuracy: ± .0% FS
         b) Non-Linearity, BFSL: ± 0.96% FS
         c) Hysteresis: 0.10% full scale
         d) Non-Repeatability: 0.05% full scale
         e) Thermal Effects (compensated range): 0F to +150F
         f) Maximum Line Pressure: 10 PSI
         g) Zero/Span Shift: 0.033%FS/F
         h) Long Term Stability: 0.5%FS/1 year

D. Carbon Dioxide Sensors:

1. Microprocessor based non-dispersive infrared sensor with range of 0 to 2,000 ppm CO2 with ± 100 ppm accuracy, maximum drift (compensated) of ± 5% full scale in five years, VOC software and hardware sensing, duct mounting where applicable, 0-10V dc or 4-20 mA output directly proportional to ppm, adjustable alarm limit, membrane filter, and terminal block. The diffusion gas chamber in the sensor shall incorporate a reflective light pipe or wave guide surrounded by a gas permeable membrane that prevents particulate contamination of the sensor. Unit shall have selectable IAQ mode with output signal and sum of CO2 and VOC levels.

E. Miscellaneous Devices:

1. Thermostat and Sensor Enclosures:

   a. Clear plastic guard with lock. Wire guard with tamperproof screws. Setpoint shall be adjustable with cover in place. Fasten to wall separately from thermostat. Provide guards in all corridors, gymnasiums, locker rooms, toilet rooms, assembly halls and as noted on the drawings.

2.13 CONDUIT AND BOXES

A. Conduit and Boxes: Refer to Electrical Section 260533 for materials, sizing, and other requirements

B. Conduit and Box Identification (Color and Labeling):

1. Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for raceway and box color requirements.
2. Refer to Electrical Section 260553 for raceway and box labeling requirements.

2.14 WIRE AND CABLE

A. Wire and Cable: Refer to Electrical Section 260513 for wire and cable materials.

1. Wire and Cable Color: Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for wire and cable color requirements.

2.15 SEQUENCE OF OPERATION (PRESCRIPTIVE)

A. The following items are prescriptive sequences. Refer to the drawings for the complete sequence of operations.

B. System Operating Modes: The system controller shall send the equipment controllers Occupied/Unoccupied, Morning Warm-up/Pre-cool, and Heat/Cool modes. If communication is lost, the equipment controllers shall operate using default modes and setpoints.

1. Night Setback: During unoccupied mode, the system shall shut off. If the zone temperature drifts to the unoccupied heating or cooling setpoint, the system shall start up to heat or cool the zone while the OA damper remains closed (unless economizing).
2. Optimal Start: The system controller shall automatically determine the optimal start time such that each zone reaches its occupied setpoint just in time for scheduled occupancy.
3. Demand Controlled Ventilation: For those zones equipped with an occupancy sensor or CO_2 sensor, outdoor airflow shall be reset based on occupancy status and/or measured CO_2 concentration.

C. Single-Zone Constant Volume System:

1. Occupied Heat/Cool: The RTU shall operate the supply fan continuously and modulate (or cycle) compressors, modulate (or stage) heat, and/or enable airside economizing to maintain zone temperature at setpoint. The OA damper shall open to bring in the required amount of ventilation.
2. Morning Warm-Up/Pre-Cool: The RTU shall operate the supply fan and modulate (or cycle) compressors or modulate (or stage) heat to raise/lower zone temperature to its occupied setpoint. The OA damper shall remain closed, unless economizing.
3. Dehumidification: Unit shall modulate hot gas reheat coil to dehumidify if space humidity level exceeds the setpoint.

D. Multiple-Zone VAV System with Terminal Heat:

1. Occupied Heat/Cool: Each VAV terminal shall use pressure-independent control, with airflow measurement, to vary primary airflow and/or modulate (or stage) heat to maintain zone temperature at its occupied setpoint. The RTU shall modulate the supply fan to maintain duct static pressure at setpoint and modulate (or cycle) compressors, modulate (or stage) heat, and/or enable airside economizing to maintain discharge air temperature at setpoint. The OA damper shall modulate in proportion to changing supply fan speed to bring in the required amount of ventilation.
2. Morning Warm-Up/Pre-Cool: Each VAV terminal unit shall vary primary airflow and/or modulate (or stage) heat to raise/lower zone temperature to its occupied setpoint. The RTU shall modulate the supply fan to maintain duct static pressure at setpoint and modulate (or cycle) compressors or modulate (or stage) heat to maintain discharge air temperature at setpoint. The OA damper shall remain closed, unless economizing.

3. Fan Pressure Optimization: The system controller shall monitor all VAV damper positions and reset the RTU's duct static pressure setpoint based on the position of the furthest-open damper.
4. Discharge Air Temperature Reset: The system controller shall reset the RTU's discharge air temperature setpoint based on the current outdoor air temperature or zone cooling/heating demand.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.

B. Install system and materials in accordance with manufacturer's instructions.

C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.

D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.

E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed 48".

F. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.

G. After completion of installation, test and adjust control equipment.

H. Check calibration of instruments. Recalibrate or replace.

I. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section. All hardware, software, equipment, accessories, wiring (power and sensor), relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.

J. Remodeling:

1. All room devices as indicated on the drawings shall be removed by this Contractor. The Contractor shall also prepare the wall for finishes. Preparing the wall shall include patching old anchor holes (after the anchoring device has been removed) and sanding the wall to remove old paint outlines remaining from original devices. The wall shall be painted to match the existing wall prior to the installation of the new room device. If wall covering requires patching, the Contractor shall furnish new wall covering to match existing. If new wall covering is not available to match existing, the Contractor shall furnish a white acrylic or Plexiglas plate, 1/4" thick and sized to cover the void.

K. Labels For Control Devices:

1. Provide labels indicating service of all control devices in panels and other locations.
2. Labels may be made with permanent marking pen in the control panels if clearly legible.

3.2 CONDUIT AND BOXES INSTALLATION

A. Conduit and Box Installation: Refer to Electrical Section 260533 for execution and installation.

B. Conduit and Box Identification (color and labeling) installation. Refer to Electrical Section 260553 for raceway and box identification installation.

C. Outlet Box Schedule: Thermostat/temperature sensor:

1. Dry Interior Locations: Provide 4" square galvanized steel with raised cover to fit flush with finished wall line. When located in concrete block walls, provide square edge title cover of sufficient depth to extend out to face of block or masonry boxes.
2. Other Conditions: Refer to Electrical Section 260533 for requirements.

3.3 WIRE AND CABLE INSTALLATION

A. Wire and Cable Installation: Refer to Electrical Section 260513 for execution and installation.

B. Field Quality Control:

1. Inspect wire and cable for physical damage and proper connection.
2. Torque test conductor connections and terminations to manufacturer's recommended values.
3. Perform continuity test on all conductors.
4. Protection of cable from foreign materials:

a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

C. Installation Schedule:

1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be made with flexible conduit rated for the environment.

3.4 FMCS INSTALLATION

A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.

B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

3.5 COMMISSIONING

A. Upon completion of the installation, this Contractor shall load all system software and start up the system. This Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.

B. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FMCS system operation. Test shall include onsite testing to verify each wireless device is responding to signals from other wireless devices and the cloud-based server without interruption.

C. This Contractor shall prove that the controls network is functioning correctly and within acceptable bandwidth criteria and shall test the system with an approved protocol analysis tool. Provide a log and statistics summary showing that each channel is within acceptable parameters. Each channel shall be shown to have at least 25% spare capacity for future expansion.

D. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

E. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 PREPARATION FOR BALANCING

A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).

B. Check the calibration and setpoints of all controllers.

C. Check the locations of all thermostats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.

D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum CFM.

E. Verify the operation of all interlock systems.

3.7 TEST AND BALANCE COORDINATION

A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

B. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

3.8 DEMONSTRATION AND ACCEPTANCE

A. At completion of installation, provide four hours minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.

3.9 TRAINING

A. On-Site:

1. After completion of commissioning, the manufacturer shall provide 4 consecutive hours of training for 2 Owner's representatives. The training course shall enable the Owner's representatives to perform Day-to-Day Operations as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.

B. Day-to-Day Operations - Training Description:

1. Proficiently operate the system.
2. Understand control system architecture and configuration.
3. Understand FMCS systems components.
4. Operate the web user interface, touchscreen display, and mobile application.
5. Log-on and off the system.
6. Access reports and logs.
7. Adjust and change system setpoints, time schedules, and holiday schedules.
8. Recognize malfunctions of the system by observation of the graphic visual signals.
9. Understand system drawings and Operation and Maintenance manual.
10. Understand the job layout and location of control components.
11. Access data from FMCS controllers and ASCs.

C. System Management - Training Description:

1. Interface with job-specific, third-party operator software.
2. Add new users and understand password security procedures.

3.10 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. 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.

E. Averaging sensors and low limits shall be installed at the top of the assembly with the element on a slight downward incline away from the sensor making a serpentine pattern over the cross-sectional area with elements spaced not over 12" apart and within 6" of the top and bottom of the area.

F. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

G. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Architect/Engineer. TCC shall prime and paint the device enclosure. Color selection by Architect.

H. Install all wall-mounted CO_2 sensors between 3 feet and 6 feet above the floor.

END OF SECTION

SECTION 232300 - REFRIGERATION PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping and Pipe Fittings

B. Moisture and Liquid Indicators

C. Filter-Driers

D. Solenoid Valves

E. Expansion Valves

1.2 QUALITY ASSURANCE

A. Remanufactured specialties are not acceptable.

1.3 REFERENCES

A. ANSI/ASME SEC 8D - Boilers and Pressure Vessels Code, Rules for Construction of Pressure Vessels.

B. ANSI/ASME SEC 9 - Boilers and Pressure Vessels Code, Welding and Brazing Qualifications.

C. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. ANSI/ASME B31.5 - Refrigeration Piping.

E. ANSI/ASTM B32 - Solder Metal.

F. ANSI/ASTM B88 - Seamless Copper Water Tube.

G. ANSI/AWS A5.8 - Brazing Filler Metal.

H. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

1.4 SUBMITTALS

A. Submit shop drawings under provisions of Section 230500.

B. Submit layout of entire piping system including equipment, critical dimensions, and all pipe sizes, traps, valves, and accessories. Layout shall be a custom drawing for this job, not a standard detail. The refrigeration equipment supplier shall stamp the approval on layout drawings.

C. Submit product data for specialties, including manufacturers catalog information.

D. Submit manufacturer's installation instructions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labels in place.

B. Protect piping and specialties from entry of foreign material by leaving caps and plugs in place until installation.

PART 2 - PRODUCTS

2.1 PIPING

A. Design Pressure: 450 psig.

1. Maximum Design Temperature: 250F.

B. Piping - 4" and under; Brazed Joint:

1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
2. Joints: Brazed with silver solder.
3. Fittings: Wrought copper solder joint, ANSI B16.22.
4. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.

2.2 MOISTURE AND LIQUID INDICATORS

A. UL listed, with copper, brass, or copper-plated steel body, flared or solder ends, extended fittings in units up to at least 1-1/8" to allow brazing without removing the cartridge, sight glass, color coded paper moisture indicator that is replaceable without breaking piping connections for units up to 1-1/8" size, and plastic cap; maximum working pressure of 500 psi, and maximum temperature of 200F.

1. Manufacturers:

a. Sporlan
b. Henry Valve Company
c. Alco Valve

2.3 VALVES

A. BA-14: Refrigerant Ball Valve: 3/8" thru 3-1/8", 500 psi, -40F to +300F, full-port up to 2-1/8" size, blow-out proof, PTFE seals, brass ball with equalizing orifice, visible position indication, seal cap, extended copper connections, replaceable stem seals, compatible with all CFC, HCFC, and HFC refrigerants.

1. Manufacturers:

a. Henry Valve Company
b. Superior Valve
c. Alco Valve

2.4 FILTER-DRIERS

A. Replaceable Cartridge Angle Type: ANSI/AHRI 710, UL listed, brass or epoxy-coated steel shell, molded desiccant high-water capacity filter core(s); maximum working pressure of 500 psi; maximum temperature of 275F, maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.

B. Permanent Straight Thru Type: ANSI/AHRI 710, UL listed, steel shell with molded desiccant filter core, maximum working pressure of 500 psi, maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.

2.5 SOLENOID VALVES

A. Valve: AHRI 760; pilot operated; copper or brass body and internal parts; synthetic seat; stainless steel stem and plunger assembly; extended solder ends to permit installation without disassembly; maximum working pressure of 500 psi; normally closed. Maximum pressure drop at system flow of 5 psi for R410a and 3 psi for R134a.

B. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, surge protector and color-coded lead wires, integral junction box, Class F temperature rated, ANSI/UL 429.

2.6 EXPANSION VALVES

A. Angle or Straight Thru Type: ANSI/AHRI 750; materials suitable for system refrigerant, external equalizer, adjustable super heat setting, balanced port design, suitable for horizontal or vertical installation, with replaceable capillary tube and remote sensing bulb.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10F super heat. Select to avoid being undersized at full load or excessively oversized at part load.

2.7 EXPANSION COMPENSATION

A. Assembly consisting of two flexible connectors, two copper flexible connectors, two 90-degree elbows, and a 180-degree return pipe. Unit shall be in the form of a pipe loop.

B. Connectors shall have corrugated copper hose bodies with copper braided casings.

C. Connectors shall be rated for 150 psi working pressure at 70F.

D. Sizes 2" and smaller shall have copper sweat ends.

E. Connectors shall be suitable for 1/2" permanent misalignment.

F. Manufacturer:

1. Metraflex Type MLS

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

3.2 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

F. Group piping whenever practical at common elevations and locations. Slope piping 1% in direction of oil return.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access doors for concealed valves and specialties.

J. Where pipe support members are welded to structural building frame, brush clean, and apply zinc rich primer to welding.

K. Insulate piping and equipment; per Section 230719 and Section 230716.

L. Provide external equalizer piping on expansion valves, and locate expansion valve sensing bulb immediately downstream of evaporator on suction line. Connect distributor to expansion valve outlet.

M. Install flexible connectors parallel to the shafts of compressors.

N. Fully charge system with refrigerant after testing.

3.3 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately.

B. All pipe, fittings, valves, equipment and accessories shall have factory applied identification sufficient to determine their conformance with specified requirements.

C. Exercise care at all times to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.

D. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings.

F. Cut all pipe to exact measurement and install without springing or forcing.

3.4 APPLICATION

A. Provide solenoid valves in liquid lines of systems, in oil bleeder lines to stop flow of oil and refrigerant into the suction line when system shuts down, and in hot gas bypass lines, as applicable.

B. Provide refrigerant charging valve connections.

C. Provide replaceable cartridge filter-driers, with three-valve bypass assembly and suction filters without bypass assembly.

3.5 JOINING OF PIPE

A. Brazed Joints:

1. Make up joints with brazing filler metal conforming to ANSI/AWS A5.8. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt, and grease just prior to brazing. Apply flux evenly, but sparingly, to all surfaces to be joined. Brazing filler metal with a flux coating may also be used. Heat joints uniformly to proper brazing temperature so braze filler metal flows to all mated surfaces. Wipe excess braze filler metal, leaving a uniform fillet around cup of fitting.
2. Flux shall conform to ANSI/AWS A5.31.
3. Remove composition discs and all seals during brazing if not suitable for a minimum of 840F or greater than the melting temperature of the brazing filler metal, whichever is greater.

B. Mechanical Press Connection:

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
2. Examination: Upon delivery to the jobsite, examine copper tubing and fittings for debris, defects, incise marks (manufacturer's engraving on tube), holes, or cracks.

3. Fully insert tubing into the fitting and mark tubing.
4. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
5. Joint shall be pressed with a tool approved by the manufacturer.
6. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

C. Axially Swaged Connection:

1. Brass axially swaged connectors shall be installed in accordance with the manufacturer's installation instructions.
2. Installers shall be trained by a certified Vulkan LOKRING trainer. Provide proof of certification upon request.

3.6 FIELD QUALITY CONTROL

A. Test piping system with nitrogen at 300 psig for at least 8 hours without loss of pressure.

B. Comply with ASHRAE Standard 147 for refrigerant system integrity testing.

C. After pressure testing, evacuate all refrigerant piping to at least 28" of mercury for 24 hours without loss of vacuum. Ensure moisture does not enter the piping prior to and during the tests.

END OF SECTION

SECTION 233100 - DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Galvanized Ductwork

B. Aluminum Ductwork

C. Ductwork Reinforcement

D. Ductwork Sealants

E. Rectangular Ductwork

F. Round and Flat Oval Ductwork

G. Exposed Ductwork (Rectangular, Round, or Oval)

H. Flexible Duct

I. Acoustical Lagging

J. Leakage Testing

K. Ductwork Penetrations

L. Duct Cleaning

M. Painting

1.2 REFERENCES: Conform to all applicable requirements of the following publications:

A. ADC Flexible Duct Performance and Installation Standards, 3rd Edition 1996.

B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASHRAE - Handbook Systems and Equipment; Chapter 19 - Duct Construction.

D. ASHRAE - Handbook Fundamentals; Chapter 21 - Duct Design.

E. ASHRAE 170 (latest published edition) - Ventilation of Health Care Facilities.

F. ASTM A90 - Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

G. ASTM A167- Stainless & Heat-Resisting Chromium-Nickel Steel Plate, Sheet, & Strip.

H. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

I. ASTM A924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

J. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

K. ASTM E90-02 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

L. ASTM E413-87 - Classification for Rating Sound Insulation.

M. AWS D9.1M/D9.1 - Sheet Metal Welding Code.

N. CDPH Standard Method V1.1-2010 - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.1.

O. IECC - International Energy Conservation Code (latest published edition)

P. NADCA ACR - Assessment, Cleaning, and Restoration of HVAC Systems.

Q. NADCA Standard 05 - Requirements for the Installation of Service Openings in HVAC Systems.

R. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.

S. NFPA 90B - Installation of Warm Air Heating and Air- Conditioning Systems.

T. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Equipment.

U. SCAQMD Rule 1168 - South Coast Air Quality Management District Rule 1168 - Adhesive and Sealant Applications.

V. SMACNA - Air Duct Leakage Test Manual.

W. SMACNA - HVAC Duct Construction Standards.

X. SMACNA - Phenolic Duct Construction Standard 022.

Y. SMACNA - Round Industrial Duct Construction Standards - 1999 Edition.

Z. UL 181 - Factory-Made Air Ducts and Air Connectors.

AA. UL 181A - Closure Systems for Use with Rigid Air Ducts and Air Connectors

BB. UL 181B - Closure Systems for Use with Flexible Air Ducts and Air Connectors.

CC. UL 1978 - Standard for Grease Ducts.

DD. UL 2221 - Standard for Tests of Fire Resistive Grease Duct Enclosure Assemblies.

1.3 SUBMITTALS

A. Submit shop drawings per Section 230500.

B. Submittals in this Section demonstrate compliance with duct fabrication standards and product requirements.

C. Submit duct fabrication standards in compliance with SMACNA and these specifications. Clearly indicate metal gauges, reinforcement, and joining methods intended for use for each pressure classification. Furnish details of all common duct fittings and joint connections to be used on this project.

D. The Architect/Engineer may require field verification of sheet metal gauges and reinforcing to verify compliance with these specifications. At the request of the Architect/Engineer, the contractor shall remove a sample of the duct for verification. The contractor shall repair as needed.

E. Coordination drawings are specified separately and are not included as part of these submittals.

F. Duct Layout Drawings (Coordination Input):
Prepare detailed duct layout drawings indicating proposed routing, fittings, elevations, dimensions including insulation thickness, hangers, access doors, and coordination with structural and architectural elements. These drawings are intended to serve as the ductwork basis for the coordination drawing process defined in Section 230500. Duct layout drawings may be submitted for general conformance with design intent when requested, but will not be reviewed for full multi-trade coordination. Duct layout drawings are not coordination drawings and do not relieve the Contractor of responsibility to comply with Section 230500.
1. Duct layout drawings shall include, at a minimum, the following information: 1/4" minimum scale complete with the following information:
2. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
3. Differentiate ducts that are wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
4. Room names and numbers, ceiling types, and ceiling heights.
5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
6. Verify clearances and interferences with other trades prior to preparing drawings. IMEG will provide electronic copies of ventilation drawings for contractor's use if the contractor signs and returns the "Electronic File Transfer" waiver. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Refer also to Section 230500.

G. Duct Leakage Test Summary Report: Upon completion of the pressure test described in Part 3, the Contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

1.4 DEFINITIONS

A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.

B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.

C. Exterior Duct: Ductwork located outside the conditioned envelope including exposed ductwork above the roof, outside exterior walls, in attics above insulated ceilings, inside parking garages, and crawl spaces.

D. Interior Duct: Ductwork located within the conditioned envelope including return air plenums and indirectly conditioned spaces.

1.5 COORDINATION DRAWINGS

A. Comply with coordination drawing requirements of Section 230500. Provide ductwork layout information necessary to support the overall coordination drawing process. Ductwork shall serve as the baseline system for coordination with piping, electrical, fire protection, and other trades. Duct layout drawings prepared under this Section may be used as the ventilation contractor's coordination file and incorporated into the composite coordination drawings package required by Section 230500.

B. Duct drawings shall be at 1/4" minimum scale complete with the following information:

1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
3. Location and size of all duct access doors.
4. Room names and numbers, ceiling types, and ceiling heights.
5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
6. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings. Architectural plans will need to be obtained from the Architect.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS AND SUPPORTS

A. Rectangular Duct - Single Wall:

1. General Requirements:

a. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
b. Transitions shall not exceed the angles in Figure 4-7.

2. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:

a. All ducts shall be cross-broken or beaded.
b. Snap lock seams are not permitted.
c. Turning vanes shall be used in all 90-degree mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:

1) Type 2:

a) Description: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.

b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

2) Type 3 (acoustical - where acoustical lagging is located or as noted on drawings):

a) Description: Same as Type 2, except filled with fiberglass and with slotted or perforated inner curve. Minimum insertion loss of 9 dB at 250 Hz and 6 dB at 1 KHz.
b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

3) Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.
4) Runners must be installed at a 45-degree angle. Elbows with different size inlet and outlet must be radius type.
5) Omitting every other vane is prohibited.

d. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. Mitered elbows (with or without turning vanes) may not be substituted for radius elbows. Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.
e. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45-degree entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.
f. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.
g. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45-degree rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.
h. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30-degree maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30-degree angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.
i. All lined duct shall utilize dovetail joints where round or conical taps occur. The dovetail joints shall extend past the liner before being folded over.
j. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.
k. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.

1) Apply sealant to all inside corners. Holes at corners are not acceptable.
2) Manufacturers:

a) Ductmate Industries - 25/35/45

b) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

l. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.

1) Apply sealant to all inside corners. Holes at corners are not acceptable.
2) Flanges shall be 24-gauge minimum (not 26 gauge).
3) Manufacturers:

a) Lockformer TDC
b) TDF
c) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

B. Rectangular Duct - Double Wall:

1. All applicable portions of Rectangular Duct - Single Wall shall apply.
2. Furnish and install double-wall insulated airtight duct as shown on the drawings.
3. Duct Construction:

a. Galvanized steel exterior wall with perforated galvanized interior wall: Interior galvanized surfaces shall have round perforations. Inner liner shall have a film between the insulation and the perforated interior wall to prevent air contact with the insulation.
b. Rectangular double wall duct shall be suitable for pressures listed in the ductwork application schedule.

c. All ductwork gauges and reinforcement shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space-consuming reinforcement.
d. Ducts shall be 1" thick and completely metal enclosed with annular space completely filled with 1-1/2# density glass fiber insulation. Insulation shall have flame spread/smoke developed ratings of less than 25/50 per ASTM E84, NFPA 255, or UL 723.
e. Divided flow fittings may be separate fittings or factory installed taps with the following construction requirements:

1) Airtight, continuous welds at intersection of fitting body and tap.
2) Tap liner spot welded to inner liner with weld spacing not over 3".
3) Insulation packed around the tap area for complete cavity filling.
4) Carefully fit branch connections to cut-out openings in inner liner without spaces for air erosion of insulation or sharp projections for noise and airflow disturbance.

f. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
g. Support inner liner of ducts and fittings with metal spacers welded to maintain spacing and concentricity.
h. Formed-on flanged transverse joint systems are acceptable if they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.

1) Apply sealant to all inside corners. Holes at corners are not acceptable.
2) Flanges shall be 24-gauge minimum (not 26 gauge).
3) Manufacturers, Formed-on Flanged Joint Systems:

a) Lockformer TDC
b) TDF
c) United McGill
d) Sheet Metal Connectors
e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

C. Round and Flat Oval Spiral Seam Ductwork - Single Wall:

1. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.

2. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
3. 90-degree elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
4. Duct and fittings shall meet the required minimum gauges listed in Chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
5. Ductwork shall be suitable for velocities up to 5,000 fpm.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
9. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.
10. Transverse Joint Connections:

a. Crimped joints are not permitted.
b. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
c. Ducts and fittings larger than 36" shall have flanged connections.
d. Secure all joints with at least 3 sheet metal screws before sealing.
e. Manufacturers, Slide-on Flanges:

1) Ductmate Industries - SpiralMate
2) Accuflange
3) Sheet Metal Connectors are acceptable.

f. Manufacturers, Self-Sealing Duct Systems:

1) Lindab
2) Ward "Keating Coupling"

D. Round and Flat Oval Spiral Seam Ductwork - Double Wall:

1. Conform to applicable portions of Rectangular Duct Section. Spiral seam round or flat oval double wall ductwork may be substituted for double wall rectangular ductwork where approved by the Architect/Engineer. Double wall spiral seam ductwork shall meet the standards set forth in this specification. Ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.

2. Interior ducts shall have an airtight outer pressure shell, a 1" insulation layer, and a perforated inner wall that completely covers the insulation.
3. Exterior ducts shall have an airtight outer pressure shell, a 2" insulation layer, and a perforated inner wall that completely covers the insulation.
4. All perforated inner walls shall have a 25/50 compliant liner between the insulation and the perforated inner wall to prevent contact between fiberglass and air stream. For exterior ductwork this shall form a continuous vapor barrier.
5. Insulation shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.
6. 90-degree elbows shall be smooth radius or have a minimum of 5 mitered joints, and R/D of at least 1.5.
7. Duct and Fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA standards for the specified pressure class. Ribbed and lightweight duct are not permitted.
8. Ductwork shall be suitable for up to 5,000 fpm velocity.
9. Divided flow fittings may be separate fittings or factory installed taps with the following construction requirements:

    a. Sound, airtight, continuous welds at intersection of fitting body and tap.
    b. Tap liner welded to inner liner with weld spacing not over 3".
    c. Insulation packed around the tap area for complete cavity filling.
    d. Carefully fit branch connections to cut-out openings in inner liner without spaces for air erosion of insulation or sharp projections for noise and airflow disturbance.

10. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
11. Support inner liner of ducts and fittings with metal spacers welded to maintain spacing and concentricity.
12. Ducts with minor axis under 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
13. Transverse Joint Connections:

    a. Crimped joints are not permitted.
    b. Provide couplings to align the inner liners. Butt joints are not permitted for inner liners. Make alignment by extending the liner of the fitting into the duct or by using a double concentric coupling with the two couplings held by spacers for rigidity and wall spacing.
    c. Above 34" ID provide a separate coupling for inner alignment with the pressure shells joined by angle ring flanged connections.
    d. Use outside slip couplings for fitting-to-fitting joints.
    e. Secure all joints with at least 3 sheet metal screws before sealing.
    f. Manufacturers, Slide-on Flanges:

        1) Ductmate Industries - SpiralMate
        2) Accuflange
        3) Sheet Metal Connectors

g. Manufacturers, Self-Sealing Duct System:

1) Lindab
2) Ward "Keating Coupling"

E. Round Snap-Lock Seam Ductwork - Single Wall:

1. Factory sealed snap-lock pipe. Transverse and longitudinal seams shall contain factory-applied self-sealing EPDM and co-polymer gasket. Snap-lock shall conform to SMACNA RL-8. Duct and gasket material shall meet the flame/smoke spread rating of 25/50 per ASTM-E84.
2. G-60 galvanized coating meeting ASTM A653 and ASTM A90 G-90 galvanized steel aluminum meeting ASTM B209 Alloy 3003 Temper H14 304 stainless steel meeting ASTM A480 2B Finish.
3. Snap-lock seams are only permitted on systems between -1"w.c. and 2"w.c. pressure class.
4. 90-degree elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
5. Duct and fittings shall meet the required minimum gauges listed in Chapter 3 of the SMACNA requirements for the specified pressure class.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Manufacturers:

a. GreenSeam Industries.

F. Hangers and Supports General Requirements:

1. Hanger and support materials shall be as defined within Materials and Application Specific section below.
2. Strap Hangers: Strap hanger shall be a minimum of 1 inch, 18 gauge attached to the bottom of ducts with spacing as required by SMACNA.
3. Cable Hangers:

a. Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork.
b. Manufacturers; Supports:

1) Gripple
2) Ductmate
3) Duro Dyne
4) Architect/Engineer approved

c. Aircraft cable with 2-point support in standard horseshoe arrangement. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. 8'-0" OC and as required by CMC/UMC and SMACNA guidelines.

4. Integral Corner Connector Hanger: Integral hanger and corner assembly for use with TDC/TDF style duct flanges. Die stamped offset hanger connects to the flanged corner assembly. For use with aircraft cable or 1/4" or 3/8" diameter threaded rods. Tested to hold up to 1,400 lbs.. Install per manufacturer’s ratings and instructions.

a. Manufacturers; Supports:

1) EZ Hanger

2.2 MATERIAL AND APPLICATION SPECIFIC

A. Galvanized Steel:

1. General Requirements:

a. Duct and reinforcement materials shall conform to ASTM A653 and A924.
b. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
c. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
d. Ductwork reinforcement shall be of galvanized steel.

2. Duct Hangers and Support Material:

a. Ductwork hangers and supports shall be of galvanized or painted steel.
b. All fasteners shall be galvanized or cadmium plated.

B. Duct Hangers and Support Material:

1. Ductwork hangers and supports shall be of galvanized or painted steel.
2. All fasteners shall be galvanized or cadmium plated.

a. Duct system shall be connected and sealed per manufacturer's recommendations to meet the leakage, pressure class, and velocity noted within these specifications.

3. Install hangers and supports per manufacturer's recommendations.

C. Exposed Ductwork (Rectangular, Round, and Flat Oval):

1. The following applies to all ductwork exposed in finished areas in addition to requirements noted above:

a. Provide extra shipping protection. Use Cardboard or other protective means to prevent dents and deformed ends.
b. Provide cardboard or other means of protection during field fabrication. Protect from scratches. Provide stiffeners to retain shape during fabrication.
c. Remove all identification stickers and thoroughly clean exterior of all ducts.
d. Locate fitting seams on least visible side of duct.
e. Provide exterior finish suitable for field painting without further oil removal.
f. Provide ramp-type internal joint couplings. Provide bead of sealant around the inside of the duct about 1/2" from the end of the duct.
g. Manufacturers, Slide-on Flanges:

1) Ductmate Industries
2) Accuflange
3) Sheet Metal Connectors

h. Manufacturers, Self-Sealing Duct System:

1) Lindab
2) Ward "Keating Koupling"

i. The system shall be free of visible dents and scratches when viewed from normal occupancy.
j. All insulation shall be internal, except at reheat coils.

2. In addition to the paragraphs above, this section applies to all ductwork specified or shown as "Architecturally Exposed":

a. All spiral ductwork fittings shall be carbon arc welded.
b. Grind all welds to remove irregularities.
c. Conical taps shall be one piece. Taps for grilles and takeoffs shall be factory installed with a continuous weld and ground smooth.
d. Welds shall be ground smooth and painted.
e. All architecturally exposed ducts shall be round or flat oval except where not possible (grilles, reheat coils, etc.).

3. Alternate manufacturers, including shop fabricated duct, must be reviewed before installation. The following information is required:

a. Metal gauge of duct and fittings.
b. Fitting type and construction.
c. Type and size of reinforcement.

4. Hangers for Exposed Ductwork:

a. Round Ducts:

1) Threaded rod with duct fixing bracket and metal strap. Provide single threaded rod centered on the duct. Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel wrapping the circumference of the duct. Spacing as required by SMACNA guidelines.
2) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Spacing and cable size as required by SMACNA guidelines.

a) Manufacturers, Supports: Gripple, Ductmate, Duro Dyne, Architect/Engineer approved.

3) Aircraft cable with 2-point support in standard horseshoe arrangement. Spacing and cable size as required by SMACNA guidelines.

b. Rectangular Ducts:

1) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" in maximum dimension. Corner saddles are required when supporting rectangular ductwork. Spacing and cable size as required by SMACNA guidelines.

a) Manufacturers, Supports: Gripple, Ductmate, Duro Dyne, Architect/Engineer approved.

2) Aircraft cable with 2-point support in standard horseshoe arrangement. Corner saddles are required when supporting rectangular ductwork. Spacing and cable size as required by SMACNA guidelines.

c. Strut-channel and all-thread rod is not acceptable for exposed ductwork.
d. All fasteners shall be galvanized or cadmium plated.

2.3 DUCTWORK REINFORCEMENT

A. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.

1. Ducts must be over 18" wide.
2. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
3. Tie rods must not exceed 1/2" diameter.
4. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

2.4 DUCTWORK SEALANTS

A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20F to +175F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30F to +175F and 2000-hour minimum UV resistance per ASTM G-53.

B. Two-part joint sealers shall consist of a minimum 3" wide mineral-gypsum compound impregnated fiber tape and a liquid sealant. Sealant system shall meet the following requirements: maximum 48-hour cure time, service temperature of 0F to 200F, resistant to mold, mildew, and water, flame spread rating below 25 and smoke developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30F to +175F and 2000-hour minimum UV resistance per ASTM G-53.

2.5 FLEXIBLE DUCT

A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.

B. Flame Spread/Smoke Developed: Not over 25/50.

C. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.

D. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.

E. Standard:

1. Flexible duct shall have corrosion-resistant wire helix, bonded to an inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh. Usage: All areas unless noted otherwise.
2. Inner liner shall be airtight and suitable for 6" WC static pressure through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft2*F*hr/Btuh. Temperature range of at least 0 to 180F. Maximum velocity of 4,000 fpm. "R" value shall not be less than 4.0 ft2*F*hr/Btuh. Ducts in unconditioned spaces and ventilated attics: "R" value shall not be less than 6.0 ft2*F*hr/Btuh.
3. Usage:
    a. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
    b. Connections to air inlets and outlets. Do not exceed 5'-0" in length.

F. Acoustic:

1. Flexible duct shall be acoustic rated in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL. Insertion loss values noted below are for flow velocities less than 2,500 fpm. Submittals shall include insertion losses ratings per sizes and lengths listed below regardless of sizes shown on the drawings.
2. Flexible duct shall have corrosion-resistant wire helix, bonded to a nylon fabric core inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh. Usage: All areas unless noted otherwise.
3. Inner liner shall be airtight and suitable for 6" WC static pressure through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft2*F*hr/Btuh. Temperature range of at least 0 to 180F. Maximum velocity of 4,000 fpm. "R" value shall not be less than 4.0 ft2*F*hr/Btuh. Ducts in unconditioned spaces and ventilated attics: "R" value shall not be less than 4.2 ft2*F*hr/Btuh.
4. Minimum Acoustic Insertion Losses per octave band:
    a. Straight Duct:

Dia	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	6 ft	4.0	13	15	15	16	17	16
6" ø	3 ft	2.3	4.9	5.3	5.3	5.5	5.8	5.4
8" ø	6 ft	5.7	14	13	15	16	18	16
8" ø	3 ft	2.9	5.0	4.9	5.7	5.6	5.8	5.6
12" ø	6 ft	5.5	13	12	15	15	18	13
12" ø	3 ft	2.8	4.8	4.7	5.3	5.3	5.8	4.9

    b. 90deg Elbow:

Dia	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	6 ft	10	15	16	17	18	17	18

Dia	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	3 ft	3.8	5.4	5.5	5.7	5.9	5.8	5.9
8" ø	6 ft	10	15	16	17	16	18	18
8" ø	3 ft	2.4	5.3	5.6	5.8	5.6	5.9	6.0
12" ø	6 ft	11	14	15	16	15	16	15
12" ø	3 ft	4.4	5.1	5.3	5.5	5.4	5.6	5.3

5. Usage:

    a. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
    b. Connections to air inlets and outlets. Do not exceed 5'-0" in length.
    c. Acceptable Manufacturers:

        1) Flexmaster USA - Type 6
        2) Thermaflex M-Ke

G. Radius Forming Elbows:

1. Flexible plastic radius forming elbow for use with flexible ducts to create 90deg elbow. One size for 6" to 16" diameter ducts. UL listed for return plenum spaces.
2. Usage: All supply air terminals with flexible ductwork connection.
3. Installation: Attach to flex duct and secure draw bands without crushing flex duct to form smooth radius elbow. Suspend radius forming elbow to structure. Install per manufacturer's instructions.
4. Acceptable Manufacturers:

    a. Hart & Cooley - Smartflow
    b. Thermaflex - Flexflow
    c. Titus - Flexright

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide openings in ducts for thermometers and controllers.

B. Locate ducts with space around equipment for normal operation and maintenance.

C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.

D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.

E. Supply ductwork shall be free of construction debris, and shall comply with Level "B" of the SMACNA Duct Cleanliness for New Construction Guidelines.

F. Repair all duct insulation and liner tears.

G. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.

H. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.

I. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.

J. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.

K. Install all exterior ductwork per SMACNA Fig. 6-3. Where drawings do not indicate otherwise, ductwork seams and joints shall be sealed watertight and pitched to shed water.

L. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible and the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, where applicable. Refer to Section 230550 for seismic requirements.

M. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.

N. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.

3.2 DUCTWORK APPLICATION SCHEDULE

A. Refer to Ductwork Application Schedule on drawings for specific requirements for system, material, shape, pressure class, seal class and insulation application.

3.3 SPECIAL INSULATION REQUIREMENTS

A. Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.):

1. Insulation:

a. ASHRAE 90.1-2022: 1-1/2" thick Type A (R=4.5)
b. IECC-2021: 1-1/2" thick Type A (R=4.5)

B. All Terminal Air Box/ Reheat Coil Headers and Duct Mounted Coil Headers:

1. Insulation: 1-1/2" thick Type A (R=4.5)

C. Linear Diffuser Supply Plenum:

1. Insulation:

a. ASHRAE 90.1-2022: 1/2" thick Type C (R=1.8)
b. IECC-2021: 1/2" thick Type C (R=1.8)

3.4 DUCTWORK SEALING

A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.
4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

B. All ducts systems, regardless of pressure class, shall be Seal Class A as defined by Section 5-1 of SMACNA HVAC Air Duct Leakage Test Manual per the Energy Code, unless specifically noted otherwise. Seal Class A shall include sealing of all transverse joints, longitudinal seams, and duct wall penetrations with welds, gaskets, mastics, or fabric-embedded mastic system. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, 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.

C. Double-wall ductwork: Install insulation end fittings at all transitions from double to single-wall construction.

D. Special Requirements for Dedicated Outside Air Systems (DOAS):

1. Apply aluminum-based adhesive sealant tape at non-flanged joints on ducts serving dedicated outside air supply (DOAS) and exhaust system in addition to Class A sealant.
2. Apply aluminum-based adhesive sealant tape on TAB boxes (all seams and joints of the box and duct connections) serving dedicated outside air supply (DOAS) system.

3.5 TESTING

A. Interior Duct - Less than 3" WG (positive or negative):

1. Leak testing of these pressure classes is not normally required for interior ductwork (inside the building envelope). However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.
2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
3. Seal ducts to bring the air leakage into compliance.
4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

B. Interior Duct - 3" WG and Above (positive or negative):

1. A minimum of 25% of interior ductwork (inside the building envelope) shall be tested. The Owner or designated representative shall select the sections to be tested. If duct has outside wrap, testing shall be done before it is applied.

2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
3. Seal ducts to bring the air leakage into compliance.
4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

C. Exterior Duct - 1/2" WG and Above (positive or negative):

1. All exterior ductwork (outside the building envelope) shall be completely pressure tested. If duct has outside wrap, testing shall be done before it is applied.
2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
3. Seal ducts to bring the air leakage into compliance.
4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

D. Pressure Test Procedure:

1. Testing shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:

    a. The required leakage class for Seal Class A, rectangular ducts, shall be 4; round shall be 2.
    b. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.
    c. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
    d. All joints shall be felt by hand, and all discernible leaks shall be sealed.
    e. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
    f. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.
    g. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.
    h. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.
    i. Positive pressure leakage testing is acceptable for negative pressure ductwork.

E. Aerosol Sealed and Tested Procedure:

1. Duct Preparation:
    a. Inspect air distribution systems for major leakage sites and significant accumulation of debris.
    b. Remove all debris and significant dust and dirt (greater than 1/8 inch deep) in air distribution system using NADCA approved duct cleaning method.
    c. Ensure adequate structural support for new and existing ductwork, including structural integrity of all mechanical duct joints and transitions per SMACNA standards.
    d. Temporarily remove or protect from aerosol particles building controls, fire and smoke sensors as recommended by manufacturer.
    e. Temporarily disable fire alarms and notify appropriate authorities.
    f. Temporarily isolate air-moving equipment and block off air inlets and outlets, and other devices and appurtenances as recommended by the manufacturer.

g. Protect occupied spaces from aerosol particles using manufacturer procedures.
h. All work shall be done in a substantial and workmanlike manner by factory trained technicians.

2. Duct Sealing:
   a. Repair all major leakage sites greater than 1/2 inch across using mastic and fiberglass mesh tape per SMACNA standards.
   b. Mastic and fiberglass mesh tape shall meet UL 181 standards.
   c. Seal existing ductwork from the inside using automated aerosolized sealant injection.
      1) Manufacturer: Aeroseal LLC, 225 Byers Rd., Miamisburg, OH 45342, 937-428-9300, www.aeroseal.com
      2) Application must be performed by a manufacturer approved service provider.
      3) Sealant shall comply with UL Outline Scope 1381.
      4) Sealant must cure with 2 hours with no VOC off-gassing thereafter.
      5) Sealant shall remain elastic after curing.
      6) Sealant shall be deposited substantially at areas of leakage only.
   d. Provide pre-sealing, post-sealing and sealing profile reports for all duct sections sealed.
   e. Repair all injection and test holes in existing ductwork using patching plates sealed tight per SMACNA standards.
   f. Any injection ports in duct board shall be made and repaired using pumpkin-cuts.
   g. Any insulation (internal or external) shall be replaced on the patching plate.
3. Duct Testing:
   a. Provide pre-sealing and post-sealing leakage profile reports indicating percentage reduction of leakage for supply, return and exhaust ductwork and shafts.
   b. Use manufacturer calibrated blower fan box with digital manometer to measure leakage before and after sealing.
   c. Following completion of air handling unit installations, duct repairs, and duct sealing, test all ductwork to ensure that the air distribution system is properly sealed.
      1) The supply ducts shall have air losses of less than 3% of the total air flow volume measured at the fan or air-moving device.
      2) The return ducts shall have air losses of less than 3% of the total air flow volume measured at the fan or air-moving device.
      3) The exhaust ducts shall have air losses of less than 5% of the total air flow volume measured at the fan or air-moving device.
      4) Ducts shall be leak tested at a static pressure that is as close as possible to the system average operating static pressure. Duct test pressure should not exceed the lesser of the duct static pressure construction class, the duct system design static pressure or 2.5 in. w.g.
4. Duct Reassembly and Cleanup:
   a. Reinstall building controls and smoke detectors.
   b. Enable fire alarms and notify appropriate authorities.
   c. Remove blocking, reinstall grills and registers, and enable air handling fans.
   d. Cleanup sealant residue that may have adhered to surfaces in occupied areas as recommended by the Manufacturer.
   e. All work shall be done in a substantial and workmanlike manner by factory-trained technicians
5. Warranty:
   a. The Contractor shall warrant that the aerosol sealant application will be free of defects for a period of 3 years from date of the sealing application. If defects should occur during this period, the Contractor shall repair or replace the defective duct seals, including the direct labor costs for performing the repair or replacement, at no additional cost to the Owner.

3.6 DUCTWORK PENETRATIONS

A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.

B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.

C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of all openings in finished rooms. Install escutcheon ring at all round duct openings in finished rooms. Trim strips and rings shall be same material and finish as exposed duct.

END OF SECTION

SECTION 233300 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manual Volume Dampers.

B. Fire Dampers.

C. Fire/Smoke Dampers.

D. Control/Fire/Smoke Dampers.

E. Smoke Dampers.

F. Backdraft Dampers.

G. Fabric Connectors.

H. Drip Pans.

I. Duct Access Doors.

J. Duct Access Sleeve.

K. Duct Test Holes.

L. Remote Volume Control Devices.

M. Temperature Control Dampers.

1.2 REFERENCES

A. AMCA Guide for Commissioning and Periodic Performance Testing of Fire, Smoke and Other Life Safety Related Dampers.

B. ASTM E477-20 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

C. ASTM E2336-04 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.

D. NFPA 72 - National Fire Alarm and Signaling Code

E. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.

F. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.

G. NFPA 92 - Standard for Smoke Control Systems.

H. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives.

I. SMACNA - HVAC Duct Construction Standards (latest edition).

J. UL 33 - Heat Responsive Links for Fire-Protection Service.

K. UL 555 - Fire Dampers and Ceiling Dampers.

L. UL 555C - Ceiling Dampers.

M. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.

N. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 230500.

B. Submit manufacturer's installation instructions.

C. Submit certification that ductwork accessories will withstand seismic forces defined in Section 230550. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 MANUAL VOLUME DAMPERS

A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.

B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.

C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.

E. Provide locking quadrant regulators on single and multi-blade dampers.

F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

H. Contractor assembled modular manual dampers are acceptable as long as it contains the components listed above.

2.2 DYNAMIC CURTAIN BLADE FIRE DAMPERS (FD)

A. Furnish and install fire dampers in ducts, where shown on the drawings, at the point where they pass through a fire wall or a floor and in all other locations required by the local fire department, The National Fire Protection Association's Pamphlet No. 90A and all other applicable codes.

B. Fire dampers shall be UL 555 listed for 1-1/2-hour fire resistance unless noted otherwise, dynamic rated with heated airflow at 2000 fpm and 4" WC, and have all blades stacked out of the airstream (Type B).

C. Fire dampers shall be held open by a fusible link rated at 165F unless otherwise called for on the drawings or by local codes.

D. Dampers shall be installed in sleeves of sufficient thickness to comply with the UL555 Standard for Safety Fire Dampers listing of the damper. Where UL555 permits sleeve thickness to be the same as that of the duct gauge, such thickness shall not be less than that specified in NFPA 90A for breakaway style sleeves. If a breakaway style duct/sleeve connection is not used, the sleeve shall be a minimum of 16 gauge for dampers up to 36" wide by 24" high and 14 gauge for dampers exceeding 36" wide by 24" high. Damper sleeve shall not extend more than 6" beyond the firewall or partition unless damper is equipped with a factory installed access door. Sleeve may extend up to 16" beyond the firewall or partition on sides equipped with the factory installed access door.

E. Maximum Curtain Damper Size (Multi-section) at less than 2000 fpm:

1. Vertical Installation: 72"w x 48"h or 48"w x 72"h or 120"w x 24"h.
2. Horizontal Installation: 36"w x 48"h or 48"w x 36"h.

F. Maximum Curtain Damper Size at greater than 2000 fpm: Vertical or horizontal - 24"w x 24"h.

G. Locate access door in the ductwork for visual inspection and on the latch side to replace link easily. Each access door shall have a label with letters at least 1/2" high, reading "FIRE DAMPER".

2.3 DYNAMIC MULTIPLE BLADE FIRE DAMPERS (FD)

A. General:

1. Furnish and install fire dampers in ducts, where shown on the drawings, at the point where they pass through a fire/smoke partition and in all other locations required by the local Fire Department, the National Fire Protection Association Pamphlet No. 90A, and all other applicable codes.
2. Fire Resistance Rating: Assemblies shall be 1-1/2 hour rated under UL Standard 555 unless noted otherwise on drawings.
3. Airflow Rating: Dynamic rated at 2000 fpm and 4" WC.
4. Temperature Rating: Assemblies shall be UL 555S listed for use in smoke control system with a 250F temperature rating.
5. Leakage Rating: Class II. Shall not leak over 20 CFM per square foot at 4" WC (Class II).

B. Construction:

1. Frame: 5 inches x minimum 16 gauge roll formed, galvanized steel hat-shaped channel, reinforced at corners.
2. Sleeve: Dampers shall be installed in sleeves of sufficient thickness to comply with UL555 Standard for Safety Fire Dampers listing of the damper. Where UL555 permits sleeve thickness to be the same as that of the duct gauge, such thickness shall not be less than that specified in NFPA 90A for breakaway style sleeves. If a breakaway style duct/sleeve connection is not used, the sleeve shall be a minimum of 16 gauge for dampers up to 36" wide by 24" high and 14 gauge for dampers exceeding 36" wide by 24" high. Damper sleeve shall not extend more than 6" beyond the firewall or partition unless damper is equipped with an actuator or factory installed access door. Sleeve may extend up to 16" beyond the firewall or partition on sides equipped with the actuator or factory installed access door.
   a. Wall Grille: When Damper is installed immediately behind wall grille, provide Style G sleeve with damper offset in sleeve with 3/4" full length grille mounting flanges. Grille provided separately. Refer to drawings for locations and quantities.
3. Blades: Opposed blade; airfoil-shaped, single piece, minimum 14 gauge double skin. Galvanized steel. Maximum 6" damper blades.
4. Seals: Blade seal shall be silicone fiberglass material to maintain smoke leakage rating to minimum of 450F and galvanized steel for flame seal to 1900F. Seal to be mechanically attached to blade edge. Jam seal shall be stainless steel, flexible metal compression type.
5. Bearings: Self-lubricating stainless-steel sleeve, in extruded hole in frame.
6. Axle: Minimum 1/2" plated steel, hex shaped, mechanically attached to blade.

C. Fusible Link: Fire dampers shall be held open by a fusible link rated at 165F unless otherwise called for on the drawings or by local codes.

D. Electronic Temperature Release Device: FSD shall contain a single 165F heat sensor capable of remote override of fire-induced closure to permit reopenable operation in a dynamic smoke management system. Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Wiring by Mechanical Contractor.

E. Maximum Multi-Blade Size (Multiple Section) at 2000 fpm and 4" WC:

1. Vertical Installation: 120"w x 48"h or 64"w x 96"h.
2. Horizontal Installation: 120"w x 48"h or 60"w x 96"h.

F. Access Door: Locate access door in the ductwork for visual inspection and on the latch side to replace link easily. Each access door shall have a label with letters at least 1/2" high, reading "FIRE DAMPER".

2.4 FIRE/SMOKE DAMPERS (FSD)

A. General:

1. Furnish and install fire/smoke dampers in ducts, where shown on the drawings, at the point where they pass through a fire/smoke partition and in all other locations required by the local Fire Department, the National Fire Protection Association Pamphlet No. 90A, UL 2043, and all other applicable codes.
2. Fire Resistance Rating: Assemblies shall be 1-1/2 hour rated under UL Standard 555 unless noted otherwise on drawings.
3. Airflow Rating: Dynamic rated at 2000 fpm and 4" WC.
4. Temperature Rating: Assemblies shall be UL 555S listed for use in smoke control system with a 250F temperature rating.

5. Leakage Rating: Class II. Shall not leak over 20 CFM per square foot at 4" WC.
6. FSD dampers shall be furnished complete with factory-mounted actuators, and the damper/operator assemblies shall meet all requirements listed below.
7. The complete assembly must be factory assembled, cycled and tested prior to shipment.
8. All operators shall be located with easy access for servicing.
9. Contractor to field verify actuator installation and clearance requirements prior to ordering. Actuator should not be taller than duct height. Rotate or turn over the actuator if this is the case.

B. Construction:

1. Frame: 5 inches x minimum 16 gauge roll formed, galvanized steel hat-shaped channel, reinforced at corners.
2. Sleeve: Dampers shall be installed in sleeves of sufficient thickness to comply with UL555 Standard for Safety Fire Dampers listing of the damper. Where UL555 permits sleeve thickness to be the same as that of the duct gauge, such thickness shall not be less than that specified in NFPA 90A for breakaway style sleeves. If a breakaway style duct/sleeve connection is not used, the sleeve shall be a minimum of 16 gauge for dampers up to 36" wide by 24" high and 14 gauge for dampers exceeding 36" wide by 24" high. Damper sleeve shall not extend more than 6" beyond the firewall or partition unless damper is equipped with an actuator or factory installed access door. Sleeve may extend up to 16" beyond the firewall or partition on sides equipped with the actuator or factory installed access door.
3. Blades: Opposed blade; airfoil-shaped, single piece, minimum 14 gauge double skin. Galvanized steel. Maximum 6" damper blades.
4. Seals: Blade seal shall be silicone fiberglass material to maintain smoke leakage rating to minimum of 450F and galvanized steel for flame seal to 1900F. Seal to be mechanically attached to blade edge. Jam seal shall be stainless steel, flexible metal compression type.
5. Bearings: Self-lubricating stainless-steel sleeve, in extruded hole in frame.
6. Axle: Minimum 1/2" plated steel, hex shaped, mechanically attached to blade.

C. Fusible Link: Fire dampers shall be held open by a fusible link rated at 165F unless otherwise called for on the drawings or by local codes.

D. Electronic Temperature Release Device: FSD shall contain a single 165Fheat sensor capable of remote override of fire-induced closure to permit reopenable operation in a dynamic smoke management system. Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Wiring by Mechanical Contractor.

E. Electric Actuator: Externally mounted, electric direct coupled. Actuator shall be 120V. Wiring by Electrical Contractor. Overload protections shall be either microprocessor or electronic-based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall electronically cut off at full open to eliminate noise generation. Actuator shall be mounted by means of a V-bolt dual nut clamp with a V-shaped toothed cradle. Aluminum clamps or setscrews are not acceptable. "Stall type" actuators are NOT acceptable. Actuator shall carry a manufacturer's 5 year warranty. Fail to closed position. Provide integral auxiliary end switches on actuators to electronically prove damper blade full-open and/or full-closed position. Auxiliary switches shall be suitable for connection to the FMCS, fire alarm system, firefighter smoke control panel, and/or remote indication devices as indicated.

F. Provide remote damper position indication to allow visual confirmation of damper blade full-open and full-closed status at the FMCS workstation and remote indicator panel mounted on ceiling below respective fire smoke damper. Remote position indication shall be derived from factory-installed actuator auxiliary switches or blade-mounted position switches, as applicable to the actuator type (electric or pneumatic).

G. Remote Inspection Panel: Provide a keyed test switch with open and closed position indication lights, mounted in the ceiling below the damper , to facilitate code-required periodic testing. A remote BACnet testing system may be employed in lieu of local test switches. Wiring by Electrical Contractor.

H. Access Door: Locate access door in ductwork for visual inspection and on the latch side to replace link easily. Each access door shall have a label with letters at least 1/2" high reading "FIRE/SMOKE DAMPER".

2.5 SMOKE DAMPER (SD)

A. General:

1. Furnish and install smoke dampers in ducts, where shown on the drawings, at the point where they pass through a fire/smoke partition and in all other locations required by the local Fire Department, the National Fire Protection Association Pamphlet No. 90A, UL 2043, and all other applicable codes.
2. Fire Resistance Rating: Assemblies shall be 1-1/2 hour rated under UL Standard 555 unless noted otherwise.
3. Airflow Rating: Dynamic rated at 2000 fpm and 4" WC.
4. Temperature Rating: Assemblies shall be UL 555S listed for use in smoke control system with a 250F temperature rating.
5. Leakage Rating: Class II. Shall not leak over 20 CFM per square foot at 4" WC.
6. SD dampers shall be furnished complete with factory mounted actuators and the damper/operator assemblies shall meet all requirements listed below.
7. The complete assembly must be factory assembled, cycled and tested prior to shipment.
8. All operators shall be located with easy access for servicing.
9. Contractor to field verify actuator installation and clearance requirements prior to ordering. Actuator should not be taller than duct height. Rotate or turn over the actuator if this is the case.

B. Construction:

1. Frame: 5 inches x minimum 16 gauge roll formed, galvanized steel hat-shaped channel, reinforced at corners.
2. Sleeve: Dampers shall be installed in sleeves of sufficient thickness to comply with UL555S Standard for Safety Fire Dampers listing of the damper. Where UL555S permits sleeve thickness to be the same as that of the duct gauge, such thickness shall not be less than that specified in NFPA 105 for breakaway style sleeves. If a breakaway style duct/sleeve connection is not used, the sleeve shall be a minimum of 16 gauge for dampers up to 36" wide by 24" high and 14 gauge for dampers exceeding 36" wide by 24" high. Damper sleeve shall not extend more than 6" beyond the firewall or partition unless damper is equipped with an actuator or factory installed access door. Sleeve may extend up to 16" beyond the firewall or partition on sides equipped with the actuator or factory installed access door.
   a. Wall Grille: When Damper is installed immediately behind wall grille, provide Style G sleeve with damper offset in sleeve with 3/4" full length grille mounting flanges. Grille provided separately. Refer to drawings for locations and quantities.
3. Blades: Opposed blade; airfoil-shaped, single piece, minimum 14 gauge double skin. Galvanized steel. Maximum 6" damper blades.
4. Seals: Blade seal shall be silicone fiberglass material to maintain smoke leakage rating to minimum of 450F and galvanized steel for flame seal to 1900F. Seal to be mechanically attached to blade edge. Jam seal shall be stainless steel, flexible metal compression type.
5. Bearings: Self-lubricating stainless-steel sleeve, in extruded hole in frame.
6. Axle: Minimum 1/2" plated steel, hex shaped, mechanically attached to blade.

C. Electric Actuator: Externally mounted, electric direct coupled. Actuator shall be 120V. Wiring by Electrical Contractor. Overload protections shall be either microprocessor or electronic-based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall electronically cut off at full open to eliminate noise generation. Actuator shall be mounted by means of a V-bolt dual nut clamp with a V-shaped toothed cradle. Aluminum clamps or setscrews are not acceptable. "Stall type" actuators are NOT acceptable. Actuator shall carry a manufacturer's 5 year warranty. Fail to closed position. Provide integral auxiliary end switches on actuators to electronically prove damper full-open and/or full-closed position. Auxiliary switches shall be suitable for connection to the FMCS, fire alarm system, firefighter smoke control panel, and/or remote indication devices as indicated.

D. Provide remote damper position indication to allow visual confirmation of damper blade full-open and full-closed status at the FMCS workstation and remote indicator panel mounted on ceiling below respective fire smoke damper. Remote position indication shall be derived from factory-installed actuator auxiliary switched or blade-mounted position switches, as applicable to the actuator type (electric or pneumatic).

E. **Remote Inspection Panel**: Provide a keyed test switch with open and closed position indication lights, mounted in the ceiling below the damper to faciliate code-required periodic testing. A remote BACnet testing system may be employed in leiu of local test switches. Wiring by Mechanical Contractor.

F. Access Door: Locate access door in ductwork for visual inspection and on the latch side to replace link easily. Each access door shall have a label with letters at least 1/2" high reading "SMOKE DAMPER".

2.6 BACKDRAFT DAMPERS

A. Gravity backdraft dampers, size 18 inches x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturer's standard construction.

B. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of extruded aluminum, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90-degree stop, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

C. Models:

1. Ruskin CBD4
2. Arrow 655
3. Safe-Air/Dowco BRL
4. Greenheck EM.

2.7 FABRIC CONNECTORS

A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.

B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.

C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalis, grease and gasoline, and shall be noncombustible.

D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.

E. All corners shall be folded, sealed with mastic and stapled on 1" centers.

F. Fabric connectors shall not be painted.

G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.

H. Materials:

1. Durodyne MFN-4-100
2. Vent Fabrics, Inc.
3. "Ventglas"
4. Proflex PFC3NGA

I. Fabric connectors exposed to sunlight and weather shall be as described above, except the coating shall be hypalon in lieu of neoprene.

J. Materials:

1. Durodyne "Duralon MFD-4-100"
2. Vent Fabrics, Inc.
3. "Ventlon"
4. Proflex PFC3HGA

2.8 DRIP PANS

A. Install drip pans under all rooftop exhaust fans, intake hoods, exhaust hoods and other roof penetrations that do not have ductwork below them to intercept dripping water.

B. Drip pans shall be 22 gauge minimum cross-broken or reinforced sheet metal with 2" welded upturned lips.

C. Pans shall extend 6" in all directions beyond the opening and shall have the top of the lip located 25% of the maximum throat dimension below the opening.

D. Insulate interior of drip pan with 1" thick elastomeric foam insulation. Adhere foam to drip pan with standard foam adhesive.

2.9 DUCT ACCESS DOORS

A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.

B. Review locations prior to fabrication. Install access doors at fire dampers, smoke dampers, motorized dampers, fan bearings, filters, automatic controls, humidifiers, louvers, duct coils and other equipment requiring service inside the duct.

C. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

D. Access doors with sheet metal screw fasteners are not acceptable.

E. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.

F. Provide duct access door in all horizontal return ductwork at 20 foot intervals per NFPA 90A.

G. Fire Damper, Fire/Smoke Damper Access Provide quantity of access doors such that two hands can fit inside ductwork to manually reset fire dampers. For ducts larger than 12" x 12" , provide one access door. For ducts 12" x 12" and smaller, provide duct access sleeve.

2.10 DUCT ACCESS SLEEVE

A. Material: Galvanized G-90 ASTM A527 Access Section. 26 gauge galvanized 12" long constructed with Pittsburgh lock seam. Access section shall be suitable for ductwork pressure class and manufactured to maintain 100 percent of ductwork free area with a clamping type draw latch.

B. Leakage: Maximum of 1/2 CFM at 2" W.G..

C. Flange Connection: 18 gauge galvanized. Clamps: 20 gauge galvanized with zinc coated draw latch.

D. Gasket: Neoprene gasket 3/16" x 1-1/4", gasket profile forms to the inside of the clamp and seals the outer edges of the access section 18 gauge flanges. Seal seams in accordance with SMACNA HVAC Duct Construction Standard - Metal and Flexible.

E. Insulation: Contractor shall insulate in field per Duct Insulation Schedule. Include removable wrap around flanges. Manufacturer shall provide duct liner in systems as defined in Duct Insulation Schedule.

F. Locations: Install duct access sleeve in the following locations:

1. Fire Dampers, Fire Smoke Dampers and Smoke Dampers: Provide duct access sleeve at dampers 12" x 12" and 12" diameter and smaller not more than 4" away from the fire damper sleeve.

G. Manufacturers:

1. Langdon, Inc. Sure Clamp

2.11 DUCT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.12 REMOTE VOLUME CONTROL DEVICES - MANUAL

A. Remote volume control balancing damper shall be supplied with either miter gears or right angle worm gears. Provide all damper shafts, gearboxes, couplings, U-joints, bearings, shafts, offsets, adapters, and adjustable concealed covers as required.

B. When distances, angles, or offsets prevent installing solid rods, the mechanical cable control system may be utilized. Provide all damper shafts, rack and pinion gear operator, cables and sleeves, and adjustable ceiling mounting cups.

C. Manufacturers:

1. Young Regulator Company
2. Metropolitan Air Technology

2.13 DUCTWORK ACCESSORY SEALANTS

A. Ductwork accessory sealants and adhesives shall conform to Section 233100.

2.14 CONTROL DAMPERS AND DAMPER ACTUATORS

A. Control dampers and damper actuators shall be furnished by the Temperature Control Contractor (Section 23 0 900) and shall be installed by this Contractor.

B. Coordinate exact sizes, locations, and installation requirements with the Temperature Control Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install accessories in accordance with manufacturer's instructions.
2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.
3. Coordinate and install access doors provided by others.
4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".
5. Provide duct test holes where indicated and as required for testing and balancing purposes.

B. Manual Volume Damper:

1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.
2. Provide ceiling access doors for manual volume dampers. When manual volume dampers are located above an inaccessible ceiling and an access door cannot be installed, provide a remote-controlled volume control device for operation of the damper. Coordinate location with the Architect/Engineer.

C. Fire Damper, Fire Smoke Damper, Smoke Damper:

1. Installation:

    a. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves and duct connections.
    b. Provide ceiling access doors for smoke and/or fire dampers. Coordinate location with the Architect/Engineer.
    c. Provide manufacturer's maintenance instructions to Owner.
    d. At fire dampers, smoke dampers and combination fire smoke damper where duct is:

        1) Internally insulated, exterior duct wrap shall be installed from the wall out to 1 foot from the wall. All edges shall be taped.
        2) Externally insulated, the exterior duct wrap shall extend up to the wall.

2. Commissioning/Testing and Acceptance:

    a. Dampers shall be tested for function in their installed condition. Cycle all dampers to ensure proper operation and signal reporting as required by the manufacturer, building codes, and NFPA, with the minimum following requirements:

        1) Visually inspect damper to ensure they are free from obstructions, have appropriate access, and are labeled.
        2) Demonstrate resetting of fire dampers to Authorities Having Jurisdiction and Owner's representative as described below.
        3) Fusible Link Operated Dampers:

            a) Ensure fan is off.
            b) With damper full-open, remove fusible link.
            c) Ensure damper closes completely without assistance.
            d) Return damper to full-open position and replace fusible link.

        4) Dampers with Position Indication Wired to Indication Lights, Control Panels or BAS:

            a) Confirm damper is full-open using position indicator signal.
            b) Remove power to allow spring return to close damper.
            c) Confirm damper is full-closed using position indicator signal.
            d) Reapply power to reopen damper.
            e) Confirm damper is full-open using position indicator signal.

        5) Dampers without Position Indication:

            a) Visually confirm damper is full-open using position indicator signal.
            b) Remove power to allow spring return to close damper.
            c) Visually confirm damper is full-closed.
            d) Reapply power to reopen damper.
            e) Visually confirm damper is full-open.

3. Report:

    a. Provide Commissioning/Testing and Acceptance Report documenting the following for all fire damper, fire smoke damper, smoke dampers.

b. A copy of the report shall be filed with the fire code official and an identical copy shall be maintained in an approved location at the building.
c. Report shall include the following:

1) Damper ID#
2) System identification (e.g. AHU-#)
3) Type (FD, FSD, SD)
4) Duct size
5) UL assembly number
6) Location of damper and access door
7) Location of position indicator
8) Fusible link temperature rating (if applicable)
9) Manufacturer and model
10) Commissioning testing and acceptance operation: Pass/Fail/Reset

D. Drain Pan:

1. Drain pans shall be installed per ASHRAE 62.1.

a. All drain pans shall be field tested under normal operating conditions to ensure proper drainage.
b. Field testing of drain pans is not required if units with factory installed drain pans have been certified (attested in writing) by the manufacturer for proper operation when installed as recommended.

E. Control Dampers and Damper Actuators:

1. Install control dampers and damper actuators in accordance with manufacturer's instructions and in coordination with the Temperature Control Contractor.
2. Seal around damper frame inside ductwork with duct sealant to prevent bypass around damper.
3. Provide duct access door at each control damper.

END OF SECTION

SECTION 233423 - POWER VENTILATORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Roof Exhaust Fan.

B. Rooftop Fan Curbs.

C. Room Exhaust Fan.

D. In-Line Cabinet Fan.

1.2 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300.

C. Fabrication: Conform to AMCA 99.

D. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.1.

1.3 REFERENCES

A. AMCA 99 - Standards Handbook.

B. AMCA 208 - Calculation of the Fan Energy Index (FEI).

C. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.

D. AMCA 230 - AMCA 230 - Laboratory Methods of Testing Air Circulating Fans for Rating and Certification.

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices.

F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.

G. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

H. ANSI/AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

I. SMACNA - HVAC Duct Construction Standards (latest edition).

1.4 SUBMITTALS

A. Submit shop drawings per Section 230500. Include data on all fans and accessories. Submit sound power levels for both fan inlet and outlet at rated capacity. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point (ceiling and HVLS fans are exempt from FEI submittal requirements).

B. Submit manufacturer's installation instructions.

C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

D. Submit motor data indicating compliance with Section 230513.

E. Submit certification that power ventilators, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 ROOFTOP EXHAUST FAN - DIRECT DRIVEN

A. Fan Wheel: Centrifugal type, aluminum or composite with backward inclined or airfoil blades, statically and dynamically balanced.

B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.

C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.

D. Any steel parts shall be galvanized or epoxy coated. Non-corrosive fasteners.

E. Direct drive, motor mounted outside of airstream and ventilated with outside air.

F. Aluminum or brass bird screen. Plastic mesh will not be allowed.

G. Mill aluminum finish.

H. Dampers: Furnish normally closed, electric motorized damper. Provide step-down transformer if required. Install and wire damper to open when fan runs. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods. Leakage shall not exceed 4 cfm/sq.ft at 1" SP (or shall be AMCA Class 1 certified).

I. Motor (as scheduled on drawings):

1. Induction: Furnish permanently lubricated sealed ball type motor and drive shaft bearings. Motor and wheel supported by vibration isolators.

    a. Disconnect as scheduled on drawings.

2. Electronically Commutated Motor (ECM): Motor shall be variable speed, constant torque, brushless permanent magnet (PM) motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall include integral surge protection. Motor and controller shall be pre-wired for specific voltage and phase. Motor frame shall be NEMA 48; All EC motors shall be a minimum of 85% efficient at all speeds. Provide motor with onboard motor control module. Motor speed shall be limited to provide electronic overcurrent protection. Provide non-fused, with thermal overload protection, factory mounted and wired disconnect switch mounted inside fan housing. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed. Operational mode shall be as follows:

    a. ECM set for constant CFM.

J. Speed Controller: For single phase shaded pole or permanent split capacity motor fans, furnish solid-state dial speed controller factory mounted inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.

K. Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

L. Manufacturers:

1. Cook "ACE-D"
2. Greenheck
3. PennBarry DX
4. Carnes
5. Twin City DCRU

2.2 ROOFTOP FAN CURBS

A. Furnish and install prefabricated roof curbs for all rooftop fans.

B. Size curb to match the curb cap of fan.

C. Roof Mounting Curb: Minimum 18 inches (mm), minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

D. Construction: Unitized construction, continuous arc welded corner seams. Insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board. Damper support angle. Pressure treated wood nailer. Curb without cant.

1. 18-gauge galvanized steel.

E. If called for in the drawings, curbs shall be of the sound attenuation type. Sound attenuation curbs shall reduce the fan sone rating by at least 40% and not decrease fan cfm more than 8% (which is accounted for in the scheduled fan cfm). Baffles shall be removable for access to the dampers.

F. Manufacturers:

1. Same manufacturer as the fan
2. Pate
3. RPS
4. Thy

2.3 ROOM EXHAUST FAN

A. Fiberglass lined sheet metal housing.

B. Rubber torsion motor mounts.

C. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for fractional horsepower induction motors, with thermal overload relay, toggle operator.

D. Built-in backdraft damper.

E. Centrifugal fan.

F. Molded white plastic or aluminum ceiling grille.

G. Provide variable speed controller if called for on the drawings.

H. Manufacturers:
1. Broan
2. Carnes
3. Cook
4. PennBarry
5. Greenheck

2.4 IN-LINE CABINET FAN

A. Fiberglass lined, sheet metal housing, arranged for in-line installation.

B. Rubber torsion motor mounts.

C. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for fractional horsepower induction motors, with thermal overload relay, toggle operator.

D. Built-in backdraft damper.

E. Centrifugal fan.

F. Provide variable speed controller if shown on the drawings.

G. Manufacturers:

1. Carnes
2. Cook
3. PennBarry
4. Greenheck

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated lag screws to roof curb.

C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.

D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

END OF SECTION

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single Duct Variable Air Volume Terminal Box.

B. Fan Powered Variable Air Volume Terminal Box.

1.2 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.

C. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 230500.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.

D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch WG.

E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

F. Submit manufacturer's installation instructions.

G. Submit certification that all air terminal units, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. orces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

C. Include directions for resetting constant volume regulators.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CONSIDERATIONS (THIS APPLIES TO ALL UNITS)

A. All units shall have noise data certified in accordance with AHRI Standard 885-98 with 5/8" 20-lb. density mineral fiber ceiling tile and shall not produce space noise values over NC-35 due to radiated and airborne noise combined. Acoustical considerations shall take priority over sizes noted in schedule. It is the manufacturer's responsibility to increase inlet size to meet acoustic levels scheduled.

2.2 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL BOX

A. Casing: Minimum 22 gauge galvanized steel.

1. Insulation: Insulation shall be UL listed and meet NFPA 90A requirements. Fully insulated with:
   a. 3/4" elastomeric closed cell insulation liner.
   b. Usage: All supply air systems.

B. Damper Blade: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.

C. Inlet Flow Sensor: Provide "cross" • or "ring• " style velocity and static sensor at inlet to box for use by unit controller.
1. Boxed located in a Return and Exhaust system shall include removable airflow sensors to allow cleaning.

D. Damper Operators: Furnish all mounting brackets, relays, and linkages. Damper operator shall be provided as follows:

1. Electronic: Provided by the manufacturer and installed in the factory. Operator shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).

E. Electronic Volume Regulator/Controller: Set boxes for maximum and minimum settings shown on the drawings. Electronic volume regulator/controller shall be provided as follows:

1. Provided by the manufacturer and installed in the factory.

F. Electric Heating Coil: Open nichrome type electric resistance coils, automatic reset thermal cutout primary safety device, manual reset thermal cutout secondary safety device, airflow switch interlock, disconnect switch on face of integral control panel, magnetic contactors, 24-volt control, control voltage transformer and fusing. Capacity and voltage shall be as scheduled on the drawings. Capacity control shall be as follows:

1. Modulating SCR electric control

G. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.

H. Refer to control diagrams and notes on control drawings for complete sequence of control.

I. Manufacturers:

1. Titus
2. Trane
3. Carnes
4. Nailor

2.3 FAN POWERED VARIABLE AIR VOLUME TERMINAL BOX

A. Casing: Series minimum 22 gauge galvanized steel. Factory mounted access panel to provide access to air valve and fan.

1. Insulation: Insulation shall be UL listed and meet NFPA 90A requirements. Fully insulated with:

a. Minimum 1/2", minimum 1-1/2 pound density fiberglass insulation.
b. Usage: All supply air systems.

2. Non-insulated.

a. Usage: Return air system, exhaust air system.

B. Fan: FC style, galvanized steel fan wheel. Fan housing shall be 22 gauge steel and fan board shall be 18 gauge steel. Maximum motor temperature rise on all speeds of 50F. Fan motor voltage shall be as scheduled on the drawings. Motors shall be permanently lubricated, direct drive.

1. ECM modulating control using 0-10Vdc modulating signal.
2. .

C. Damper Blades: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.

D. Inlet Flow Sensor: Provide "cross" or "ring" style velocity and static sensor at inlet to box for use by unit controller.
1. Boxed located in a Return and Exhaust system shall include removable airflow sensors to allow cleaning.

E. Damper Operators: Furnish all mounting brackets, relays, and linkages. Damper operator shall be provided as follows:

1. Electronic: Provided by the manufacturer and installed in the factory. Operator shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).

F. Electronic Volume Regulator/Controller: Set boxes for maximum and minimum settings shown on the drawings. Electronic volume regulator/controller shall be provided as follows:

1. Provided by the manufacturer and installed in the factory.

G. Electric Heating Coil: Open nichrome type electric resistance coils, automatic reset thermal cut-out primary safety device, manual reset thermal cut-out secondary safety device, airflow switch interlock, disconnect switch on face of integral control panel, magnetic contactors, 24-volt control, control voltage transformer and fusing. Capacity and voltage shall be as scheduled on the drawings. Coil position in the discharge air position. Capacity control shall be as follows:

1. Modulating SCR electric control.
2. -stage electric control.

H. Fan Inlet:

1. Factory provided induced air acoustic attenuator inlet with filter.

I. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.

J. Refer to control diagrams and notes on control drawings for complete sequence of control.

K. Manufacturers:

1. Titus
2. Trane
3. Carnes
4. Nailor

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Maintain minimum working clear space for all electrical connections in accordance with NFPA 70, National Electrical Code.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure. Do not support from adjacent ductwork.

E. Where boxes are located adjacent to a wall or joist, the damper motors and control valves shall be located on the side of the box away from the wall or joist to permit easy access.

F. Comb fins on coils to repair bent fins.

G. Insulate terminal air box hydronic reheat coils to prevent condensation. Tape insulation tight to box. Do not insulate or interfere with actuator, access panel and control panel.

3.2 ADJUSTING

A. All boxes shall be set to the cfm shown on the drawings. TCC shall be responsible to field recalibrate all boxes that are not set correctly.

END OF SECTION

SECTION 233700 - AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Grilles And Registers.

B. Architectural Square Panel Diffusers.

C. Linear Diffusers.

D. Louvers.

E. Roof Hoods.

F. Roof Curbs.

G. Goosenecks.

1.2 QUALITY ASSURANCE

A. Test and rate performance of air inlets and outlets per ASHRAE 70.

B. Test and rate performance of louvers per AMCA 500L-99.

C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 REFERENCES

A. AMCA 500-L-12 - Laboratory Methods of Testing Louvers for Rating.

B. ANSI/ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Inlets and Outlets.

C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. ASHRAE 170 (latest published edition) - Ventilation of Health Care Facilities.

E. SMACNA - Duct Construction Standards.

1.4 SUBMITTALS

A. Submit product data under provisions of Section 230500.

B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.

C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.

D. Submit manufacturer's installation instructions.

E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

F. Where color selection by Architect is necessary, provide physical color chips for color selection directly to the Architect. Electronic color charts are not acceptable.

1.5 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

B. Conform to ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 AIR TERMINALS - GRILLES AND REGISTERS

A. Reference to a grille means an air supply, exhaust or transfer device without a damper.

B. Reference to a register means an air supply, exhaust or transfer device with a damper.

C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.

D. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.

E. The capacity and size of the unit shall be as shown on the drawings.

F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect. .

G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.

H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.

I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.

J. Where specified to serve registers, provide opposed blade volume dampers operable from the face of the register.

K. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.

L. Manufacturers:
   1. Titus

2. Price
3. Nailor

2.2 AIR TERMINALS - ARCHITECTURAL SQUARE PANEL DIFFUSERS

A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.

B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule. Flat-oval inlets are not acceptable for connection to flexible ducts.

C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.

D. The capacity and size of the unit shall be as shown on the drawings.

E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect. .

F. Diffusers shall be architectural solid square panel and flush with ceiling.

G. The exposed surface shall be smooth, flat and free of visible fasteners. The face panel shall be 22 gauge steel with a rolled edge or shall be 18 gauge with a smooth ground, uniform edge.

H. The back pan shall be one piece 22 gauge stamped and shall include an integral inlet. (Welded inlets and corner joints are not acceptable).

I. Diffusers with a 24x24 back pan shall have a minimum 18x18 face panel size. Diffusers with a 12x12 back pan shall have a minimum 9x9 face panel size.

J. The face panel shall be mechanically fastened to the back panel with steel components. (Plastic fasteners are not acceptable.)

K. Manufacturers:
1. Titus
2. Price
3. Nailor
4. Carnes

2.3 AIR TERMINALS - SQUARE MODULAR CORE DIFFUSERS

A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.

B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule.

C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to bid date. Submission of bid indicates ceiling and air inlet and outlet types have been coordinated.

D. The capacity and size of the unit shall be as shown on the drawings.

E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect. .

F. Modular core diffusers shall consist of an outer frame assembly to facilitate mounting and shall include an integral square collar to allow connection to the square duct. Where shown on the drawings, the diffuser shall be supplied with a square to round adapter. Flat-oval inlets are not acceptable for connection to flexible ducts.

G. The diffuser core shall consist of fixed louver directional modules that may be field adjusted from the diffuser face without any type of tools or mechanical device for or four-way horizontal discharge airflow.

H. Each louvered module shall be removable to allow access to any damper or other component in or near the diffuser neck.

I. The core's blade spacing shall be 1 inch on center.

J. Manufacturers:
1. Titus
2. Price
3. Nailor
4. Carnes

2.4 AIR TERMINALS - LINEAR DIFFUSERS

A. Plenum Slot Diffusers (Lay-In):

1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
2. The capacity and size of the unit shall be as shown on the drawings.
3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect. .
4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
5. Linear diffusers and mounting frames shall be furnished as one piece up to 5' in length.
6. Diffusers shall be furnished with factory installed adjustable gasket edged blade deflector.
7. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
8. Number and width of slots shall be as shown on the drawings.
9. Provide integral insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
10. Manufacturers:
    a. Carnes DA
    b. Price TBD
    c. Nailor 5800
    d. Titus TBD

B. Linear Slot Diffusers (Continuous):

1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
2. The capacity and size of the unit shall be as shown on the drawings.
3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect..
4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
5. Provide with concealed fasteners for installation in the field.
6. Linear diffusers and mounting frames shall be furnished as one piece up to 6' in length. Provide auxiliary support per manufacturer's recommendations for slot diffusers greater than 4' in length.
7. Diffusers shall be furnished with adjustable pattern deflectors capable of providing 180-degree pattern adjustment.
8. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
9. Number and width of slots shall be as shown on the drawings.
10. Provide insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
11. Manufacturers:
    a. Carnes CH
    b. Price SDS
    c. Nailor 5000
    d. Titus ML

C. Linear Slot Diffusers (High Performance):

1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
2. The capacity and size of the unit shall be as shown on the drawings.
3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect per ANSI/ASHRAE 70.
4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
5. Provide with concealed fasteners for installation in the field.
6. Linear slot diffusers and mounting frames shall be furnished as one piece up to 6' in length. Provide auxiliary support per manufacturer's recommendations for slot diffusers greater than 4' in length.
7. Diffusers shall be furnished with adjustable pattern deflectors.
8. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
9. Number and width of slots shall be as shown on the drawings.
10. Provide insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
11. Manufacturers:

    a. Price JS

b. Titus FL

D. Linear Bar Grille Diffusers:

1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
2. The capacity and size of the unit shall be as shown on the drawings.
3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect per ANSI/ASHRAE 70.
4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
5. Provide with concealed fasteners for installation in the field.
6. Linear bar diffusers and mounting frames shall be furnished as one piece up to 6' in length. Provide auxiliary support per manufacturer's recommendations for slot diffusers greater than 4' in length.
7. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each bar grille. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
8. Diffuser length and width, bar width, and spacing between bars shall be as shown on the drawings.
9. Provide insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum section for details.
10. Manufacturers:
    a. Carnes CC;CT;CW
    b. Price LB
    c. Nailor 4900
    d. Titus CT

2.5 LOUVERS - FIXED - ALUMINUM

A. Louvers shall be minimum 4" deep and constructed of extruded aluminum. Blade, jamb and sill thickness shall be minimum 0.081". Blades shall be spaced at a maximum of 5.1" apart.

B. Louvers shall be of the drainable blade design with water collected on the leading edge of the blade and diverted to the jamb.

C. Louvers shall be furnished with aluminum bird screen mounted on the inside surface.

D. Size, cfm, finish and pressure drop for louvers shall be as scheduled on the drawings.

E. AMCA Certified performance for 48" x 48" samples with intake airflow of 8,000 cfm shall not exhibit more than 0.19" pressure drop. Maximum water penetration shall be 0.01 ounces per square foot at the scheduled intake velocity based on 15 minute test duration when subjected to a water flow rate of 0.25 gal/min as described under the Water Penetration Test in AMCA 500-L-07.

F. Contractor shall provide the General Contractor with the correct sizes and locations of all louvers required in masonry walls.

G. Louvers shall be sealed around perimeter to avoid moisture penetration between the louver frame and wall.

H. Louvers shall be suitable for duct connection.

I. Manufacturers:
1. Ruskin - "ELF375DX"
2. Vent Products - "2760"
3. Greenheck - ESD "403"
4. Pottorff - EFD

2.6 ROOF HOODS

A. Hoods shall be constructed of roll formed, interlocking aluminum panels. Vertical end panels are fully locked into hood.

B. Top of curb to hood inlet shall be minimum of 5" .

C. Curb cap shall be of 14 gauge formed aluminum with mitered corners continuously heliarc-welded. Hood shall be of the same material and cross-broken for added strength. Underside of hood shall be coated with insulating mastics.

D. Hoods shall be furnished with aluminum bird screen.

E. Hood and throat shall be reinforced with extruded aluminum angle and have a minimum snow load rating of 30 lbs. per square foot.

F. Size, cfm, finish and pressure drop for hoods shall be as scheduled on the drawings.

G. Inlet area shall be minimum 150% of throat area for intake hoods. Outlet area shall be minimum 125% of throat area for exhaust hoods and relief vents.

H. Hoods shall be furnished with 12" high curb (above top of roof) and be of the size and type as shown on the drawings.

I. Hood shall be furnished with motorized damper unless otherwise noted on the drawings.

J. Manufacturers:
1. Carnes
2. Cook

2.7 ROOF CURBS

A. Furnish and install, where shown on the drawings, prefabricated roof curbs for all rooftop hood openings.

B. Roof Mounting Curb: Curb shall be sized to match curb cap of the hood. Minimum 18 inches (mm), minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

C. Curbs shall be unitized construction, 18 gauge galvanized steel, with continuous arc welded corner seams, insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board and damper support angle.

D. Curb without cant - suitable for use with membrane type roof.

E. Manufacturers:

1. Same manufacturer as the equipment it serves or Pate, RPS, or Thy.

2.8 GOOSENECKS

A. Fabricate in accordance with SMACNA Duct Construction Standards of minimum 18 gauge galvanized steel.

B. Mount on minimum 12 inch high curb base.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install items in accordance with manufacturers' instructions.
2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
3. Install diffusers to ductwork with air tight connections.
4. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.
5. Supply grille and register blades shall be aimed in the field to provide adequate air distribution in the space. All return grilles and registers blades shall be oriented to minimize sight distance beyond installed device.

B. Volume Damper:

1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.

C. Roof Hood and Louvered Penthouse:

1. If manufacturer has no recommendations, secure roof hoods and louvered penthouses to curbs with 1/4" lag bolts on 8" maximum centers.
2. Provide 20 gauge sheet metal duct blank-off behind louvers at unused portions of louver openings in exterior walls. Back with 2" rigid 3# density fiberglass board insulation with foil scrim facing the room. Seal watertight.

D. Maintaining Duct Cleanliness:

1. When grilles, registers, and diffusers are installed, Contractor shall prevent construction dust, dirt, and debris from entering ductwork as required by Section 230500.

END OF SECTION

SECTION 236213 - AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Condensing Unit Package.

B. Charge of Refrigerant and Oil.

C. Controls and Control Connections.

D. Refrigerant Circuit.

E. Motor Starters.

F. Electrical Power Connections.

1.2 REFERENCES

A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ANSI/UL - Safety for Heating and Cooling Equipment.

C. AHRI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

D. ASHRAE 23 - Methods of Testing for Rating Positive Displacement Condensing Units.

1.3 SUBMITTALS

A. Submit shop drawings per Section 230500 indicating components, assembly, dimensions, weights and loadings, required clearances, location and size of field connections, rated capacities, and electrical nameplate data. Include schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system. Piping diagrams shall apply specifically to this job. Include description of capacity control logic and interface with building control system.

B. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

C. Submit operation and maintenance data including start-up instructions, maintenance instructions, parts lists, controls, and accessories.

D. Submit certification that condensing units, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage. Protect coils.

1.5 WARRANTY

A. Provide a one-year parts and labor warranty. Compressors shall have an additional four year warranty covering all material and labor costs for compressor repair or replacement at the Owner's option.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Units: Self-contained, packaged, factory assembled and wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, and screens.

B. Construction and Ratings: In accordance with AHRI 210/240 and ANSI/UL 207 and 303. Testing shall be in accordance with ASHRAE 14.

C. Performance Ratings: EER and COP meeting ANSI/ASHRAE 90.1.

2.2 CASING

A. House components in welded steel frame with galvanized steel panels with painted finish meeting ASTM B117 salt spray test standard.

B. Mount starters, disconnects, and controls in weatherproof panel with full opening access doors.

C. Provide gasketed removable access doors or panels with quick fasteners.

2.3 CONDENSER COILS

A. Aluminum fins mechanically bonded to seamless copper tubing. Provide 12F of refrigerant subcooling at design conditions.

B. Coil Guard: Painted expanded metal or PVC coated steel wire.

C. Provide hail guards on all condenser coils.

2.4 CONDENSER FANS AND MOTORS

A. Vertical discharge direct drive propeller type condenser fans with fan guards.

B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in thermal overload protection.

C. Dynamically and statically balanced fans.

D. Separate motors for each fan.

2.5 COMPRESSORS

A. Construction: Semi-hermetic or hermetic scroll type with suction and discharge valves.

B. Mounting: Dynamically balance rotating parts and mount on vibration isolators.

C. Lubrication System: Oil pump with oil charging valve, oil level sight glass, oil filter, and magnetic plug or strainer.

D. Capacity Reduction Equipment: Multiple compressors, and/or multi-speed or variable-speed compressors.

E. Motor: Suction gas cooled with electronic sensor and winding over temperature protection.

F. Crankcase Heater: Evaporates refrigerant in crankcase during shutdown.

G. Suitable for operating on voltages plus or minus 15% of nameplate ratings.

2.6 REFRIGERANT CIRCUIT

A. Refrigerant may be new or reclaimed, and shall meet ARI-700-2004 Standard for Refrigerant Purity.

B. Provide each unit with the number of refrigerant circuits needed to provide the scheduled unloading and properly transport oil.

C. Provide the following for each refrigerant circuit:

1. Replaceable core type filter dryer.
2. Liquid line sight glass and moisture indicator.
3. Thermal expansion valve.
4. Insulated suction line.
5. Suction and liquid line service valves.
6. Schraeder valve.
7. Condenser pressure relief valve.
8. Suction filter.
9. Liquid line solenoid valve.

D. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control using thermistors.

E. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

2.7 CONTROLS

A. On unit, mount NEMA 4 steel control panel containing power and control wiring, factory wired with single point power connection.

B. For each compressor, provide across-the-line starter, factory wired non-fused disconnects, non-recycling compressor overload, starter relay, and control power transformer. For each condenser fan, provide across-the-line starter with starter relay.

C. Provide the following safety controls arranged so operating any one will stop unit:

1. Manual reset high discharge pressure switch for each compressor.
2. Automatic reset low suction pressure switch for each compressor.
3. Manual reset oil pressure switch.

D. Provide the following operating controls:

1. Timer(s) that prevents compressor short cycling.
2. Low ambient temperature (as scheduled) thermostat to lock out compressor.
3. If discharge or return air control is provided with the unit, provide adjustable time delay between stages of operation. All units shall be compatible with direct control of staging by DDC systems. Suction pressure control of staging is not acceptable.
4. Pump down control that activates when the lead compressor of each circuit stops.
5. Thermostat to cycle fan motors in response to head pressure.
6. Head pressure controlled damper or variable speed fan control on first stage condenser fan. Rated for starting at 0F.

2.8 MANUFACTURERS

A. Trane

B. York

C. Daikin

D. Carrier

E. Units shall be of the same manufacturer as the evaporator coil.

2.9 REMOVABLE FILTER SCREEN

A. Description: Removable, washable cottonwood airborne matter screen compatible with equipment intake.

B. Submittal: Filter screen shall be included by equipment manufacturer to ensure equipment airflow/capacity is coordinated with screen.

C. Filter Material: Flexible, UV resistant fine polyester screen.

D. Fasteners: Commercial plastic/polyester twist lock fasteners fastened to equipment using self-tapping screws w/ bonded washer.

E. Approved Manufacturers:

1. By Equipment Manufacturer
2. Air Solution Company

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Comb all condenser coils to repair bent fins.

C. Install on vibration isolators as scheduled on the drawings or in Section 230548.

D. Connect to refrigeration piping and evaporators.

3.2 MANUFACTURER'S FIELD SERVICES

A. Provide initial start-up by factory authorized service representatives. Adjust units to provide proper superheat.

B. Supply initial charge of refrigerant and oil for each refrigerant circuit. Replace losses of refrigerant and oil during the warranty period.

END OF SECTION

SECTION 237416.12 - PACKAGED ROOFTOP AIR CONDITIONING UNITS 25 TON AND BELOW

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged Rooftop Unit.

B. Unit Controls.

C. Roof Mounting Frame and Base.

D. Economizers.

E. Power Exhaust.

1.2 QUALITY ASSURANCE

A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).

B. All units must be UL or ETL listed and must contain UL labeled components.

C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.

D. Conform to ASHRAE 90.1.

E. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 REFERENCES

A. AHRI 210 - Unitary Air Conditioning Equipment.

B. AHRI 240 - Air Source Unitary Heat Pump Equipment.

C. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.

D. ASHRAE 37 - Methods of Testing for Rating Unitary Air Conditioning and Heat Pump Equipment.

E. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

F. NFPA 70 - National Electrical Code.

G. NFPA 90A - Installation of Air Conditioning and Ventilating System.

H. UL - Underwriters' Laboratory.

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 230500.

B. Indicate electrical service and duct connections on shop drawings or product data.

C. Submit manufacturer's installation instructions.

D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

E. Submit fan curves, including minimum and maximum fan speed, with specified operating points clearly plotted.

F. Provide 8 octave maximum sound power levels at unit discharge and return connection.

G. Submit certification that the packaged rooftop air conditioning units, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

1.7 WARRANTY

A. Provide five (5) year manufacturer's warranty for compressors.

B. Provide ten (10) year manufacturer's warranty for heat exchanger.

C. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

1.8 MAINTENANCE SERVICE

A. Contractor shall furnish complete service and maintenance of packaged roof top units for one year from Date of Substantial Completion.

B. Provide maintenance service with a two-month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.

C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of four (quarterly) filter replacements, minimum of one fan belt replacement, and controls checkout, seasonal adjustments, and recalibrations.

D. Submit copy of service call work order or report and include description of work performed to Owner and Architect/Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 230500 for additional information.

B. Trane

2.2 MANUFACTURED UNITS

A. Provide roof-mounted units having gas burner,.

B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, exhaust fan, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil, condenser fan, and a full refrigerant charge.

C. Unit shall be furnished with non-fused disconnect switch, short fuse protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection.

D. AHRI rated for direct expansion use with low GWP refrigerants (e.g. R32 or R454B)

E. Refrigerant Detection System (RDS)

1. Units manufactured using A2L refrigerants (e.g. R-32, R-454B) shall include a Refrigerant Detection System (RDS) with one or more refrigerant detection sensors to detect leaked refrigerant within the conditioned air stream in compliance with UL 60335-2-40. Minimum Safety Measures Activation shall include: Activating ventilation systems or fans to disperse refrigerant, disabling electrical ignition sources and issuing alarms or notifications.

2.3 FABRICATION

A. Cabinet: Galvanized steel with baked enamel finish, access doors with quick fasteners screwdriver operated flush cam type locking door handle type with piano hingesAccess doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors of minimum 20 gauge.

B. Outside Air Intakes: The outside air intakes shall be located a minimum of 15 inches above the roof mounting curb to minimize the effect of heat pickup from the roof during the natural cooling cycle and the effects of snow on the roof during winter operation. Each air intake shall be furnished with rain eliminators.

C. Insulation: Minimum of 1" thick 1.5lb./cuft. aluminum foil faced glass fiber on all sections.

D. Heat Exchangers: Aluminized steel, of welded construction.

E. Air Filters: Two inch thick glass fiber disposable media in metal frames.

2.4 ROOF MOUNTING FRAME AND BASE

A. Roof Mounting Curb: Minimum 24 inches high, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

2.5 FANS/MOTORS

A. Fans:

1. Supply Fans: centrifugal; SWSI plenum or vane axial fan.
2. Exhaust Fans: Propeller or SWSI plenum fan.
3. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
4. Fan and motor assemblies shall be resiliently mounted.
5. Direct drive motor or with V-belt drive and rubber isolated hinge mounted motor.
6. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
7. All fans must be statically and dynamically balanced.

B. Motors:

1. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 230513.
2. No equipment shall be selected or operate above 90% of its motor nameplate rating.
3. Motor shall have 1.15 service factor.

C. Belt Drive Fans:

1. Belt drive fans must be within ± 10% of scheduled RPM.
2. Belt drive fans shall have slide rails, adjusting screws, anchor bolts, and bedplates.
3. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. On units over 20 HP, use fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.

4. Units used with variable speed drives shall have fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.

2.6 BURNER

A. Gas Burner: Induced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shutoff, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shutoff pilot. fully modulating gas valve with minimum 4:1 turndown.

B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.

C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.

D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, or adjustable time delay relays with switch for continuous fan operation.

2.7 EVAPORATOR COIL

A. Provide copper tube with aluminum fin coil assembly.

B. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft2 of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.

C. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

D. Provide insulation on liquid refrigerant and suction piping between compressor and evaporator coil where not protected by drain pans. Insulation shall be elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.27 maximum 'K' value at 75F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.

E. Drain Pan Condensate Overflow Switch: Float with integral magnet overflow switch conforming to UL508. Factory installed in drain pan and wired to shut the rooftop unit down with a fault alarm. No standby power required.

2.8 HOT GAS REHEAT COIL

A. Provide copper tube with aluminum fin coil assembly.

B. Valves to reroute hot refrigerant gas from the discharge line of the compressor through the reheat coil.

2.9 COMPRESSOR

A. Provide hermetic or semi-hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater for operation down to 0F, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.

B. Provide capacity control by staging multiple compressors, digital scrolls, inverter duty scroll compressors.

C. Five minute timed off circuit shall delay compressor start.

D. The use of hydrochlorofluorocarbon (HCFC) or chlorofluorocarbon (CFC) based refrigerants is prohibited.

2.10 CONDENSER

A. Condenser shall provide design capacity between the minimum and maximum ambient conditions scheduled on the drawings.

B. Condenser Coil:

1. Round Copper Tube and Aluminum Fins: Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Air test under water to 450 psig.
2. Microchannel: All aluminum brazed fin construction. The maximum allowable working pressure of the condenser is 450 psig. Air test under water to 450 psig.

C. Condenser Fans: Provide direct drive low noise blade design propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be aluminum or composite material.

D. Condenser Motors: Fan motors shall be an ECM type motor for proportional control. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

E. Entire fan assembly shall be statically and dynamically balanced.

F. Provide refrigerant pressure switches to cycle condenser fans.

G. Provide hail guards on all condenser coils.

H. Liquid and discharge isolation valves with staged and digital scrolls.

2.11 MIXING SECTION

A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper shall fail to closed position. Relief dampers may be gravity balanced.

B. Gaskets: Provide tight fitting dampers with edge gaskets. Gaskets must be mechanically fastened (use of adhesive alone shall not be acceptable). Damper blades shall be gasketed with side seals to provide an air leakage rate of Class 1A at 1" w.c. pressure differential for a 24"x 24" damper. A barometric exhaust damper shall be provided to exhaust air out the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator.

C. Damper Actuator: 24 volt with gear train sealed in oil, with spring return on units 7.5 tons cooling capacity and larger.

2.12 ECONOMIZERS

A. Factory installed by approved rooftop unit manufacturer with fully modulating motorized outside air and return air dampers.

B. To be controlled by differential enthalpy with fixed dry-bulb controller with minimum position setting.

C. Shall be equipped with 100% capable relief barometric damper relieving up to 100% return air and sealed to meet ASHRAE 90.1 requirements.

D. Shall be capable of introducing up to 100% outside air.

E. Shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy.

F. Dampers shall be capable of completely closing when unit is in unoccupied mode.

G. Outside air damper normally closed and return air damper normally open.

H. Provide factory installed and tested, outdoor air monitor that controls outdoor air ± 15% accuracy down to 40 CFM per ton.

I. Provide a field installed duct/space-mounted C02 sensor. Outside air damper position shall modulate between the demand control ventilation limit (minimum position setpoint) and the ventilation limit (maximum non-economizer position setpoint) to satisfy the space requirements. Damper position shall be controlled to the greater of the two command signals, either minimum outside airflow or space IAQ (CO2).

J. Economizer Fault Detection and Diagnostics (FDD):

1. Air-cooled unitary direct-expansion units that are equipped with an economizer shall include a fault detection and diagnostics system complying with the following:

a. The following temperature sensors shall be permanently installed to monitor system operation:

1) Outside air.
2) Supply air.
3) Return air.

b. Temperature sensors shall have an accuracy of ± 2F over the range of 40F to 80F.
c. Refrigerant pressure sensors, where used, shall have an accuracy of ± 3 percent of full scale.
d. The unit controller shall be configured to provide system status by indicating the following:

1) Free cooling available.
2) Economizer enabled.
3) Compressor enabled.
4) Heating enabled.
5) Mixed air low limit cycle active.
6) The current value of each sensor.

e. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans, and the heating system can be independently tested and verified.
f. The fault detection and diagnostics system shall be configured to detect the following faults:

1) Air temperature sensor failure/fault.
2) Not economizing when the unit should be economizing.
3) Economizing when the unit should not be economizing.
4) Damper not modulating.
5) Excess outdoor air.

g. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel or annunciated locally on zone thermostats.

2.13 POWER EXHAUST

A. Factory installed by economizer supplier or compatible equivalent.

B. Controlled by economizer controls.

C. Power exhaust shall be factory wired to electrical section complete with conduit, feeders, disconnect, and overcurrent protection. Power exhaust shall be energized based on building pressure or when dampers open past the adjustable setpoint of the economizer control.

D. Must comply with Energy Code Fan Power Limitation formula.

E. Fans:

1. Exhaust Fans: Propeller
2. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
3. Fan and motor assemblies shall be resiliently mounted
4. Direct drive motor.
5. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
6. All fans must be statically and dynamically balanced.

F. Motors:

1. Motors shall be open drip-proof with grease lubricated bearings.
2. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 230513.
3. No equipment shall be selected or operate above 90% of its motor nameplate rating.

2.14 ELECTRICAL

A. Provide with single point power connection to service all controls, dampers, outlet, and fans, complete with non-fused disconnect switch, short circuit protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection, transformer, and convenience outlet.

B. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect**.**

C. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.

D. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.

E. All units shall include a transformer for controls and convenience outlet.

F. Only one power cable connection to the unit shall be necessary.

G. Motor shall include phase failure protection and prevent the motor from operation in the event of phase loss.

2.15 OPERATING CONTROLS - SINGLE ZONE UNITS

A. When ECM are applied:

1. Single Zone VAV: The unit controller shall proportionally control the ECM motors on the supply fan based on space temperature. The unit controller shall increase/decrease the speed of the supply fan in order to maintain the space temperature within its setpoint and deadband. The unit controller shall provide discharge air temperature control with the compressor modulation.

B. When variable speed drives are applied:

1. Single Zone VAV: An electronic variable frequency drive shall be provided for the supply air fan. Each drive shall be factory installed out of the airstream in a conditioned cabinet. Drives shall meet UL Standard 95-5V. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly. Mounting arrangements that expose drives to high temperature unfiltered ambient air are not acceptable.

C. Room thermostat shall incorporate:

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set-up for four separate temperatures per day.
4. Instant override of setpoint for continuous or timed period from one hour to 31 days.
5. Short cycle protection.
6. Programming based on weekdays, Saturday and Sunday.
7. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.

D. Room thermostat display shall include:

1. Time of day.
2. Actual room temperature.
3. Programmed temperature.
4. Programmed time.
5. Duration of timed override.
6. Day of week.
7. System model indication: heating, cooling, auto, off, fan auto, fan on.
8. Stage (heating or cooling) operation.

E. Provide low limit sequence to close outside air dampers and stop supply fan.

F. Mixed Air Controls: Maintain selected supply air temperature and revert dampers to minimum outside air position on a call for heating and above 75F ambient, when ambient air enthalpy exceeds return air enthalpy.

G. Dehumidification Controls: Maintain the relative humidity setpoint with the hot refrigerant gas reheat coil.

2.16 OPERATING CONTROLS - VARIABLE VOLUME UNITS

A. Temperature transmitter located in supply air shall signal electronic logic panel to control mixing dampers and cooling in sequence to maintain 55F (adj.).

B. Control cooling by modulating compressors.

C. Control logic shall allow adjustable supply air reset under low load or airflow conditions.

D. Each unit shall also have the ability to accept a time schedule via BAS network communications.

E. Provide two stage morning warm-up thermostat to hold outdoor dampers closed and energize heat until return air temperature reaches set point.

F. Program Options: Each central control panel is individually configurable as an air conditioner controller for a variable volume system.

G. Supply Air Temperature Sensor Input: The supply air temperature sensor monitors the air handling unit discharge air temperature. It is used by the central control panel to control the stages of heating and cooling, and to protect the air handling unit from excessively high or low discharge air temperatures. The leaving air temperature sensor requires twisted, shielded pair wire. Terminations are screw terminals.

H. System Control: The central control panel scans the unit control modules to determine the deviations from temperature setpoint, time of deviation, time from last changeover, and number of UCMs requiring heating or cooling. Based upon this information, the system heat/cool mode and stage of capacity is selected. The central control panel also monitors the system air temperature to ensure that high and low temperature limits are maintained.

2.17 DDC TEMPERATURE CONTROLS

A. Install standalone control module providing communication between unit controls and packaged DDC temperature control system.

B. Control module shall be compatible with temperature control system specified in Section 230900. Provide BACnet gateway for communication.

2.18 ACOUSTICS

A. Manufacturer shall submit calculated sound power levels.

2.19 REMOVABLE FILTER SCREEN

A. Description: Removable, washable cottonwood airborne matter screen compatible with equipment intake.

B. Submittal: Filter screen shall be included by equipment manufacturer to ensure equipment airflow capacity is coordinated with screen.

C. Filter Material: Flexible, UV resistant fine polyester screen.

D. Fasteners: Commercial plastic/polyester twist lock fasteners fastened to equipment using self-tapping screws w/ bonded washer.

E. Approved Manufacturers:
1. By Equipment Manufacturer
2. Air Solution Company

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.

B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount units on factory built roof mounting curb and provide watertight enclosure to protect ductwork and utility services. Install unit level.

C. All field wiring shall be in accordance with the National Electrical Code.

D. P-traps must be provided for all drain pans.

E. Comb all coils to repair bent fins.

F. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

3.3 MANUFACTURER'S FIELD SERVICES

A. Provide initial start-up and shutdown during first year of operation.

END OF SECTION

SECTION 237416.13 - PACKAGED ROOFTOP AIR CONDITIONING UNITS - ABOVE 25 TON

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged Rooftop Unit.

B. Unit Controls.

C. Roof Mounting Frame and Base.

D. Economizers.

E. Power Exhaust.

1.2 QUALITY ASSURANCE

A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).

B. All units must be UL or ETL listed and must contain UL labeled components.

C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.

D. Conform to .

E. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 REFERENCES

A. AHRI 210 - Unitary Air Conditioning Equipment.

B. AHRI 240 - Air Source Unitary Heat Pump Equipment.

C. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.

D. ASHRAE 37 - Methods of Testing for Rating Unitary Air Conditioning and Heat Pump Equipment.

E. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

F. NFPA 70 - National Electrical Code.

G. NFPA 90A - Installation of Air Conditioning and Ventilating System.

H. UL - Underwriters' Laboratory.

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 230500.

B. Indicate electrical service and duct connections on shop drawings or product data.

C. Submit manufacturer's installation instructions.

D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

E. Submit fan curves, including minimum and maximum fan speed, with specified operating points clearly plotted.

F. Provide 8 octave maximum sound power levels at unit discharge and return connection.

G. Submit certification that the packaged rooftop air conditioning units, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

1.7 WARRANTY

A. Provide five (5) year manufacturer's warranty for compressors. Provide ten (10) year manufacturer's warranty for heat exchanger.

B. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

1.8 MAINTENANCE SERVICE

A. Contractor shall furnish complete service and maintenance of packaged roof top units for one year from Date of Substantial Completion.

B. Provide maintenance service with a two-month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.

C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of four (quarterly) filter replacements, minimum of one fan belt replacement, and controls checkout, seasonal adjustments, and recalibrations.

D. Submit copy of service call work order or report and include description of work performed to Owner and Architect/Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 230500 for additional information.

B. Trane

2.2 MANUFACTURED UNITS

A. Provide roof-mounted units having gas burner, and electric refrigeration.

B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, exhaust fan, heat exchanger and burner, electric heating elements, controls, air filters, refrigerant cooling coil and compressor, condenser coil, condenser fan, and a full refrigerant charge.

C. Unit shall be furnished with non-fused disconnect switch, short fuse protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection.

D. AHRI rated for direct expansion use with low GWP refrigerants (e.g. R32 or R454B).

E. Refrigerant Detection System (RDS)

1. Units manufactured using A2L refrigerants (e.g. R-32, R-454B) shall include a Refrigerant Detection System (RDS) with one or more refrigerant detection sensors to detect leaked refrigerant within the conditioned air stream in compliance with UL 60335-2-40. Minimum Safety Measures Activation shall include: activating ventilation systems or fans to disperse refrigerant, disabling electrical ignition sources, and issuing alarms or notifications.

2.3 FABRICATION

A. Cabinet: Galvanized steel with baked enamel finish, access doors with quick fasteners locking door handle type with piano hinges. Access doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors minimum 20 gauge.

B. Outside Air Intakes: The outside air intakes shall be located a minimum of 15 inches above the roof mounting curb to minimize the effect of heat pickup from the roof during the natural cooling cycle and the effects of snow on the roof during winter operation. Each air intake shall be furnished with rain eliminators.

C. Insulation: Minimum of 1" (1.5lb./cuft.) aluminum foil faced glass fiber on all sections. All sections shall be double wall, foam injected casings.

D. Heat Exchangers: Aluminized steel, of welded construction.

E. Air Filters: Two inch thick glass fiber disposable media in metal frames.

2.4 ROOF MOUNTING FRAME AND BASE

A. Roof Mounting Curb: Minimum 24 inches high, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

2.5 FANS/MOTORS

A. Fans:

1. Supply Fans: Airfoil DWDI centrifugal; SWSI plenum or vane axial fan.
2. Return: Airfoil DWDI centrifugal; SWSI plenum or vane axial fan.
3. Exhaust Fans: Airfoil DWDI centrifugal; SWSI plenum or vane axial fan.
4. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
5. Fan and motor assemblies shall be resiliently mounted.
6. Direct drive motor or with V-belt drive and rubber isolated hinge mounted motor.
7. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
8. All fans must be statically and dynamically balanced.

B. Motors:

1. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 230513.
2. No equipment shall be selected or operate above 90% of its motor nameplate rating.
3. Motor shall have 1.15 service factor.

C. Belt Drive Fans:

1. Belt drive fans must be within ± 10% of scheduled RPM.
2. Belt drive fans shall have slide rails, adjusting screws, anchor bolts, and bedplates.

3. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. On units over 20 HP, use fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
4. Units used with variable speed drives shall have fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.

2.6 BURNER

A. Gas Burner: Forced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shutoff, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shutoff pilot. Fully modulating gas valve with minimum 10:1 turndown. The burner shall operate efficiently at all firing rates. The burner shall have proven open damper low-high-low pre-purge cycle and proven low fire start. The combustion air control damper shall be in the closed position during the off cycle to reduce losses.

B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.

C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.

D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, or adjustable time delay relays with switch for continuous fan operation.

2.7 EVAPORATOR COIL

A. Provide copper tube with aluminum fin coil assembly.

B. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft2 of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.

C. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

D. Provide insulation on liquid refrigerant and suction piping between compressor and evaporator coil where not protected by drain pans. Insulation shall be elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.27 maximum 'K' value at 75F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.

E. Drain Pan Condensate Overflow Switch: Float with integral magnet overflow switch conforming to UL508. Factory installed in drain pan and wired to shut the rooftop unit down with a fault alarm. No standby power required.

2.8 HOT GAS REHEAT COIL

A. Provide copper tube with aluminum fin coil assembly.

B. Valves to reroute hot refrigerant gas from the discharge line of the compressor through the reheat coil.

2.9 COMPRESSOR

A. Provide hermetic or semi-hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater for operation down to 0F, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.

B. Provide capacity control by staging multiple compressors, digital scrolls, inverter duty scroll compressors.

C. Five minute timed off circuit shall delay compressor start.

D. The use of hydrochlorofluorocarbon (HCFC) or chlorofluorocarbon (CFC) based refrigerants is prohibited.

2.10 CONDENSER

A. Condenser shall provide design capacity between the minimum and maximum ambient conditions scheduled on the drawings.

B. Condenser Coil:

1. Round Copper Tube and Aluminum Fins: Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Air test under water to 450 psig.
2. Microchannel: All aluminum brazed fin construction. The maximum allowable working pressure of the condenser is 450 psig. Air test under water to 450 psig.

C. Condenser Fans: Provide direct drive low noise blade design propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be aluminum or composite material.

D. Condenser Motors: Fan motors shall be an ECM type motor for proportional control. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

E. Entire fan assembly shall be statically and dynamically balanced.

F. Provide refrigerant pressure switches to cycle condenser fans.

G. Provide hail guards on all condenser coils.

H. Liquid and discharge isolation valves with staged and digital scrolls.

2.11 MIXING SECTION

A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper shall fail to closed position. Relief dampers may be gravity balanced.

B. Gaskets: Provide tight fitting dampers with edge gaskets. Gaskets must be mechanically fastened (use of adhesive alone shall not be acceptable). Damper blades shall be gasketed with side seals to provide an air leakage rate of Class 1A at 1" w.c. pressure differential for a 24"x24" damper. A barometric exhaust damper shall be provided to exhaust air out the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator.

C. Damper Actuator: 24 volt with gear train sealed in oil, with spring return on units 7.5 tons cooling capacity and larger.

2.12 ECONOMIZERS

A. Factory installed by approved rooftop unit manufacturer with fully modulating motorized outside air and return air dampers.

B. To be controlled by differential enthalpy with fixed dry-bulb controller with minimum position setting.

C. Shall be capable of introducing up to 100% outside air.

D. Shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy.

E. Dampers shall be capable of completely closing when unit is in unoccupied mode.

F. Outside air damper normally closed and return air damper normally open.

G. Provide factory installed and tested, outdoor air monitor that controls outdoor air ± 15% accuracy down to 40 CFM per ton.

H. Provide a field installed duct/space-mounted C02 sensor. Outside air damper position shall modulate between the demand control ventilation limit (minimum position setpoint) and the ventilation limit (maximum non-economizer position setpoint) to satisfy the space requirements. Damper position shall be controlled to the greater of the two command signals, either minimum outside air flow or space IAQ (CO2).

I. Economizer Fault Detection and Diagnostics (FDD):

1. Air-cooled unitary direct-expansion units that are equipped with an economizer shall include a fault detection and diagnostics system complying with the following:

a. The following temperature sensors shall be permanently installed to monitor system operation:

1) Outside air.

2) Supply air.
3) Return air.

b. Temperature sensors shall have an accuracy of ± 2F over the range of 40F to 80F.
c. Refrigerant pressure sensors, where used, shall have an accuracy of ± 3 percent of full scale.
d. The unit controller shall be configured to provide system status by indicating the following:

1) Free cooling available.
2) Economizer enabled.
3) Compressor enabled.
4) Heating enabled.
5) Mixed air low limit cycle active.
6) The current value of each sensor.

e. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans, and the heating system can be independently tested and verified.
f. The fault detection and diagnostics system shall be configured to detect the following faults:

1) Air temperature sensor failure/fault.
2) Not economizing when the unit should be economizing.
3) Economizing when the unit should not be economizing.
4) Damper not modulating.
5) Excess outdoor air.

g. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel or annunciated locally on zone thermostats.

2.13 POWER EXHAUST

A. Factory installed by economizer supplier or compatible equivalent.

B. Controlled by economizer controls.

C. Power exhaust shall be factory wired to electrical section complete with conduit, feeders, disconnect, and overcurrent protection. Power exhaust shall be energized based on building pressure or when dampers open past the adjustable setpoint of the economizer control.

D. Must comply with Energy Code Fan Power Limitation formula.

E. Fans:

1. Exhaust Fans: Propeller or SWSI plenum fan.
2. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
3. Fan and motor assemblies shall be resiliently mounted.
4. Direct drive motor.
5. All fan bearings must be capable of being lubricated by easily accessible grease fittings.

6. All fans must be statically and dynamically balanced.

F. Motors:

1. Motors shall be open drip-proof with grease lubricated bearings.
2. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 230513.
3. No equipment shall be selected or operate above 90% of its motor nameplate rating.
4. Motor shall have 1.15 service factor.

2.14 ELECTRICAL

A. Provide with single point power connection to service all controls, dampers, outlet, and fans, complete with non-fused disconnect switch, short circuit protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection, transformer, and convenience outlet.

B. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.

C. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.

D. All units shall include a transformer for controls and convenience outlet.

E. Only one power cable connection to the unit shall be necessary.

F. Motor shall include phase failure protection and prevent the motor from operation in the event of phase loss.

2.15 OPERATING CONTROLS - SINGLE ZONE UNITS

A. When ECM are applied:

1. Single Zone VAV: The unit controller shall proportional control the ECM motors on the supply fan based on space temperature. The unit controller shall increase/decrease the speed of the supply fan in order to maintain the space temperature within its setpoint and deadband. The unit controller shall provide discharge air temperature control with the compressor modulation.

B. When variable speed drives are applied:

1. Single Zone VAV: An electronic variable frequency drive shall be provided for the supply air fan. Each drive shall be factory installed out of the airstream in a conditioned cabinet. Drives shall meet UL Standard 95-5V. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly. Mounting arrangements that expose drives to high temperature unfiltered ambient air are not acceptable.

C. Room thermostat shall incorporate:

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set-up for four separate temperatures per day.
4. Instant override of setpoint for continuous or timed period from one hour to 31 days.
5. Short cycle protection.
6. Programming based on weekdays, Saturday and Sunday.
7. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.

D. Room thermostat display shall include:

1. Time of day.
2. Actual room temperature.
3. Programmed temperature.
4. Programmed time.
5. Duration of timed override.
6. Day of week.
7. System model indication: heating, cooling, auto, off, fan auto, fan on.
8. Stage (heating or cooling) operation.

E. Provide low limit sequence to close outside air dampers and stop supply fan.

F. Mixed Air Controls: Maintain selected supply air temperature and revert dampers to minimum outside air position on a call for heating and above 75F ambient, when ambient air enthalpy exceeds return air enthalpy.

G. Dehumidification Controls: Maintain the relative humidity setpoint with the hot refrigerant gas reheat coil.

2.16 OPERATING CONTROLS - VARIABLE VOLUME UNITS

A. Temperature transmitter located in supply air shall signal electronic logic panel to control mixing dampers and cooling in sequence to maintain 55F (adj.).

B. Control cooling by modulating compressors.

C. Control logic shall allow adjustable supply air reset under low load or airflow conditions.

D. Dehumidification Controls: Maintain the relative humidity setpoint with the hot refrigerant gas reheat coil.

E. Seven-day timeclock with spring carry over (or electronic clock with battery backup) shall control unit on occupied/unoccupied schedule. At night, unit shall be off. Locate clock in remote control panel with status lights. Each unit shall also have the ability to accept a time schedule via BAS network communications.

F. Provide two stage morning warm-up thermostat to hold outdoor dampers closed and energize heat until return air temperature reaches set point.

G. Program Options: Each central control panel is individually configurable as an air conditioner controller for a variable volume system.

H. Supply Air Temperature Sensor Input: The supply air temperature sensor monitors the air handling unit discharge air temperature. It is used by the central control panel to control the stages of heating and cooling, and to protect the air handling unit from excessively high or low discharge air temperatures. The leaving air temperature sensor requires twisted, shielded pair wire. Terminations are screw terminals.

I. Operators Panel: An operator's panel may be used to control up to two central control panels. The 16-button keypad and 2 line/40-character display shall give the operator individual zone status and control from one location.

1. Zone control functions include:

a. Occupied heat/cool setpoints.
b. Unoccupied heat/cool setpoints.

2. Zone status includes:

a. Current zone temperature.
b. Current occupancy mode.
c. Current heat/cool mode.

3. Time-of-day scheduling shall be available by group, individually for each of the four groups. Scheduling shall be two on/off periods per day for each of the seven weekdays. A holiday schedule shall also be available for each group. Up to 24 holiday dates can also be scheduled. Groups timed override can be enabled from the keypad for a two-hour period. Operator's panel shall have a 365 day clock with daylight savings time and leap year functions.

2.17 DDC TEMPERATURE CONTROLS

A. Install standalone control module providing communication between unit controls and packaged DDC temperature control system.

B. Control module shall be compatible with temperature control system specified in Section 230900. Provide BACnet gateway for communication.

2.18 ULTRAVIOLET GERMICIDAL IRRADIATION (UVGI)

A. Provided and installed by unit manufacturer. Refer to Section 233300 for requirements.

B. Portal: The UV lamp plenum area shall be equipped with a viewing port for viewing the lamp assembly. Portal shall be constructed to allow viewing without the possibility of exceeding the Minimal Erythermal Dose.

C. Interlock: Include all interlocks and wiring to assure UV light assembly is not energized when any access door is opened. Provide lockout tagout switches to turn off UV lamps when persons are in the unit. Signage shall indicate Caution: Ultraviolet energy in duct. Do not override the safety device or otherwise activate lamps with door open.

D. Location: System shall be installed a minimum of 8 inches and maximum of 20 inches from coil surface (based on UVC manufacturer's calculations and recommendations.) Install on tracks allowing the UV fixture to slide into place. Tracks shall be designed so the UV fixtures can be easily maintained and replaced. Interlock all UV lamps to turn on and off together.

2.19 ACOUSTICS

A. Manufacturer shall submit calculated sound power levels.

2.20 REMOVABLE FILTER SCREEN

A. Description: Removable, washable cottonwood airborne matter screen compatible with equipment intake.

B. Submittal: Filter screen shall be included by equipment manufacturer to ensure equipment airflow capacity is coordinated with screen.

C. Filter Material: Flexible, UV resistant fine polyester screen.

D. Fasteners: Commercial plastic/polyester twist lock fasteners fastened to equipment using self-tapping screws w/ bonded washer.

E. Approved Manufacturers:

1. By Equipment Manufacturer
2. Air Solution Company

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.

B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount units on factory built roof mounting curb and provide watertight enclosure to protect ductwork and utility services. Install unit level.

C. All field wiring shall be in accordance with the National Electrical Code.

D. P-traps must be provided for all drain pans.

E. Comb all coils to repair bent fins.

3.3 MANUFACTURER'S FIELD SERVICES

A. Provide initial start-up and shutdown during first year of operation.

END OF SECTION

SECTION 238126 - SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Split system heat pump units.

1.2 REFERENCES

A. ARI 210 - Unitary Air Conditioning Equipment

B. ARI 240 - Air Source Unitary Heat Pump Equipment

C. ANSI NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

D. ANSI/ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.

E. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

F. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

G. ASHRAE 52 - Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

H. ASTM B1003 - Standard Specification for Seamless Copper Tube for Linesets.

I. FS TT-C-490 - Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings.

J. UL - Underwriters' Laboratories.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 230500.

B. Indicate drain, electrical, and refrigeration rough-in connections on shop drawings or product data.

C. Submit manufacturer's installation instructions.

D. Submit certification that split system air conditioning equipment, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Comply with manufacturer's installation instruction for rigging, unloading, and transporting units.

C. Protect units from weather and construction traffic by storing in dry, roofed location until units are ready for immediate installation.

1.5 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A for the installation of computer room air conditioning units.

B. Conform to ASHRAE 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.7 WARRANTY

A. Provide five (5) year manufacturer's warranty on all compressors.

PART 2 - PRODUCTS

2.1 SPLIT SYSTEM WALL AND CEILING-MOUNTED UNITS

A. Manufacturers:

1. Carrier/Toshiba
2. LG
3. Samsung
4. Daikin Applied
5. Trane/Mitsubishi

B. Manufactured Units:

1. Provide packaged, air-cooled, factory assembled, pre-wired and pre-piped unit consisting of cabinet, fans, filters, remote condensing unit, and controls. Wall-mounted units shall be furnished with integral wall mounting bracket and mounting hardware.
2. Assemble unit for wall-mounted or ceiling installation with service access required.
3. Performance shall be as scheduled on the drawings.
4. Unit shall be rated per AHRI Standards 210/240 and listed in the AHRI directory as a matched system.

5. Provide unit with factory-supplied cleanable air filters.
6. The units shall be listed by Electrical Laboratories (ETL) in accordance with UL-1995 certification and bear the ETL label.
7. All wiring shall be in accordance with the National Electric Code (NEC).

C. Evaporator Cabinet and Frame:

1. Cabinet:

a. Refer to schedule on drawings for mounting type (wall-mounted).
b. Exposed units shall have a finished appearance with concealed refrigerant piping, condensate drain piping, and wiring connections.

D. Evaporator Fans and Motors:

1. Fans:

a. The evaporator fan shall be direct drive with a single motor having permanently lubricated bearings.
b. The fan shall be statically and dynamically balanced.
c. The indoor fan shall have at least three speeds.

2. Motor:

a. Direct driven, digitally controlled with multiple speeds. Permanently lubricated with internal overload protection.

E. Evaporator Coils (Direct Expansion):

1. Direct expansion cooling coil of seamless copper tubes expanded into aluminum fins.
2. Single refrigeration circuit with externally equalized expansion valve.
3. Coils shall be pressure tested at the factory.
4. A sloped, corrosion-resistant condensate pan with drain shall be provided under the coil.

F. Electrical Panel:

1. Service Connections, Wiring, and Disconnect Requirements: Conform to the National Electrical Code and local electrical codes.

G. Control:

1. The unit shall have a hard-wired 7-day programmable remote controller to operate the system. Provide wall mounting bracket for controller.
2. Remote controller shall have "automatic", "dry" (dehumidification), and "fan only" operating modes.
3. The remote controller shall have the following features:

a. On/Off power switch.
b. Mode Selector to operate the system in auto, cool, heat, fan, or dehumidification (dry) operation.
c. Fan Setting to provide multiple fan speeds.
d. Swing Louver for adjusting supply louver discharge.
e. On/Off Timer for automatically switching the unit off or on.

f. Temperature Adjustment allows for the increase or decrease of the desired temperature.
g. Powerful Operation to allow quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time.

4. The remote controller shall perform fault diagnostic functions that may be system related, indoor or outdoor unit related depending on the fault code.
5. Temperature range on the remote controller shall be 64F to 90F in cooling mode and 50F to 86F in heating mode.
6. The indoor unit microprocessor shall have the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote controller.
7. Integration: Manufacturer shall provide a BACnet interface with the building automation system in accordance with ASHRAE/ANSI Standard 135. This may be accomplished through a system integration panel or "gateway". Integration panels shall be provided as part of the split system.

H. Outdoor Unit:

1. General:

a. The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be completely factory assembled and pre-wired with all necessary electronic and refrigerant controls.

2. Cabinet:

a. The outdoor unit shall be fabricated of galvanized steel, bonderized and coated with a baked enamel finish for corrosion protection.

3. Fan:

a. The fan shall be direct drive, propeller type fan with fan guard.
b. Fan blades shall be statically and dynamically balanced.
c. The fan shall have permanently lubricated type bearings.
d. Motor shall be protected by internal thermal overload protection.
e. Airflow shall be horizontal discharge.

4. Coil:

a. The outdoor coil shall be nonferrous construction with corrugated fin tube.
b. The coil shall be protected with an internal guard.
c. Refrigerant flow from the condenser shall be controlled via a metering device.

5. Compressor:

a. Hermetic or scroll refrigerant compressors with resilient suspension system, inverter driven, oil strainer, sight glass/moisture indicator, internal motor protection, high pressure switch, and crankcase heater.
b. The outdoor unit shall have an accumulator and four-way reversing valve.

6. Refrigerant:

a. AHRI rated for direct expansion use with low GWP refrigerants (e.g. R32 or R454B).

I. Integral Condensate Pump:

1. Packaged unit matched to evaporator unit including float switch, pump, motor assembly, check valve, and reservoir.
2. Provide alarm to indicate high level reservoir.
3. Unit shall be powered from evaporator unit with appropriate field connections available.

2.2 PIPING

A. Design Pressure: 450 psig; Maximum Design Temperature: 250F

B. Type ACR Seamless Copper Tube Linesets; Brazed Joints:

1. 3/4" and under.
2. Tubing: Type ACR seamless copper tube linesets, ASTM B1003. Sizes indicated are nominal designation.
3. Joints: Brazed with silver solder.
4. Fittings: Wrought copper solder joint, ANSI B16.22.
5. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged, and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.
6. Limitations:

a. Only between refrigerant splitter box and indoor terminal unit.
b. For use above ceiling only. Do not use in exposed areas.

C. Type ACR Hard Drawn Seamless Copper Tube; Brazed Joint:

1. 4" and under.
2. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
3. Joints: Brazed with silver solder.
4. Fittings: Wrought copper solder joint, ANSI B16.22.
5. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.

D. Refrigerant linesets are permitted.

1. Provide manufacturer-packaged refrigerant linesets and accessories of sizes needed for installation. Verify lengths of piping required for installation.

2.3 INSULATION

A. EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).

2.4 ROOF MOUNTING CURB

A. Minimum 18 inches (mm), minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

2.5 EXPANSION COMPENSATION

A. Assembly consisting of two flexible connectors, two copper flexible connectors, two 90 elbows, and a 180 return pipe. Unit shall be in the form of a pipe loop.

B. Connectors shall have corrugated copper hose bodies with copper braided casings.

C. Connectors shall be rated for 150 psi working pressure at 70F.

D. Sizes 2" and smaller shall have copper sweat ends.

E. Connectors shall be suitable for 1/2" permanent misalignment.

F. Manufacturer:

1. Metraflex Type MLS

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that proper power supply is available.

3.2 INSTALLATION

A. General Installation Requirements:

1. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
2. Install units in accordance with manufacturer's instructions. Install all units level and plumb. Indoor units shall be installed using manufacturer's standard mounting hardware securely fastened to building structure.
3. Refer to Section 230529 for roof support rails for outdoor unit.
4. Coordinate the exact mounting location of all indoor and outdoor units with architectural and electrical work. Coordinate installation of ceiling-mounted units with ceiling grid layout. Provide additional ceiling grid reinforcement or modification as required and coordinate the work with the GC. Locate the indoor unit where it is readily accessible for maintenance and filter changes. Where outdoor units are located on the roof, locate at least 10' from the roof edge.
5. Verify locations of wall-mounted remote controllers with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Height above finished floor shall not exceed 48".
6. Maintain minimum clearances to all equipment. Maintain manufacturer's minimum maintenance, and airflow clearances, and maintain minimum spaces about electrical equipment, whichever is greater.

a. 120V: 36" deep x 30" wide or the width of the panel whichever is wider.
b. 208V: 42" deep x 30" wide or the width of the panel whichever is wider.
c. 480V: 42" deep x 30" wide or the width of the panel whichever is wider.

B. Condensate Removal:

1. Install condensate piping with trap and route from drain pan to nearest drain. Discharge to nearest code-approved receptor or to a properly vented indirect waste fitting. Flush all piping before making final connections to units.

C. Comb all coils to repair bent fins.

D. Install new filters in the unit at Substantial Completion.

E. A factory-authorized service agent shall assist in commissioning the unit and inspecting the installation prior to startup. Submit startup report with O&M manuals.

3.3 REFRIGERANT PIPING

A. Install refrigerant piping from the indoor unit(s) to the condensing unit. Refrigerant pipe sizes, lengths, specialties and configurations shall be as recommended by the manufacturer. Evacuate refrigerant piping and fully charge system with refrigerant per manufacturer's requirements.

B. Provide weather-tight insulated roof curb to accommodate refrigerant piping and conduit roof penetrations.

C. Insulate all refrigerant piping. Both liquid and suction lines shall be insulated between the indoor and outdoor units.

D. Joining of Piping:

1. Brazed Joints:

a. Make up joints with brazing filler metal conforming to ANSI/AWS A5.8. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt, and grease just prior to brazing. Apply flux evenly, but sparingly, to all surfaces to be joined. Brazing filler metal with a flux coating may also be used. Heat joints uniformly to proper brazing temperature so braze filler metal flows to all mated surfaces. Wipe excess braze filler metal, leaving a uniform fillet around cup of fitting.
b. Flux shall conform to ANSI/AWS A5.31.
c. Remove composition discs and all seals during brazing if not suitable for a minimum of 840For greater than the melting temperature of the brazing filler metal, whichever is greater.

2. Mechanical Press Connection:

a. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
b. Examination: Upon delivery to the jobsite, examine copper tubing and fittings for debris, defects, incise marks (manufacturer's engraving on tube), holes, or cracks.
c. Fully insert tubing into the fitting and mark tubing.

d. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
e. Joint shall be pressed with a tool approved by the manufacturer.
f. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

3. Axially Swaged Connection:

a. Brass axially swaged connectors shall be installed in accordance with the manufacturer's installation instructions.
b. Installers shall be trained by a certified Vulkan LOKRING trainer. Provide proof of certification upon request.

E. Insulation:

1. Insulate all refrigerant pipes between the outdoor and indoor units. This includes the liquid pipe, the suction pipe, the hot gas pipe, and the high/low pressure gas pipe. All fittings, valves, and specialty refrigerant components in the piping between the indoor and outdoor units shall also be insulated. The insulation shall have a continuous vapor barrier and shall pass through hangers and supports unbroken. All exterior insulated piping shall be painted with minimum of one (1) coat of UV resistant paint. Over size hangers and supports to allow the insulation to pass through unbroken. Following are the minimum insulation thicknesses unless noted otherwise in the manufacturer's literature or required by local AHJ:

a. Code/Year: ASHRAE 2010IECC 2021

b. Refrigerant Suction (40F & Below):

1) Up to 1" (25 mm) pipe size: 1/2" (15 mm) thick
2) 1" pipe size and up: 1"

c. Refrigerant Suction (41F to 60F):

1) Up to 1-1/2": 1/2"
2) 1-1/2" pipe size and up: 1"

d. Refrigerant Liquid:

1) Up to 1-1/2": 1"
2) 1-1/2" pipe size and up: 1-1/2"

END OF SECTION

SECTION 238145 - VARIABLE REFRIGERANT FLOW HEAT PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Variable refrigerant flow split system heat pump (heat/cool).

B. Variable refrigerant flow split system heat pump with heat recovery (simultaneous heat/cool).

C. Refrigerant piping/tubing and insulation.

1.2 QUALITY ASSURANCE

A. Manufacturer: Manufacturer shall have a factory trained service contractor within 100 miles of project site.

B. Installed: Company with minimum five years documented experience performing the work of this Section.

C. Installer: Refrigerant system installer shall be certified with one of the following:

1. ASSE 6010 Medical Gas Installer Certificate
2. Commercial Refrigeration Technician Certificate

1.3 REFERENCES

A. ANSI/AHRI 210/240 - Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.

B. ANSI/AHRI 270 - Sound Rating of Outdoor Unitary Equipment.

C. ANSI/ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.

D. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

E. MIL-H-22547B - Heat Pump, Heating and Cooling (Unitary).

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 230500.

B. Indicate water, drain, and electrical rough-in connections on shop drawings or product data.

C. Submit manufacturer's installation instructions.

D. Submit manufacturer's warranty information.

E. Submit installing contractor's manufacturer training certification.

F. Submit ASSE 6010 or Commercial Refrigeration Technician Certificates for all installers.

G. Submit refrigerant charge. Charge calculation should be based on installed piping lengths and equipment capacities.

H. VRF Piping Layout Drawings:

1. Submit manufacturer's detailed VRF piping layout drawings at 1/8" = 1'-0" minimum scale complete with the following information at beginning of project:

    a. Actual pipe routing, fittings, hanger and support types, accessories, etc. with lengths and refrigerant charge noted.
    b. Include insulation thickness and type of insulation.
    c. Room names and numbers, ceiling types, and ceiling heights.
    d. Indicate location of all beams, bar joists, etc., along with bottom of steel elevations, for each member.

2. Submit VRF piping and equipment layout drawings. Verify clearances and interferences with other trades prior to preparing drawings. IMEG will provide electronic copies of piping drawings for Contractor's use if the Contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Submittals shall be in accordance with Section 230500.
3. Following installation and prior to refrigerant charge, Contractor shall verify actual installation, pipe routing, elevation changes, and piping lengths, noting variations from the original manufacturer's design and resubmit to the manufacturer. Manufacturer shall verify layout and determine the final refrigerant charge prior to operation.

1.5 DELIVERY STORAGE AND HANDLING

A. Protect finished cabinets from physical damage by leaving factory packing cases in place before installation and providing temporary covers after installation.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.7 WARRANTY

A. Installing contractor shall perform tasks required by manufacturer to ensure maximum available warranty is achieved. This will include but is not limited to:

1. System design performed by manufacturer certified designer.
2. System installation performed by manufacturer certified installer.
3. Complete system commissioning paperwork and submit to manufacturer.

B. Provide minimum five (5) year manufacturer's parts warranty (one-year basic warranty plus four-year extended warranty) on all parts (excluding compressors) and one (1) year labor warranty.

C. Provide minimum five (5) year manufacturer's compressor parts warranty.

D. Contractor shall provide one (1) year parts and labor warranty on the associated controls system, including all devices, wiring, and programming.

1.8 DEMONSTRATION

A. Engage manufacturer or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain individual units and complete system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Daikin AC

B. Carrier/Toshiba

C. Samsung

D. Trane/Mitsubishi

2.2 SYSTEM DESCRIPTION

A. The variable capacityheat pump air conditioning system shall be a variable refrigerant flow split system. The system shall consist of multiple evaporators using PID control and inverter driven heat pump unit. The unit shall consist of direct expansion (DX), air-source heat pump air conditioning system, and variable speed driven compressor multi zone split system.

B. Air-Source Heat Pump Unit - General: The heat pump unit is designed specifically for use with the manufacturer's components:

1. AHRI rated for direct expansion use with low GWP refrigerants(e.g. R32 or R454B).
2. The air-source heat pump unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant control. The refrigeration circuit of the heat pump unit shall consist of a compressor, motors, fans, condenser coil, electronic expansion valves, oil separators, service ports, liquid receivers, and accumulators.
3. All refrigerant lines shall be individually insulated between the heat pump and indoor units.
4. The connection ratio of the nominal capacity of indoor units to heat pump unit shall be 50-130%.
5. The sound pressure shall be no greater than 63 dBA at 4 feet from the heat pump unit at full load at fan height.
6. The system shall automatically restart operation after a power failure and shall not cause any settings to be lost, thus eliminating the need for re-programming.
7. The following safety devices shall be included on the heat pump unit: high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature. Oil recovery cycle shall be automatic as required to maintain oil levels at the heat pump unit.

8. The heat pump unit shall be able to operate in heating mode to -13F dry bulb ambient temperature without additional ambient controls.

    a. Heating capacity at design condition of -5F, shall be no less than 100% of the value scheduled on the drawings.

9. The heat pump unit shall have air cooled heat exchange coils constructed from copper tubing with aluminum fins. The coils shall be capable of being divided into sections to enable the heat pump unit to match the capacity required by the indoor units and to allow individual defrosting to take place as required.
10. The heat pump unit shall have at least one inverter controlled compressor, depending on scheduled capacity. The system shall use a control sequence to ensure that indoor loads are matched to the compressor capacity control.
11. The refrigeration process of the heat pump unit will be maintained by pressure and temperature sensors controlling solenoid valves, check valves, and bypass valves. The heating or cooling mode of the heat pump unit will be controlled using a combination of 2 and 3-way valves that shall reverse the cycle of the refrigerant to change the mode of the heat pump unit.
12. Unit Cabinet: The heat pump unit model shall be completely weatherproof and corrosion resistant. The heat pump unit shall be constructed from steel plate and treated with an anti-corrosive paint. Provide hail guards on all condenser coils.
13. Fan:

    a. The heat pump unit shall consist of propeller type, direct-drive fan motors that have multiple speed operation via a DC inverter.
    b. The fans shall be a vertical discharge. The fan motors shall have inherent protection and permanently lubricated bearings.
    c. The fans shall be provided with fan guards.

14. Condenser Coil: The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
15. Compressor:

    a. The variable speed compressor shall be capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the heat pump unit.
    b. The inverter driven compressor in each heat pump unit shall be DC, hermetically sealed, scroll type.
    c. The capacity control range shall be a minimum of 20% to 100% of total capacity.
    d. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
    e. Oil separators shall be standard with the equipment, together with an oil balancing circuit.
    f. The compressor shall be mounted to avoid the transmission of vibration.

16. Bypass Filter Assembly: Provide bypass cartridge filter at outdoor unit. The purpose is to provide refrigerant contaminate filtration for the first 24 hours of operation. Normal operation will bypass filter to outdoor unit.

    a. Replaceable Cartridge Angle Type: ANSI/AHRI 710, UL listed, brass or epoxy-coated steel shell, molded desiccant high-water capacity filter core(s); maximum working pressure of 500 psi; maximum temperature of 275F; maximum pressure drop of 3 psi with design refrigerant at system flow rate.

C. Indoor Units:

1. General – Each indoor unit shall have a heat exchanger that shall be constructed from copper tubing with aluminum fins. The flow of refrigerant through the heat exchanger shall be controlled by an electronic modulating expansion valve. This valve shall be controlled by internal temperature sensors and shall be capable of controlling the variable capacity of the indoor unit between at least 25% and 100%. The units shall be shipped from the factory fully charged with dehydrated air.
2. The indoor units shall be designed for installation within a conditioned space to be connected to an air-source heat pump air conditioning system.

3. Vertical Air Handling Unit:

a. The indoor unit shall be a floor standing vertical air handling unit with ducted discharge.
b. Acoustic Performance: Sound pressure shall range from not exceed 41 dBA at low speed measured 3.3 feet from the unit.
c. Construction:

1) Indoor unit shall be completely factory assembled and tested. The unit shall include factory wiring, piping, electronic modulating expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function.
2) The indoor units shall be equipped with a return air thermistor.
3) The indoor unit shall be separately powered.

d. Unit Cabinet:

1) Unit cabinet shall be constructed of galvanized steel with painted finish.
2) Cabinet shall be single wall construction with sound absorbing foamed polystyrene and polyethylene insulation.
3) Cabinet shall be factory insulated for use in unconditioned indoor spaces.

e. Fan:

1) Fan shall be direct-drive, forward curved fan, statically and dynamically balanced impeller with high, medium and low fan speeds.
2) Fan shall have static pressure up to 0.5" W.C.
3) Fan motor shall be thermally protected.

f. Filter: The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
g. Coils:

1) Coils shall be of the direct expansion type, constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2) The refrigerant connections shall be flare connections, and the condensate shall be coordinated with piping material specified in Section 232100.
3) A condensate pump with at least 20 inches of lift shall be located below the coil in the condensate pan, with a built-in high-level safety alarm to shut down the unit.
4) A thermistor shall be located on the liquid and gas line.

2.3 PIPING

A. Design Pressure: 450 psig.

1. Maximum Design Temperature: 250F.

B. Type ACR Seamless Copper Tube Linesets; Brazed Joints:

1. 1" and under.
2. Tubing: Type ACR seamless copper tube linesets, ASTM B1003. Sizes indicated are nominal designation.
3. Joints: Brazed with silver solder.
4. Fittings: Wrought copper solder joint, ANSI B16.22.
5. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged, and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.
6. Limitations:

    a. Only sizes 1" and under.
    b. For use above ceiling only. Do not use in exposed areas.

C. Type ACR Hard Drawn Seamless Copper Tube; Brazed Joint:

1. 4" and under.
2. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
3. Joints: Brazed with silver solder.
4. Fittings: Wrought copper solder joint, ANSI B16.22.
5. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.

D. Insulation:

1. EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).

2.4 CONTROLS GENERAL

A. The unit shall have controls provided with the unit by the manufacturer to perform input functions necessary to operate the system.

B. Computerized PID control shall be used to maintain room temperature within 1F of setpoint.

C. The unit shall be equipped with a programmable drying cycle that dehumidifies while inhibiting changes in room temperature.

D. The indoor circuit board shall be wired to enable auxiliary heating when at least one of the following occurs:

1. Coil thermistor temperature drops below a factory setpoint in heating mode.

2. Heat pump temperature drops below setpoint (adj.).
3. Based on a user adjustable schedule.

2.5 SIMPLE REMOTE CONTROL - TYPE A

A. The wired remote controller shall be able to control one (1) group (maximum of 16 units) and shall be able to function as follows:

1. The controller shall have a self-diagnosis function that constantly monitors the system for malfunctions.
2. The controller shall be able to immediately display fault location and condition.
3. An LCD digital display shall allow the temperature to be set in 1F units.
4. The controller shall be equipped with a thermostat sensor in the remote controller, making possible more comfortable room temperature control.

B. The wired remote controller shall have the following features:

1. Operation: Start/Stop, Temperature Setting, Fan Speed.
2. Monitoring: Status, malfunction flashing, malfunction content, filter sign, operation mode, temperature setting, permit/prohibit selection, fan speed, airflow direction.
3. Control Management: Field Setting Mode, Group Setting, Auto Restart.
4. The controller shall also be able to switch an external dry contact via a 12-volt DC relay (field supplied).

2.6 SYSTEM INTEGRATION

A. Integration: Manufacturer shall provide a BACnet interface with the building automation system in accordance with ASHRAE/ANSI Standard 135. This may be accomplished through a system integration panel or "gateway". Integration panels shall be provided as part of the VRF system.

2.7 ROOF MOUNTING CURB

A. Minimum 18 inches (mm), minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

2.8 EXPANSION COMPENSATION

A. Assembly consisting of two flexible connectors, two copper flexible connectors, two 90-degree elbows, and a 180-degree return pipe. Unit shall be in the form of a pipe loop.

B. Connectors shall have corrugated copper hose bodies with copper braided casings.

C. Connectors shall be rated for 150 psi working pressure at 70F.

D. Sizes 2" and smaller shall have copper sweat ends.

E. Connectors shall be suitable for 1/2" permanent misalignment.

F. Install in every straight run of hard drawn seamless copper tube; 30 feet long or longer. Expansion compensation is not required for flexible line sets.

G. Manufacturer:

1. Metraflex Type MLS

2.9 REMOVABLE FILTER SCREEN

A. Description: Removable, washable cottonwood airborne matter screen compatible with equipment intake.

B. Submittal: Filter screen shall be included by equipment manufacturer to ensure equipment airflow capacity is coordinated with screen.

C. Filter Material: Flexible, UV resistant fine polyester screen.

D. Fasteners: Commercial plastic/polyester twist lock fasteners fastened to equipment using self-tapping screws w/ bonded washer.

E. Approved Manufacturers:
1. By Equipment Manufacturer
2. Air Solution Company

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

B. Install in accordance with manufacturer's instructions. Install all piping, fittings, and insulation to meet manufacturer's requirements. Install units level and plumb. Evaporator fan components shall be installed using manufacturer's standard mounting devices securely fastened to building structure. Install and connect refrigerant tubing and fittings.

C. Installing contractor shall attend manufacturer sponsored training to obtain installation certification. Submit training certificates as noted in Part 1.

D. Installer shall supply isolation ball valves for zoned refrigerant isolation. Installer shall supply isolation ball valves with Schrader connection for isolating refrigerant charge and evacuation at each connected indoor unit and heat pump unit. Isolation ball valves, with Schrader connection, are required for instances of indoor unit isolation for troubleshooting, repair, or replacement without affecting the remainder of the system. Isolation ball valves with Schrader connection are also required at heat pump unit connection to isolate unit for troubleshooting, repair, or replacement and as required to provide partial capacity heating/cooling in the instance of a failure of one of the multiple heat pump unit compressors.

E. Insulate all refrigerant pipes between the heat pump and indoor units. This includes the liquid pipe, the suction pipe, the hot gas pipe, and the high/low pressure gas pipe. All fittings, valves, and specialty refrigerant components in the piping between the indoor and heat pump units shall also be insulated. The insulation shall have a continuous vapor barrier and shall pass through hangers and supports unbroken. All exterior insulated piping shall be painted with minimum of one (1) coat of UV resistant paint. Over size hangers and supports to allow the insulation to pass through unbroken. Following are the minimum insulation thicknesses unless noted otherwise in the manufacturer's literature or required by local AHJ:

1. ASHRAE 2016:
2. IECC 2018:

    a. Refrigerant Suction (40F & Below):

        1) Up to 1": 1/2"
        2) 1" pipe size and up: 1"

    b. Refrigerant Suction (41F to 60F):

        1) Up to 1-1/2": 1/2"
        2) 1-1/2" pipe size and up: 1"

    c. Refrigerant Liquid:

        1) Up to 1-1/2": 1"
        2) 1-1/2" pipe size and up: 1-1/2"

F. Engage manufacturer or factory-authorized service representative to perform startup service. Manufacturer shall provide on-site startup and commissioning assistance through job completion. Complete installation and startup checks according to manufacturer's written instructions.

G. Fully charge system with refrigerant based on volume per manufacturer's requirements using actual field dimensions (not original design submittal). Installing Contractor must coordinate final pipe sizes and lengths, and equipment location, with manufacturer to determine exact fill volume.

H. Field Quality Control:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing.
2. Perform the following field tests and inspections, and prepare test reports:

    a. Positive Pressure Leak Test: After installation, test for leaks by charging the system per manufacturer’s airtight positive test criteria for a minimum of 24 hours. Repair leaks and retest until no leaks exist.
    b. Negative Pressure Leak Test: After positive pressure leak test, evacuate the system with a vacuum pump per manufacturer’s vacuum drying test criteria. The system shall maintain vacuum without pump operation or gauge movement for a minimum of 1 hour. If the gauge rises, the system may contain moisture or have leaks. Repair leaks and retest until no leaks exist.
    c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    e. Provide field test reports to manufacturer to include with manufacturer’s startup report.

I. Coordinate installation of units with architectural and electrical work. Coordinate installation of ceiling recessed units with ceiling grid layout. Additional ceiling grid reinforcement or modification is the responsibility of the Mechanical Contractor and shall be coordinated with the General Contractor.

J. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Height above finished floor shall not exceed 48".

K. Contractor is responsible for routing all condensate drains from all indoor equipment to a nearby floor drain or standpipe. If ceiling heights or space finish does not accommodate gravity drainage, Contractor is responsible for providing a condensate pump and all electrical work required.

L. Contractor is responsible for installing VRF heat pump control system. Contractor shall coordinate with the Temperature Controls Contractor to determine extent of integration with building automation system (BAS). Equipment that is required to integrate the VRF heat pump system with the BAS is the responsibility of the VRF heat pump installing contractor. Final connections between VRF heat pump system and BAS shall be by the Temperature Controls Contractor.

M. Maintain minimum clearances to all equipment. Maintain manufacturer’s minimum maintenance, and airflow clearances and maintain minimum spaces about electrical equipment, whichever is greater.

1. 120V: 36" deep x 30" wide or the width of the panel whichever is wider.
2. 208V: 42" deep x 30" wide or the width of the panel whichever is wider.
3. 480V: 42" deep x 30" wide or the width of the panel whichever is wider.

3.2 REFRIGERANT PIPING SUPPORTS AND ANCHORS

A. Horizontal Supports: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

1. Type ACR Hard Drawn Seamless Copper Tube (Liquid Service):

a. Maximum Spacing:

1) 3/4" and under: 5'-0"
2) 1": 6'-0"
3) 1-1/4": 6'-0"
4) 1-1/2" 6'-0"
5) 2": 8'-0"

2. Type ACR Hard Drawn Seamless Copper Tube (Vapor Service):

a. Maximum Spacing:

1) 3/4" & under: 6'-0"
2) 1": 6'-0"
3) 1-1/4": 6'-0"
4) 1-1/2": 6'-0"
5) 2": 8'-0"

3. ACR Seamless Copper Tube Linesets:

a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 10 feet.

C. Install piping support within 2 feet of equipment connections.

END OF SECTION

SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Interior Communications Pathways Section 270528. This section is also applicable to Fire Alarm and Detection Systems Section 283100.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

1.3 SCOPE OF WORK

A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.

B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Electrical Work a finished and working system.

C. Separate contracts will be awarded for the following work.

D. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

E. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the Construction Manager's scope statements for complete scope of work description.

F. Description of Systems shall be as follows:

1. Electrical power system to and including luminaires, equipment, motors, devices, etc.
2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
3. Grounding system.
4. Fire alarm system.
5. Public address and intercom system.
6. Nurse call system.
7. Clock and program system.
8. Security system.
9. Rescue assistance communication system.
10. Distributed antenna system (DAS).
11. Wiring system for temperature control system as shown on the drawings.
12. Lightning protection system.
13. Wiring of equipment furnished by others.

14. Removal work and/or relocation and reuse of existing systems and equipment.
15. Telecommunications rough-in, as shown on drawings, for installation of telecommunications equipment by others under separate contract.
16. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.
17. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.

G. Work Not Included:

1. Telecommunications cabling will be by others, in raceways and conduits furnished and installed as part of the Electrical work.
2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

1.4 OWNER FURNISHED PRODUCTS

1.

B. The Owner will supply manufacturer's installation data for Owner-purchased equipment for this project.

C. This Contractor shall make all electrical system connections shown on the drawings **or** required for fully functional units.

D. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

1.5 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours are required.

B. Itemize all work and list associated hours and pay scale for each item.

1.6 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, and CONTROL CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.

3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
9. Low Voltage Technology Wiring: The wiring associated with the technology systems, used for analog or digital signals between equipment.
10. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications/technology information outlets.

C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
4. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:

    a. Luminaires.
    b. Gravity flow piping, including steam and condensate.
    c. Electrical bus duct.

d. Sheet metal.
e. Cable trays, including access space.
f. Other piping.
g. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.
2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

G. General (Electrical/Technology):

1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".
2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.

3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.
4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.7 COORDINATION DRAWINGS

A. Provide coordination drawings showing the complete, coordinated installation of mechanical, electrical, plumbing, fire protection, and other systems within available building spaces.

B. Definitions:

1. Coordination Drawings: Coordination drawings are defined as composite drawings or models that incorporate work of multiple trades and demonstrate coordinated routing, elevations, and clearances.

    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.

e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. Provide one complete, composite coordination drawing package for each building area, system, or phase demonstrating fully coordinated conditions.
3. The composite coordination drawing package may be created from multiple trade-specific electronic files; however, the final deliverable shall clearly represent a single coordinated installation.
4. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.

    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.

5. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

C. Participation:

1. The Contractor shall be responsible for coordinating all trades and preparing coordination drawings.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.

    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

D. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

    a. Scale of drawings:

        1) General plans: 1/4 Inch = 1 '-0" (minimum).
        2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
        3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
        4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).
        5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

E. General:

1. Provide coordination drawing files to the Architect/Engineer for review of identified conflicts. The Architect/Engineer will not act as the project coordinator and is not responsible for coordination of the work. The Architect/Engineer will review only clearly identified conflicts submitted by the Contractor and will not perform clash detection or coordination. The Architect/Engineer will not compile or reconcile multiple trade files and will rely on the Contractor's composite coordination drawing package.
2. The Contractor remains solely responsible for coordination regardless of any review or comment provided by the Architect/Engineer.
3. A plotted set of coordination drawings shall be available at the project site.
4. Coordination drawings are not shop drawings and are not subject to approval. Receipt of review of coordination drawings does not constitute approval of routing, layout, means, methods, sequencing, or constructability.
5. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
6. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
7. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
8. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
9. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
10. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.

11. Complete the coordination drawing process and obtain documented sign-off from all participating trades confirming that coordination drawings have been reviewed and coordinated prior to installation. Sign-off shall consist of signatures on the composite coordination drawing package or a coordination log identifying participating trades and acceptance of the coordinated layout.
12. Do not begin installation of work in an area until coordination drawings for that area are complete and trade sign-offs have been obtained.
13. Submit unresolved coordination conflicts to the Architect/Engineer for direction prior to installation. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination. Conflicts identified after installation due to incomplete coordination shall be corrected at no additional cost to the Owner.
14. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.
15. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.8 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Lowell Codes, Laws, Ordinances and other regulations having jurisdiction.
2. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.

3. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
6. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.
8. Pay all telephone company charges related to the service or change in service.

E. Utility Company Requirements:

1. Secure from the private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. The Owner shall make application for and pay for new electrical service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and Utility Company.
4. The contractor is responsible for completing utility requested forms and sharing utility requested load data from the construction documents.
5. Furnish the CT cabinet, CT's, and meter socket, per Utility requirements.Verify approved manufacturers and equipment with the Utility Company.
6. The Owner shall apply and pay for any changes for removal of existing electrical service by the utility company. The Contractor shall verify approved manufacturers and equipment with the Utility Company.

F. Examination of Drawings:

1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.
8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

H. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

1.9 WEB-BASED PROJECT SOFTWARE

A. The General Contractor shall provide a web-based project software site for the purpose of hosting and managing project communication and documentation until completion of the warranty phase.

B. The web-based project software shall include, at a minimum, the following features: construction schedule, submittals, RFIs, ASIs, construction change directives, change orders, drawing management, specification management, payment applications, contract modifications, meeting minutes, construction progress photos.

C. Provide web-based project software user licenses for use by the Architect/Engineer. Access will be provided from the start of the project through the completion of the warranty phase.

D. At project completion, provide digital archive of entire project in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

1.10 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item	Coordination Drawing
26 05 03	Through Penetration Firestopping	
26 05 13	Wire and Cable	
26 05 26	Grounding and Bonding	
26 05 33	Conduit and Boxes	+> 1.5"
26 05 48	Seismic Requirements for Equipment and Supports	
26 05 53	Electrical Identification	
26 05 73	Power System Study	
26 09 13	Energy Metering and Management System	
26 09 33	Lighting Control System	
26 20 00	Service Entrance	
26 22 00	Dry Type Transformers	Yes
26 24 13	Switchboards	Yes
26 24 16	Panelboards	Yes
26 27 16	Cabinets and Enclosures	Yes
26 27 26	Wiring Devices	Ceiling mount
26 28 13	Fuses	
26 28 16	Disconnect Switches	Yes
26 28 21	Contactors	Yes
26 43 00	Surge Protection Devices	
26 51 19	LED Lighting	Yes

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

a. Date
b. Project title and number
c. Contractor's name and address
d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
e. Description of items submitted and relevant specification number
f. Notations of deviations from the contract documents
g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

a. Date
b. Project title and number
c. Architect/Engineer
d. Contractor and subcontractors' names and addresses
e. Supplier and manufacturer's names and addresses
f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
g. Description of item submitted (using project nomenclature) and relevant specification number
h. Notations of deviations from the contract documents
i. Other pertinent data
j. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
b. Unstamped submittals will be rejected.
c. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.
2) Addenda items have been incorporated.
3) Catalog numbers and options match those specified.
4) Performance data matches that specified.
5) Electrical characteristics and loads match those specified.
6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
7) Dimensions and service clearances are suitable for the intended location.
8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

   a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
   b. The Contractor shall clearly indicate the size, finish, material, etc.
   c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
   d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.

    a. Allow at least two weeks for Architect’s/Engineer's review and processing of each submittal, excluding mailing.

16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer’s opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

a. Submittal file name: 26 XX XX.description.YYYYMMDD
b. Transmittal file name: 26 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

D. Paper Copy Submittal Procedures:

1. Paper copies are acceptable where electronic copies are not provided.
2. The Contractor shall submit ten (10) paper copies of each shop drawing.
3. Each set shall be bound in a three-ring binder or presentation binder. Copies that are loose or in pocket folders are not acceptable.

1.11 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:

a. Material: Delivered cost of product with taxes paid.
b. Labor: Labor cost, excluding overhead and profit.

3. Itemize the cost for each of the following:

a. Overhead and profit.
b. Bonds.
c. Insurance.
d. General Requirements: Itemize all requirements.

4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:

a. Each piece of equipment requiring shop drawings. Use the equipment nomenclature (SB-1, PANEL P-1, etc.) on the Schedule of Values.
b. Each type of small unitary equipment (e.g., FDS, FCS, CS, etc.). Multiple units of the same type can be listed together provided quantities are also listed so unit costs can be determined.

c. Each conduit system (medium voltage, normal, emergency, low voltage systems, etc.). In addition, for larger projects breakdown the material and labor for each conduit system based on geography (building, floor, and/or wing).
d. Fire alarm broken down into material and labor for the following:

1) Engineering
2) Controllers, devices, sensors, etc.
3) Conduit
4) Wiring
5) Programming
6) Commissioning

e. Site utilities (5' beyond building)
f. Seismic design
g. Testing
h. Commissioning
i. Record drawings
j. Punchlist and closeout

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.12 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.13 PRODUCT DELIVERY, STORAGE, HANDLING and MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.

B. Protect equipment, components, and openings with airtight covers and exercise care at every stage of storage, handling, and installation of equipment to prevent airborne dust and dirt from entering or fouling equipment to include, but not limited to:

1. Distribution equipment - branch panels, distribution panels, switchboards, motor control centers, etc.
2. Variable frequency drives.
3. Transformers, ventilated.
4. Electronic equipment, UPS, harmonic filters, power factor correction.
5. Lighting luminaires and lighting control systems.

C. Equipment and components that are visibly damaged or have been subject to environmental conditions prior to building turnover to Owner that could shorten the life of the component (for example, water damage, humidity, dust and debris, excessive hot or cold storage location, etc.) shall be repaired or replaced with new equipment or components without additional cost to the building owner.

D. Keep all materials clean, dry and free from damaging environments.

E. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, they shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

F. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.14 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

B. The following network connected equipment shall be equipped with restricted access protocols:

1. Adjustable trip overcurrent protection devices
2. Power monitoring and control
3. Electrical controls
4. Lighting control system
5. Variable frequency drives
6. Package engine generator and remote annunciator
7. Transfer switch and remote annunciator
8. Static uninterruptible power supply (UPS)
9. Fire alarm and automatic detection

1.15 WARRANTY

A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.16 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.17 CONTINGENCY

A. Include in the Base Bid a contingency of 10% percent to be used only by change orders issued by the Architect/Engineer. The unused portion of the contingency shall be deducted from the Contract price before final payment is made.

1.18 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractor's part or on the part of other Contractors whose work is affected.

D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on the Contractors part or on the part of other Contractors whose work is affected.

E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

1.19 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS

2.1 GENERAL

A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locators can be found by calling 811.
2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.

8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.
9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.
10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.
12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.

C. Dewatering:

1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.
2. Provide all necessary sand and/or CA6 for backfilling.
3. Native soil materials may be used as backfill if approved by the Geotechnical Engineer.
4. Dispose of the excess excavated earth as directed.
5. Backfill materials (native soil material, sand, and/or CA6) shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.
6. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.
7. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Spread fill and backfill materials in 6" uniform horizontal layers with each layer compacted separately to required density.
8. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.
9. Conduits that are concrete encased or in a ductbank, conduit spacers, and cradles shall be installed on a bed of compacted CA-6 gravel. Refer to conduit section for backfilling and ductbank requirements.
10. Backfill with native soil material (if approved) or sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.

11. Place all backfill above the sand in uniform layers not exceeding 6" deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.
12. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
13. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting and landscaping features removed or damaged to its original condition. At least 6" of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition. Broken edges shall be saw cut and repaired as directed by Architect/Engineer.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation:

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:

    a. All junction boxes are closed and identified in accordance with Section 260553 Electrical Identification.
    b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.
    c. Luminaire whips are supported above the ceiling.
    d. Conduit identification is installed in accordance with Section 260553 Electrical Identification.
    e. Luminaires are suspended independently of the ceiling system when required by these contract documents.
    f. All wall penetrations have been sealed.

2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until full access has been provided.

3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. IDPH Pre-Occupancy Requirements:

1. Each Contractor must submit all forms and certifications required by IDPH relating to their work at 85% completion of the project or when directed by the Owner/Architect/Engineer.

C. Final Jobsite Observation:

1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
4. Contractor shall notify Architect/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.

D. The following must be submitted before Architect/Engineer recommends final payment:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and submit receipt to Architect/Engineer.
5. Inspection and testing report by the fire alarm system manufacturer.
6. Start-up reports on all equipment requiring a factory installation or start-up.

E. Circuit Directories:

1. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

    a. O&M file name: O&M.div26.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, 2 paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are not acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.
15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.

D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

E. The instructions shall include:

1. Maintenance of equipment.
2. Start-up procedures for all major equipment.
3. Description of emergency system operation.

F. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.

G. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.
2. If the Contractor does not have staff that can adequately provide the required instructions, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 RECORD DOCUMENTS

A. The following paragraphs supplement Division 1 requirements.

B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

F. Record actual routing of conduits exceeding 2 inches.

3.8 PAINTING

A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.

B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.

C. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.

D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Architect the color preference before ordering.

E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, and storage rooms. Equipment furnished with a suitable factory finish need not be painted; provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

F. All electrical conduit and equipment, fittings, hangers, structural supports, etc., in unfinished areas, such as equipment and storage room area, shall be painted two (2) coats of oil paint of colors selected by the Architect.

G. Do NOT paint electric conduits in crawl spaces, tunnels, or spaces above suspended ceilings except that where conduit is in a damp location give exposed threads at joints two coats of sealer after joint is made up.

H. After surfaces have been thoroughly cleaned and are free of oil, dirt or other foreign matter, paint all raceway and equipment with the following:

1. Bare Metal Surfaces - Apply one coat of metal primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
2. Plastic Surfaces - Paint plastic surfaces with two coats of semi-gloss acrylic latex paint.

3.9 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.

C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.

B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.

D. Raceway and Cable Routing Restrictions: Raceways and cable are restricted from being routed in the following locations, unless serving the space or permitted by the authority having jurisdiction.

1. Elevator machine rooms and hoistways.
2. Exit enclosures.
3. Other areas restricted by code.
4. Technology, data, server rooms.
5. Fire pump and sprinkler rooms.
6. Normal power in emergency power equipment rooms: Limited to feeders and branch circuits serving the emergency power equipment located in the room.

7. Emergency power in normal power equipment rooms: Limited to feeders and branch circuits serving the normal power equipment located in the room.

3.11 INDOOR AIR QUALITY (IAQ) MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Within the Limits of Construction:

1. The Electrical Contractor shall coordinate all work with the contractor responsible for IAQ.
2. The means, methods and materials used by the Electrical Contractor shall be coordinated with the contractor responsible for IAQ and shall comply with the IAQ requirements set forth in Division 1 and Division 21/22/23 of these specifications.

B. Outside the Limits of Construction:

1. IAQ shall be the responsibility of the electrical contractor for work that is required outside the limits of construction.
2. The Electrical Contractor is responsible for the IAQ set forth in Division 1 and Division 21/22/23 of these specifications.
3. The Electrical Contractor shall review and coordinate all IAQ plans and procedures with the owner's IAQ representative.

C. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. General Contractor shall erect and maintain dust barriers throughout the construction work. These barriers shall be reasonably airtight and shall prevent entry into the construction zone by unauthorized persons. Reasonably airtight means construction equivalent to full-height temporary or permanent walls with joints taped or sealed, and shafts and other penetrations sealed as well as possible. Fire resistant polyethylene is acceptable; if flame spread/smoke developed ratings are demonstrated to conform to the applicable building codes and licensing acts.
2. The Contractor shall continuously maintain the construction zone under a negative pressure of at least 0.01" w.g. minimum relative to all adjacent areas of the building.

    a. Exhaust fans used for this purpose shall filter air and discharge it outdoors or to the least populated area adjacent to the construction work using negative air machines designed specifically for this purpose. All filtration for air recirculated back into the building shall be HEPA (99.97% DOP efficiency) for work adjacent to healthcare or elderly facilities. If no work is adjacent to these areas, 95% filtration is acceptable. Filtering air discharged to outdoors shall be accomplished with 30% filters.
    b. If air is discharged outdoors, maintain all required distances to doors, windows, air intakes, etc.
    c. If high levels of Volatile Organic Compounds (VOC's) or odors are released, activated carbon or equivalent filtration shall also be employed. Exhaust shall not discharge near doors, air intakes, pedestrians, gathering areas, or operable windows.
    d. Adjusting existing air handling equipment to assist in pressure control is acceptable, if approved by the Owner and the authority having jurisdiction.
    e. Seal return, exhaust, and supply air openings in or near the construction zone that serve existing air handling systems, and rebalance the systems for proper operation. If this is impractical, add filters at the intakes of sufficient cross sectional area to minimize the pressure drop and avoid the need for rebalancing.

f. Maintain pressure control one hour before and after all construction periods, and 24 hours per day in healthcare or elderly facilities.

3. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

   a. Minimizing the amount of dust generated.
   b. Reducing solvent fumes and VOC emissions.
   c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.

4. Request that the Owner designate an IAQ representative.
5. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
6. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
7. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
8. Request copies of and follow all Owner's IAQ and infection control policies.
9. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
10. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
11. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings under Construction".

3.12 SYSTEM STARTING AND ADJUSTING

A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.

C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.

D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for troubleshooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.13 FIELD QUALITY CONTROL

A. General:

1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than Electrical Code Standards. Take readings between conductors, and between conductors and ground.
6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.

B. Ground Resistance:

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)
2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain.
3. If the ground resistance value obtained is more than the value set forth in Section 260526, the following shall be done to obtain the value given:

    a. Verify that all connections in the service ground system are secure.
    b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.
    c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.
    d. Review results with the Architect/Engineer.

4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:

    a. Date of test.
    b. Number of hours since the last rain.
    c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.
    d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.
    e. Make, model, and calibration date of test equipment.
    f. Tabulation of measurements taken and calculations made.

C. Ground-Fault Equipment Performance Testing:

1. Test: Perform ground-fault performance testing when system is installed. The test process shall use primary current injection per manufacturer instruction and procedures. Perform test for the following:

    a. Service disconnects
    b. Solid state molded case circuit breakers and solid-state insulated case circuit breakers equipped with ground fault protection.
    c. Fusible switches with ground fault relay protection.
    d. Outside branch circuits and feeders.
    e. Code required.

2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.

D. Arc Energy Reduction Equipment Performance Testing:

1. Test: Perform arc energy protection performance testing when system is installed. The test process shall use primary current injection or approved method per manufacturer instructions and procedures. Perform test for the following:

    a. All arc energy reduction systems installed.

2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.

E. Other Equipment:

1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.

F. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.

G. Contractor shall thermographic study all electrical gear, switchboard, panelboards, etc. at the end of construction to identify any unusual conditions/heating within the equipment. Coordinate with Owner/Architect/Engineer to have an Owner/Architect/Engineer representative present during testing.

H. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.

I. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for "benchmark" amperages.

3.14 UTILITY REBATE

A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.

B. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to requesting a final job observation.

1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Smoke and fire/smoke dampers are wired and have been tested.
4. Per Section 260500, cable insulation test results have been submitted.
5. Per Section 260500, medium voltage testing report has been submitted.
6. Per Section 260500, ground resistance test results have been submitted.
7. Operation and Maintenance manuals have been submitted as per Section 260500.
8. Bound copies of approved shop drawings have been submitted as per Section 260500.
9. Report of instruction of Owner's representative has been submitted as per Section 260500.
10. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
11. Start-up reports from factory representative have been submitted as per Section 260500.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 260503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this Section.

B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

A. UL 263 - Fire Tests of Building Construction and Materials

B. UL 723 - Surface Burning Characteristics of Building Materials

C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops

D. UL 2079 - Tests for Fire Resistance of Building Joint Systems

E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)

F. Intertek / Warnock Hersey - Directory of Listed Products

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops

I. The Building Officials and Code Administrators National Building Code

J. 1997 Uniform Building Code

K. International Building Code, Current Adopted Edition

L. NFPA 5000 - Building Construction Safety Code

M. HCAI - Health Care Access and Information (California)

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Submit Firestopping Installers Certification for all installers on the project.

C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Interek / Warnock Hersey Assembly number.

D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:

1. Types of penetrating items.
2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
4. F ratings for each firestop system.

E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.

B. Install material prior to expiration of product shelf life.

1.6 PERFORMANCE REQUIREMENTS

A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.

B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:

1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

2. L-Rated Systems: Provide through-penetration firestop systems with L-ratings of not more than 5.0 CFM/sq.ft. at both ambient temperature and 400F .

C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.7 MEETINGS

A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.

1. Review foreseeable methods related to firestopping work.
2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.8 WARRANTY

A. Provide one year warranty on parts and labor.

B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

1. 3M; Fire Protection Products Division
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk
4. Tremco; Sealant/Weatherproofing Division
5. Johns-Manville
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Wiremold/Legrand: FlameStopper
10. Dow Corning Corp.
11. Fire Trak Corp.
12. International Protective Coating Corp.
13. HoldRite

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.

B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.

C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.

D. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.

E. Provide firestopping systems allowing continuous insulation for all insulated pipes.

F. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:

   a. F Rating = Floor/Wall Rating
   b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

   a. F Rating = Wall Rating
   b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999

Penetrating Item	UL System No.
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

   a. F Rating = Wall/Floor Rating
   b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

G. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.

H. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.

B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.

C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.

D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.

B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.

C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:

1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.

B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.

C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.

D. The Contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the Contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The Contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the Contractor's expense.

END OF SECTION

SECTION 260505 - ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical demolition

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY BOX, CONDUIT, OR WIRE THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS.

B. Where walls, ceilings, structures, etc., are indicated as being removed on general or electrical drawings, the Contractor shall be responsible for the removal of all electrical equipment, devices, fixtures, raceways, wiring, systems, etc., from the removed area.

C. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

D. Where mechanical or technology equipment is indicated as being removed on electrical, mechanical, or technology drawings, the Contractor shall be responsible for disconnecting the equipment and removing all starters, VFD, controllers, electrical equipment, raceways, wiring, etc. associated with the device.

E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area. Extended conduit and conductors to match existing size and material.

F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.

G. Bid submittal shall mean the Contractor has visited the project site and has verified existing conditions and scope of work.

3.2 PREPARATION

A. The Contractor shall obtain approval from the Owner before turning off power to circuits, feeders, panels, etc. Coordinate all outages with Owner.

B. Coordinate utility service outages with Utility Company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.

D. Disconnect electrical systems in walls, floors, structures, and ceilings scheduled for removal.

E. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Service changeover shall be completed on an overtime basis.

F. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.Provide a watchman to make required premise observations during all outages, requirements as dictated by codes and Owner's insurance carrier.

G. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. System changeover shall be completed on an overtime basis.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of Division 1 of Specifications and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring and raceway to source of supply. Existing conduit in good condition may be reused in place by including an equipment ground conductor in reused conduit. Reused conduit and boxes shall have supports revised to meet current codes. Relocating conduit shall not be allowed.

D. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.

E. Disconnect and remove outlets and devices that are to be demolished. Remove outlet or devices' associated back box, supports, and conduit and conductors back to source. Patch opening created from removal of device to match surrounding finishes.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories. Ballasts in light fixtures installed prior to 1980 shall be incinerated in EPA approved incinerator or disposed of in EPA certified containers and deposited in an EPA landfill certified for PCB disposal or recycled by permitted ballast recycler. Punctured or leaking ballasts must be disposed of according to Federal Regulations under the Toxic Substance Control Act. Provide Owner and Architect/Engineer with a Certificate of Destruction to verify proper disposal.

I. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide junction boxes and access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Extended conduit and conductors to match existing size and material.

L. HID and fluorescent lamps, determined by the Toxicity Characteristic Leachate procedure (TCLP), to be hazardous waste shall be disposed of in an EPA-permitted hazardous waste disposal facility or by a permitted lamp recycler.

M. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

N. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to structural plans for additional information.

O. Floor slab is post-tensioned. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid any tension cables or utilities encased in floor construction.

P. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes X-ray or similar non-destructive means. Where conduit is in concrete slab, cut conduit flush with floor, pull out conductors, and plug conduit ends.

Q. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.4 EXISTING ENCLOSURES - NEW EQUIPMENT

A. Existing enclosures may be reused to house new equipment including branch panels, industrial controls, and similar systems pending documented verification of the following provided with the applicable new equipment submittals.

1. New equipment or panelboard is listed for the existing enclosure or application.

2. Existing enclosure and new equipment is field evaluated by the manufacturer or nationally recognized testing laboratory for the available fault current, condition, and application.
3. Authority Having Jurisdiction (AHJ) approval.

3.5 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: Remove existing luminaires for cleaning as indicated on the drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts. Replacement parts shall match specified components for new luminaires of same type when applicable. Reinstall luminaire and connect to circuiting as indicated on drawings.

D. ELECTRICAL ITEMS (E.G., LIGHTING FIXTURES, RECEPTACLES, SWITCHES, CONDUIT, WIRE, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.6 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 1 of Specifications.

END OF SECTION

SECTION 260513 - WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building Wire - Copper

B. Building Wire - Aluminum or Copper-Clad Aluminum

C. Cabling for remote control, signal, and power limited circuits

D. Fire rated and circuit integrity (CI) cable and assemblies

E. Healthcare facilities cable (HFC)

F. Armored cable (AC)

G. Metal-clad cable (MC)

H. Nonmetallic-sheathed cable (NM)

1.2 RELATED WORK

A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

A. ASTM B800-05 - Standard Specification for 8000 Series Aluminum Alloy Wire Electrical Purposes-Annealed and Intermediate Tempered.

B. ASTM B801-07 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation

C. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy

D. NFPA 70 - National Electrical Code (NEC)

E. UL 44 - Thermoset-Insulated Wires and Cables

F. UL 83 - Thermoplastic-Insulated Wires and Cables

G. UL 854 - Service-Entrance Cables

H. UL 1581 - Standard for Electrical Wires, Cables, and Flexible Cords

I. UL 2196 - Fire Resistive, Fire Resistant and Circuit Integrity Cables

1.4 SUBMITTALS

A. Submit shop drawings and product data under the provisions of Section 260500.

B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 BUILDING WIRE - COPPER

A. The basis of design is copper conductor.

B. Feeders and Branch Circuits 8 AWG and larger: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.

C. Feeders and Branch Circuits 8 AWG and larger in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.

D. Feeders and Branch Circuits 10 AWG and Smaller: Copper, solid or stranded conductor, 600-volt insulation, THHN/THWN, unless otherwise noted on the drawings.

E. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings. Three conductor stranded copper, 600-volt XHHW-2 insulation, with copper ground and overall helical copper tape shield. Shield shall be terminated at both ends of cable with an approved termination.

F. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.

G. Operating Room Power Isolation Systems: Copper, stranded conductor, with low leakage insulation, Type 'XLP' 'XHHW-2'.

H. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

2.2 BUILDING WIRE - ALUMINUM OR COPPER-CLAD ALUMINUM

A. The basis of design is copper conductors. Aluminum conductor only allowed when scheduled as "AL", aluminum, copper-clad aluminum, or otherwise approved in writing.

B. Feeders and Branch Circuits 6 AWG and larger: Aluminum, AA-8000 series alloy, compact stranded conductor, 600-volt insulation, USE-2/RHH/RHW-2 or XHHW-2.

C. Feeders and Branch Circuits 6 AWG and larger in Underground Conduit: Aluminum, AA-8000 series alloy, compact stranded conductor, 600-volt insulation, USE-2/RHH/RHW-2.

D. Feeders and Branch Circuits 8 AWG and smaller, aluminum conductors not allowed.

E. Aluminum conductors shall be terminated with compression lugs, copper plated terminal pins, or manufacturer approved method. Apply anti-oxidation paste. Torque test conductor connections and terminations to manufacturer's recommended values.

F. Aluminum conductors shall NOT be allowed for the following:

1. Utility service entrance conductors.
2. Fire pump service entrance, controller, and motor.
3. Elevator equipment.

4. Feeders and Branch Circuits rated less than 100 amps.
5. Motor feeders and branch circuits.
6. Emergency generator conductors to and from generator distribution panel / paralleling gear.
7. When prohibited by the manufacturer of the equipment.
8. Grounding and Bonding.
9. Refer to Section 264100 - Lightning Protection System for acceptance of AL conductors.

2.3 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS

A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.

1. Fire alarm
2. Low voltage switching and lighting control
3. Electronic control

B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60C, individual conductors twisted together, shielded, and covered with a PVC jacket.

C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.4 FIRE-RATED AND CIRCUIT INTEGRITY (CI) CABLE AND ASSEMBLIES

A. Properties and requirements of fire rated cables and assemblies:

1. 2HR fire rated for horizontal and vertical installations.

B. Acceptable fire-rated cables and listed assemblies:

1. Feeder assembly located outside the structure (example: below finished grade), rated metal stud and drywall enclosure, or encased in concrete; minimum 5 inches of concrete.
2. Exothermal Mat Material: Raceway / Cable protected with exothermic mat material, UL listed.

    a. Install per manufacturer guidelines and requirements. Apply appropriate quantity of wrapped layers of material as required to achieve rating.
    b. Contractor shall upsize cable / wiring / raceway sizes as required for derating.
    c. Provide cable / wire ampacity derating calculations for each application, reference manufacturer for additional information, document and submit derated calculations as a shop drawing submittal for approval prior to installation. Minimum cable / wire derating shall be:

        1) Individual conduit raceways (less than or equal to 4" trade size): 10%.
        2) Parallel conduit raceways associated with the same feeder and protected by a common installation assembly: 15%.
        3) Cable tray raceway: 50%.

d. Manufacturer:

1) 3M Interam Endothermic Mat
2) Or submitted for engineer review prior to bid.

3. Mineral Insulated Cables: Copper conductor, 600-volt insulation, rated 90C, Type MI.

a. Manufacturer:

1) Raychem Pyrotenax MI

4. MC Cable: Copper conductor, 600V thermoset, low smoke zero halogen silicone rubber insulation, continuously welded corrugated copper armor for equipment grounding conductor, rated 90C, UL listed 2196. MC fire rated cable shall not be used for branch circuits that required redundant equipment ground paths per code.

a. Manufacturers:

1) VITALink MC
2) Draka Lifeline MC Series

5. Fire rated cable in EMT or IMC raceway: Copper conductor, 300-volt or ethernet power-limited circuit cables low smoke zero halogen (LSZH), rated 105C. Assembly including raceway shall be UL listed 2196 and UL circuit integrity (FHIT).

a. Manufacturers:

1) VITALINK CI/CIC or ethernet series
2) Draka RHW-2 EMT Series

6. Fire rated cable in phenolic RTRC conduit: Copper conductor, 600-volt RHW-2 or RW90 low smoke zero halogen (LSZH) insulation, rated 90C. Assembly shall be UL listed 2196 and UL circuit integrity (FHIT).

a. Manufacturer:

1) Draka Lifeline RHW-2

2.5 HEALTHCARE FACILITIES CABLE (HFC)

A. At the Contractor's option, healthcare-grade armored cables with redundant copper ground conductor may be used for branch circuit wiring as defined in the Electrical Code subject to acceptance by State and local codes. Healthcare armored cable shall include a green identifying strip on the exterior of the armor.

B. Armored cable shall be constructed in strict accordance with Underwriters Laboratories, Inc., Standard for Type AC Cables, UL 4, and include flexible metallic interlocked armor.

C. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.

D. Armored cable shall NOT be used for circuits serving the Essential Electrical System.

2.6 ARMORED CABLE (AC)

A. Conductors shall be copper, 600-volt insulation, THHN. Armored cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Armored Cables, UL 4, and include flexible metallic interlocked armor.

B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.

C. Armored cables may be used for branch circuit wiring as defined in the Electrical Code, subject to acceptance by State and local codes.

D. Armored cable shall NOT be used for circuits serving the Essential Electrical System.

2.7 METAL-CLAD CABLE (MC)

A. Conductors shall be copper, 600-volt insulation, THHN. Metal clad cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Metal-Clad Cables, UL 1569, exterior of metal interlocked armor.

B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.

C. Metal-clad cables may be used for branch circuit wiring as defined in the Electrical Code, subject to acceptance by State and local codes.

D. Metal-clad cable shall NOT be used for circuits serving the Essential Electrical System.

2.8 NONMETALLIC-SHEATHED CABLE

A. Nonmetallic-Sheathed Cable, Size 14 through 4 AWG:

1. Copper conductor, 600-volt insulation, rated 90C, Type NM. Nonmetallic-sheathed cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Nonmetallic-sheathed Cables, UL 719.
2. An equipment grounding conductor shall be provided with circuit conductors in all cables. Size per Electrical Code.
3. Nonmetallic-sheathed cables may be used for branch circuit wiring as defined in the Electrical Code. Nonmetallic-sheathed cables shall not be used for other circuits.

B. Underground Feeder and Branch Circuit Cable: Copper conductor, 600-volt insulation, rated 60C, Type UF.

C. Service Entrance Cable: Copper conductor, 600-volt insulation, XHHW, Type USE.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE

A. Above Accessible Ceilings:

1. Building wire shall be installed in raceway.

2. Metal clad cable, Type MC, 1/2" size with minimum #12 conductors and ground, shall be allowed for flexible whips to individual luminaires on non-essential circuits. The flexible whips shall be between 18" to 72" in length per Electrical Code.

B. All Other Locations: Building wire in raceway.

C. Above Grade: All conductors installed above grade shall be type "THHN".

D. Underground or In Slab: All conductors shall be type "THWN".

E. Low Voltage Cable (less than 100 volts): Low voltage cables in ducts, plenums, and other air handling spaces shall be plenum listed. Low voltage cables in non-accessible areas shall be installed in conduit. Low voltage cable may be installed without conduit in accessible areas using the following types of cable supports. Cable support types/systems shall comply with the warranty requirements of the low voltage cable manufacturer.

1. J-hooks
2. Bridle rings with saddle supports

F. Low Voltage Cable (less than 100 volts): Low voltage cable shall be installed in raceway.

G. Fire-Rated 2-Hour Feeders and Circuit Requiring Continuous Operation (CI): Refer to Part 2 of this section for acceptable products and assemblies. Installation shall meet UL 2196.

3.2 CONTRACTOR CHANGES

A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30C, NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)). Service entrance conductors are based on copper conductor installed in underground electrical ducts, NEC Table B.2(7) (2011 - 2017 edition Table B310.15(B)(2)(7); 2008 or later edition B.301.7) or calculated in accordance with Annex B Application Information for Ampacity Calculation.

B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if other than the basis of design.

C. Underground electrical duct ampacity rating shall be in accordance with NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)) or calculated in accordance with Annex B Application Information for Ampacity Calculation. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.

D. Conductor length(s) listed on plans and schedules. The drawings are diagrammatic with intent to convey the components of the electrical distribution system. Conductor length(s) when listed on plans and schedules are for engineering calculation purposes. Conductor length(s) shall NOT be used for bidding purposes.

E. Record drawing shall include the calculations and sketches.

3.3 GENERAL WIRING METHODS

A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring 100 volts or greater.

B. Low voltage control wiring, use no wire smaller than 18 AWG for low voltage control wiring below 100 volts.

C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.

D. Use no wire smaller than 8 AWG for outdoor lighting branch circuits.

E. The ampacity of multiple conductors in one conduit shall be derated per the Electrical Code. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.

F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.

G. Splice only in junction or outlet boxes.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

I. Make conductor lengths for parallel circuits equal.

J. All conductors shall be continuous in conduit from last outlet to their termination.

K. Terminate all spare conductors on terminal blocks, and label the spare conductors.

L. Cables or wires shall not be laid out on the ground before pulling.

M. Cables or wires shall not be dragged over earth or paving.

N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.

O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.

P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.4 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.

D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.

E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.

F. Only nylon rope shall be permitted to pull cables into conduit and ducts.

G. Completely and thoroughly swab raceway system before installing conductors.

H. Conductor Supports in Vertical Raceways:

1. Support conductors in vertical raceways in accordance with the Electrical Code Spacing of Conductors Supports.
2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

3.5 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage.

B. Cable fittings, connectors, and supports shall be listed.

C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.

D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.

E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.

F. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.

G. Underground installations; direct buried and conductors within raceways. Provide a warning ribbon with tracer wire at least twelve inches above the underground raceway.

H. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

3.6 FIRE-RATED CABLE AND ASSEMBLY INSTRUCTIONS

A. Terminations of the fire-rated cable must be outside of the fire zone.

B. Fire-rated cable shall be installed according to the manufacturer's instructions, recommendations, and UL listing.

C. Route fire-rated cable and assemblies separate from other feeders and distribution. Install cable and assemblies in locations protected from physical damage.

D. Refer to Electrical Identification Section 260553 for specific identification requirements.

3.7 WIRING CONNECTIONS AND TERMINATIONS

A. Splice and tap only in accessible junction boxes.

B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.

C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.

D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.

E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Cold shrink connector insulator with 1kV rating shall be used in damp and wet locations.

F. Lever style insulated splicing connectors, reversible, listed. Application limited to 14-10 awg, stranded/solid, copper conductor, and manufacturer’s listing. Obtain Engineer/Owner written approval by Request For Information RFI or addendum prior to use. Example manufacturers Wago lever nuts, Ideal lever connectors.

G. Thoroughly clean wires before installing lugs and connectors.

H. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

I. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.

J. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:

1. Facing the front and operating side of the equipment, the phase identification shall be:

    a. Left to Right - A-B-C
    b. Top to Bottom - A-B-C

K. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

L. Use antioxidant joint compound on all aluminum conductor terminations. Apply antioxidant joint compound per manufacturer's recommendations.

3.8 AC, MC CABLE INSTALLATION

A. AC/MC shall NOT be used for circuits serving the Essential Electrical System.

B. Cable shall be supported by an approved means every 4.5' and within 12" of outlet boxes, junction boxes, cabinets, or fittings.

C. Cable may be unsupported in the following conditions:

1. Cable is no longer than 2' in length at terminals where flexibility is necessary.
2. Cable is not more than 4.5' from the last point of support for connections within an accessible ceiling to light fixtures or equipment.

D. Conductor ampacity shall be derated as required by the Electrical Code where more than three current carrying conductors are used.

E. Each 120 and 277-volt circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for cable derating.

F. Cables shall be cut using a rotary cutter as recommended by the manufacturer to eliminate nicking and cutting of the conductors.

G. Bending radius shall comply with the requirements listed in the Electrical Code for the type and size of cable being installed, but shall not be less than 5-times the diameter of the cable in any case.

H. At cable terminations, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and, in addition, an insulating bushing or its equivalent protection shall be provided between the conductors and the armor.

I. All wiring devices supplied by nonmetallic-sheathed cables shall be mounted in an outlet box.

3.9 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a "Megger". The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.

C. MI cable shall have the insulation resistance of each cable tested with a 500-volt dc megohmeter prior to energizing the cables. Tabulate resistance values and submit to Architect/Engineer for acceptance.

D. Inspect wire and cable for physical damage and proper connection.

E. Torque test conductor connections and terminations to manufacturer's recommended values.

F. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

G. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.

H. Protection of wire and cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.

I. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment grounding system

B. Bonding system

C. Grounding electrode system

D. Grounding of systems over 1kV

E. Substation grounding

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

B. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with UL 467 Grounding and Bonding Equipment.

E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

F. Comply with Electrical Code; for overhead-line construction and medium-voltage underground construction, comply with IEEE/ANSI C2 National Electrical Safety Code (NESC).

1.3 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

B. NFPA 99 - Standard for Healthcare Facilities

1.4 SUBMITTALS

A. Submit shop drawings under provisions of Section 260500.

B. Product Data: For the following:

1. Ground rods.
2. Chemical electrodes.

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

D. Field Test Reports: Submit written test reports to include the following:

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.

E. Indicate layout of ground field, location of system grounding electrode connections, and routing of grounding electrode conductor and ground ring.

1.5 SUMMARY

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.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section 260513 "Wire and Cable".

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated. Refer to Section 260553 for insulation color.

D. Isolated Ground Conductors: Insulated. Refer to Section 260553 for insulation color.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Copper Bonding Conductors: As follows:

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.

H. Aluminum Bonding Conductors: As follows:

1. Bonding Cable: 10 strands of No. 14 AWG aluminum conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded aluminum conductor.
3. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules; 1-5/8 inches wide and 1/16 inch thick.

I. GB; Grounding Bar:

1. Bare, annealed copper bars of rectangular cross section, with insulators. 1/4" x 2", length of technology or applicable room.

J. IBT; Intersystem Bonding Termination:

1. Copper bar, 1/4" x 2" x 24". Provide with wall mounting brackets, insulators and pre-tapped holes.
2. Manufacturers:

a. Harger GBI Series.
b. Erico EGB Series.

2.2 CONNECTOR PRODUCTS

A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Connectors: Hydraulic compression type, in kit form, and selected per manufacturer's written instructions.

C. Bolted Connectors: Bolted-pressure-type connectors.

D. Substation connectors shall comply with IEEE 837 listed for use for specific types, sizes, and combinations of conductors and connected items.

2.3 GROUNDING ELECTRODES

A. Ground Rods Copper-clad steel.

B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.

C. Test Wells: Provide handholes as shown on drawings or as specified in Division 2 Section "Underground Ducts and Utility Structures."

D. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to Electrical Code, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet of 1/2"steel reinforcing bar.

PART 3 - EXECUTION

3.1 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.

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. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

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.

D. 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.

E. 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 non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.

G. Underground Connections: Exothermic-welded connections. Use for underground connections, except those at test wells.

H. Connections at Test Wells: Use compression-type connectors on conductors and make two bolted- and clamped-type connections between conductors and ground rods.

I. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity. The connection to the non-metallic boxes shall be made to any metallic fitting or device requiring grounding.

J. 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.

K. 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.

3.2 INSTALLATION

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. Grounding Conductors: 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. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.

C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.

D. 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.

E. In raceways, use insulated equipment grounding conductors.

F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

G. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, below access floors, and elsewhere as indicated, with bolted connections to form a continuous ground path.

3.3 EQUIPMENT GROUNDING SYSTEM

A. Comply with Electrical Code, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by Electrical Code are indicated.

B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by Electrical Code:

1. Lighting and receptacle circuits. Terminate each end on a grounding lug or bus.
2. Single-phase and three-phase motor and appliance branch circuits.
3. Flexible raceway runs, including FMC and LFMC.
4. Armored and metal-clad cable runs.

D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

E. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

F. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

G. Isolated Grounding Circuits: Install an insulated equipment grounding conductor connected to the receptacle or equipment grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at isolated equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

H. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3.4 BONDING SYSTEM

A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.

B. Isolated Equipment Enclosure: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment bonding conductor.

C. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.

D. Equipment Circuits: Install a bonding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, dampers, and heaters. Bond conductor to each unit and to air duct. 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 or copper conductor sized equal to the equipment grounding conductor.

E. Bond metal ducts of dust collectors, particulate conveying, fume hoods, and other hazardous materials to the equipment grounding conductors of associated pumps, fans, or blowers. Use braided-type bonding straps. Provide braided bare copper bonding conductor in nonmetallic dust collector ductwork to each equipment inlet location, and bond to equipment.

F. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.

G. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

H. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated bonding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location. Leave 10 feet of slack conductor at terminal board.

I. Telecom Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bar.

J. Industrial Control Panels, Terminal Cabinets, and Similar Installation: Terminate bonding conductor on cabinet grounding terminal. Provide an equipment grounding conductor and bond adjacent and associated control panels together.

K. Equipment Ground Conductor Continuity: All spliced equipment grounding conductors in junction boxes, cabinets, and distribution equipment shall be connected together and bonded to the metal enclosure.

L. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.

M. Metal Poles Supporting Outdoor Lighting Fixtures Greater Than 15 Feet: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

N. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

O. Medical Gas Piping: Bond to pipe with grounding clamp connectors. Bonding conductor shall be a #6 AWG minimum and may be connected to panelboard ground bar serving the area.

3.5 GROUNDING ELECTRODE SYSTEM

A. Ground Ring (Counterpoise):

1. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at average distances not more than 60 feet apart. Provide a grounding conductor, electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 2 AWG for ground ring and for tap to building steel. Bury conductor not less than 30 inches below grade, 24 inches from building foundation, and 18 inches outside of roof drip line.

B. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.

C. Provide bonding at Utility Company's metering equipment and pad mounted transformer.

D. Ground Rods: Install at least two rods spaced at least 20 feet from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.
2. 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. 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.

F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters, filtering devices, and similar equipment. Connect to pipe with grounding clamp connectors.

G. Natural Gas Service Piping: Bond to natural gas main service with grounding clamp connectors. Bonding conductor shall be connected to the main service ground bar. Provide grounding jumpers around all breaks in metallic continuity.

H. Natural Gas Equipment Piping: Bond each aboveground portion of natural gas metallic piping system at each equipment location with grounding clamp connectors. Bonding shall be performed after any flexible attachment nearest the equipment. The equipment grounding conductors may serve as the bonding means.

I. 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 or floor.

J. Concrete-Encased Grounding Electrode (Ufer):Install concrete-encased grounding electrode encased in at least 2 inches of concrete horizontally within the foundation that is in contact with the earth. 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 below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.6 CONCRETE OR WOOD BUILDING GROUNDING SYSTEM

A. Provide a copper common grounding electrode conductor for the attachment of multiple separately derived systems in accordance with Electrical Code. Individual grounding conductor taps from the separately derived systems to the common grounding electrode shall be sized in accordance with Electrical Code. All tap connections shall be made in an accessible location in such a manner that common grounding electrode conductor remains without a splice or joint.

3.7 EQUIPOTENTIAL (MULTI-POINT) GROUNDING SYSTEM

A. Provide an equipotential grounding system in the following locations:

1. Class I Div 1 and Div 2 locations as required in Electrical Code.
2. Swimming pool, fountains, and similar locations as required in Electrical Code.
3. Critical patient care and special care areas as indicated on drawings.

B. The non-current-carrying metal parts of equipment, raceways and other enclosures shall be bonded to the grounding system.

3.8 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches 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 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

B. 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. 4 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.

C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation. The pad rebar shall be attached to the counterpoise conductor at the four corners.

3.9 OVERHEAD-LINE GROUNDING

A. Comply with IEEE C2 requirements. Use 2 or more parallel ground rods if a single ground rod electrode resistance to ground exceeds 25 ohms.

B. Drive ground rods to a depth of 12 inches below finished grade in undisturbed earth.

C. Ground Rod Connections: Use clamp-type connectors listed for the purpose for underground connections and connections to rods.

D. Lightning Arresters: Separate arrester grounds from other grounding conductors.

E. Secondary Neutral and Tank of Transformer: Interconnect and connect to grounding conductor.

F. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

3.10 SUBSTATION GROUNDING

A. Provide an underground fence ground conductor, minimum 1/0 copper buried 18", located 3 feet outside the fence perimeter. Bond the fence ground grid into the substation ground grid. Ground fence at each side of gate or other openings. Gates shall be bonded to the grounding conductor, with a jumper to the gate. A buried bonding jumper shall be used across the gate or other openings. Provide an underground grounding conductor under the gate swing area. Barbed wire strands used above the fence fabric shall be bonded to the grounding conductor, jumper or fence. Fence posts shall be connected to the grounding conductor with suitable connecting means. Ground all corner posts and line post every 50 feet.

B. Provide a substation underground ground grid of 4/0 bare stranded copper cable buried 18" below grade in a minimum 10' by 20' grid. Exothermic weld connections of 4/0 cables at all junctions.

C. Provide grounding conductor for the grounded neutral for transformers, reactors and capacitors. Provide grounding conductor for lighting arrestors, gaps and similar devices. Provide grounding for all exposed metal parts of switches, structures, transformer tanks, metal walkway, steelwork of buildings, switchboards, instrument-transformer secondaries, etc.

D. Provide two ground rods/chemical electrodes, or as shown on drawings. Connect to underground grounding conductor.

3.11 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
2. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
3. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
4. Testing: Perform the following field quality-control testing:

    a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

b. 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.

c. 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.

    1) Equipment Rated 500 kVA and Less: 10 ohms.
    2) Equipment Rated 500 to 1000 kVA: 5 ohms.
    3) Equipment Rated More Than 1000 kVA: 3 ohms.
    4) Substations and Pad-Mounted Switching Equipment: 5 ohms.
    5) Manhole Grounds: 10 ohms.

d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

3.12 GRADING AND PLANTING

A. 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 2. Maintain restored surfaces. Restore disturbed paving.

END OF SECTION

SECTION 260527 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit and Equipment Supports

B. Fastening Hardware

C. Concrete Housekeeping Pads

1.2 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.3 REFERENCES

A. UL 62275 - Cable Management Systems - Cables Ties for Electrical Installations

1.4 COORDINATION

A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Allied Support Systems

B. Cooper B-Line

C. Erico, Inc.

D. Hilti

E. Power Fasteners

F. Orbit Industries

2.2 MATERIAL

A. Support Channel: Hot-dip galvanized stainless steel for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.

B. Hardware: Corrosion resistant.

C. Anchorage and Structural Attachment Components:

1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.

    a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125/F3125M Standard Specification for High Strength Structural Bolts and Assemblies.
3. Welding Lugs: Comply with MSS-SP-69, Type 57.
4. Beam clamps for Steel Beams and Joists:

    a. Double sided beam clamp hangers required.
    b. Single sided beam clamp hangers are not allowed.

5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.
7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

D. Conduit Sleeves and Lintels:

1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
2. Refer to Structural General Notes for lintel requirements in masonry construction.
3. Refer to Structural plans and specifications for lintel requirements and sizes.
4. Lintels:

    a. Lintels in non-bearing masonry wall openings can be sized in accordance with the note below. Lintels that occur in existing bearing walls are to be sized according to similar conditions and spans in the new construction and lintel schedule. Bottom plate size shall be a minimum of 3/8" thick. The width of the plate shall be 3/4" less than the field verified wall thickness. The plate shall be the full length of the lintel member. Lintels are not required over openings that are 12" wide or less and at least 1 course below the top of the wall.
    b. All lintels shall have a minimum of 8" end bearing.
    c. All lintels in exterior wall construction shall be hot-dip galvanized.
    d. For all openings not otherwise detailed or scheduled, minimum lintels shall be for each 4 inch of masonry width:

        1) 0 to 2'-0" span: 5/16" plate (3/4" less than wall width)
        2) 2'-0" to 4'-0" span: L 3 1/2 x 3 1/2 x 1/4
        3) 4'-0" to 6'-0" span: L4 x 3 1/2 x 5/16 (llv)
        4) 6'-0" to 8'-0" span: L5 x 3 1/2 x 5/16 (llv)

e. All angles that are back to back shall be welded top and bottom 3" at 12" minimum.

5. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.
6. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.
7. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
8. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
9. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
10. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
11. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
12. Size sleeves large enough to allow expansion and contraction movement.

E. Concrete Housekeeping Pads:

1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6" of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2" thick concrete.
2. Bases shall extend 3" on all sides of the equipment (6" larger than factory base).
3. Where the base is less than 12" from a wall, the base shall be carried to the wall to prevent a "dirt-trap".
4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.
5. Additional equipment requiring bases is as follows:

a. Refer to Evaluations.

F. Rooftop Support System:

1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4" above roof.
2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.
4. Products:

a. Anvil International HBS-Base Series

b. Cooper B-Line Dura-Blok
c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load).

G. Truss and Joist Support System: Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:

a. The hanger is attached within 6" from a web/chord joint.
b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.

3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

H. Cable Ties:

1. Cables ties, Listed and Labeled for cable management applications, securement and support, Type 1, 11, 2, 21.
2. Acceptable Applications: Low Voltage Wire and Cabling.

a. Bundle wires and cables within cable trays, auxiliary gutters, and similar applications for organization.

3. Cable ties, Listed and Labeled for securement and support, Type 2S, 21S.
4. Acceptable Applications: Low Voltage Wire, Cabling, Flexible Conduit, and Flexible Tubing.

a. Bundle wires and cables within cable trays, auxiliary gutters, and similar applications for organization.
b. Organize and support wiring and cables within equipment and distribution systems.

5. Cable ties, special ratings for suitable application and environment.

a. Exterior, wet/damp locations, direct sunlight.
b. Plenum rated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.

B. Trapeze support installation: Cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

D. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.

E. Do not use powder-actuated anchors without specific permission.

F. Do not drill structural steel members.

G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

H. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.

I. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting. Provide steel channel supports to stand surface-mounted panelboard or cabinet one inch off wall.

J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

K. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

L. Refer to Section 260533 for special conduit supporting requirements.

3.2 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.

B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION

SECTION 260533 - CONDUIT AND BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Rigid metallic conduit and fittings (RMC)

B. Stainless steel conduit (316SS) and fittings

C. Intermediate metallic conduit and fittings (IMC)

D. Electrical metallic tubing and fittings (EMT)

E. Flexible metallic conduit and fittings (FMC)

F. Liquidtight flexible metallic conduit and fittings (LFMC)

G. Rigid polyvinyl chloride conduit and fittings (PVC)

H. High density polyethylene conduit and fittings (HDPE)

I. Phenolic reinforced thermosetting resin conduit (Phenolic RTRC)

J. Wall and ceiling outlet boxes

K. Electrical connection

L. Pull and junction boxes

M. Rough-ins

N. Foundation - Underground Sleeves and Seals

O. Raceway Seals and Sealant

P. Accessories

1.2 RELATED WORK

A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
4. ANSI C80.6 - Intermediate Metal Conduit, Zinc Coated
5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports

6. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

B. Federal Specifications (FS):

1. A-A-50553A - Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
2. A-A-55810 - Specification for Flexible Metal Conduit

C. NECA "Standards of Installation"

D. National Electrical Manufacturers Association (NEMA):

1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
2. RN 1 - Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit, Rigid Aluminum Conduit, and Intermediate Metal Conduit
3. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
4. TC 9 - Fittings for PVC Plastic Utilities Duct for Underground Installation

E. NFPA 70 - National Electrical Code (NEC)

F. Underwriters Laboratories (UL): Applicable Listings

1. UL 1 - Flexible Metal Conduit
2. UL 6 - Rigid Metal Conduit
3. UL 360 - Liquid Tight Flexible Steel Conduit
4. UL514-B - Conduit Tubing and Cable Fittings
5. UL651-A - Type EB and a PVC Conduit and HDPE Conduit
6. UL651-B - Continuous Length HDPE Conduit
7. UL746A - Standard for Polymeric Materials - Short Term Property Evaluations
8. UL797 - Electrical Metal Tubing
9. UL1242 - Intermediate Metal Conduit

G. American Standard of Testing and Materials (ASTM):

1. ASTM D 570 - Standard Test Method for Water Absorption of Plastics
2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
3. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edge Wise Position
4. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
5. ASTM D 2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
6. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material

H. Definitions:

1. Fittings: Conduit connection or coupling.
2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.

4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.
5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

1.4 SUBMITTALS

A. Include fittings and conduits 1.5" and larger in coordination files. Include all in--floor and underfloor conduit in coordination files. Refer to Section 260500 for coordination drawing requirements.

PART 2 - PRODUCTS

2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

A. Manufacturers:

1. Atkore Allied Tube & Conduit
2. Nucor
3. Electroline
4. Western Tube
5. Wheatland Tube Co
6. or approved equal.

B. Manufacturers of RMC Conduit Fittings:

1. ABB/Thomas & Betts
2. Eaton/Crouse-Hinds
3. Electroline
4. Emerson Appleton & OZ Gedney
5. Hubbell Raco and Killark
6. NSI Bridgeport
7. Orbit Industries
8. Wesco Regal
9. or approved equal.

C. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

D. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.

4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

E. PVC Externally Coated Conduit: Compliant with UL 6, ANSI C80.1 and NEMA RN 1; rigid galvanized steel conduit with external 40 mil PVC coating and internal 2 mil urethane coating surface. All fittings and conduit bodies shall be complete with coating. Threads shall be hot galvanized and coated with a clear coat of urethane. The PVC coated system shall include necessary PVC coated fittings, boxes and covers to form a complete encapsulated system.

1. Acceptable Manufacturers:

a. Atkore Calbond Calpipe
b. Robroy Perma-cote and Plati-Bond
c. ABB Ocal
d. or approved equal.

2.2 STAINLESS STEEL RIGID CONDUIT (316SS) AND FITTINGS

A. Manufacturers:

1. Gibson Stainless & Specialty
2. Atkore Calbrite
3. Eaton/Crouse-Hinds
4. ABB/Thomas & Betts
5. or approved equal.

B. All material shall be Type 316 stainless steel, meet ASTM A-321 and SA-312 standards, and be UL 6A approved.

C. All conduit shall be heavy wall Schedule 40 with standard NPT threads.

D. Minimum Size Stainless Steel: 3/4 inch, unless otherwise noted.

E. Fittings, conduit bodies, couplings, nipples, bushings, connectors, supports, clamps, and all accessory hardware shall be made of Type 316 stainless steel.

2.3 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

B. Manufacturers:

1. Atkore Allied Tube & Conduit
2. Nucor
3. Electroline
4. Western Tube
5. Wheatland Tube Co
6. or approved equal.

C. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

D. Manufacturers of IMC Conduit Fittings:

1. ABB/Thomas & Betts
2. Easton/Crouse-Hinds
3. Electroline
4. Emerson Appleton & OZ Gedney
5. Hubbell Raco and Killark
6. NSI Bridgeport
7. Orbit Industries
8. Wesco Regal
9. or approved equal.

2.4 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.

B. Manufacturers of EMT Conduit:

1. Allied Tube & Conduit
2. Calbond Calpipe
3. Nucor
4. Electroline
5. Western Tube
6. Wheatland Tube Co
7. or approved equal.

C. Fittings and Conduit Bodies:

1. 2" Diameter or Smaller: Compression or steel set screw type of steel designed for their specific application.
2. Larger than 2": Compression or steel set screw type of steel designed for their specific application.
3. Push-on Connectors and Couplers: 1/2" and 3/4" conduit push-on connectors and couplers with locking ring and washer of zinc plated steel, listed for use in dry locations.
4. Expansion Joints: Electrical metallic tubing hot dip galvanized providing a minimum of 2 inches of movement, listed wet/damp/dry for application.
5. Manufacturers of EMT Conduit Fittings:

    a. ABB/Thomas & Betts
    b. Eaton/Crouse-Hinds

c. Electroline
d. Emerson Appleton & OZ Gedney
e. Hubbell Raco and Killark
f. NSI Bridgeport
g. Orbit Industries
h. Wesco Regal
i. or approved equal.

2.5 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8" FMC shall be six (6) feet.

B. Manufacturers:

1. ABB/Thomas & Betts
2. Anamet Electrical
3. Atkore American Flex AFC and Flexicon
4. Electri-Flex Co
5. Electroline
6. Southwire Alflex
7. or approved equal.

C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.

D. Fittings and Conduit Bodies:

1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:

a. ABB/Thomas & Betts
b. Eaton/Crouse-Hinds
c. Electroline
d. Emerson Appleton & OZ Gedney
e. Hubbell Raco and Killark
f. NSI Bridgeport
g. Orbit Industries
h. Wesco Regal
i. or approved equal.

2.6 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

A. Manufacturers:

1. ABB/Thomas & Betts
2. Anamet Electrical
3. Atkore American Flex AFC and Flexicon
4. Electri-Flex Co

5. Electroline
6. Southwire Alflex
7. or approved equal.

B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

C. Fittings and Conduit Bodies:

1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:

a. ABB/Thomas & Betts
b. Eaton/Crouse-Hinds
c. Electroline
d. Emerson Appleton & OZ Gedney
e. Hubbell Raco and Killark
f. NSI Bridgeport
g. Orbit Industries
h. Wesco Regal
i. or approved equal.

2.7 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.

B. Acceptable Manufacturers:

1. ABB/Carlon
2. Chevron Phillips Chemical Company
3. Cantex, J.M. Mfg.
4. Atkore Heritage Plastics
5. or approved equal.

C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90C.

D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.

E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

2.8 HIGH DENSITY POLYETHYLENE (HDPE)

A. Minimum Size: 2 inch, unless noted otherwise.

B. Acceptable Manufacturers:

1. ABB/Carlon
2. Chevron Phillips Chemical Company

3. Atkore Cascade Poly Pipe / Elite Polymers Solutions
4. or approved equal.

C. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	less than 0.941
D-1238	Melt Index, g/10 min Condition E	greater than 0.55 grams/10 min.
D-638	Tensile Strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.
D-790	Flexural Modulus, MPa (psi)	less than 80,000
D-746	Brittleness Temperature	-75C Max

D. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.

E. Fitting and Conduit Bodies:

1. Directional Bore and Plow Type Installation: Electrofusion or Universal Aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.
2. For all other type of installation: Coupler must provide a water tight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.
3. E-loc type couplings are not acceptable in any situations.
4. Acceptable Manufacturers:

    a. ABB/Carlon
    b. Atkore Cascade Poly Pipe / Elite Polymer Solutions
    c. Orbia Dura-line
    d. or approved equal.

2.9 PHENOLIC REINFORCED THERMOSETTING RESIN CONDUIT AND FITTINGS (PHENOLIC RTRC)

A. Minimum Size: 1 inch.

B. Manufacturers:

1. Champion Fiberglass Flameshield XW
2. Atkore - FRE Composites BreathSaver
3. or approved equal.

C. Conduit shall be low smoke, no flame, low toxicity. Conduit shall be fiberglass reinforced phenolic using a filament winding process. Conduit, elbows, conduit bodies, and fittings shall be manufactured from the same resin/hardener/glass system and the same filament wound system. Resin systems shall be phenol with no fillers. Fiberglass used shall be E-type.

D. Fitting and Conduit Bodies:

1. Expansion fittings shall be provided in accordance with Electrical Code.
2. Joints in wet locations and underground locations shall be watertight.

2.10 OUTLET BOXES

A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, 16 gauge (approximately 0.0625 inches), with 1/2-inch male fixture studs where required.

B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.

C. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast feralloy, or stainless steel deep type, gasketed cover, threaded hubs.

D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.

E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.

F. Technology Rough-in(s): Backboxes for technology rough-in on walls shall be minimum of 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line.

G. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.11 ECONN; ELECTRICAL CONNECTION

A. Electrical connection to equipment and motors, sized per Electrical Code. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.12 JB; PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.

B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.

C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.

E. Flanged type boxes shall be used where installed flush in wall.

2.13 TECHNOLOGY ROUGH-IN

A. Provide with one (1) flush mount double gang box with single gang plaster ring and appropriate cover plate, unless otherwise noted.

B. Refer to technology drawings for additional backbox and conduit size/routing requirements.

2.14 ROUGH-IN

A. Provide with one (1) flush mount double gang box with single gang plaster ring and appropriate cover plate,

B. Conduit stubbed to above the lay-in ceiling.

C. RI-TECH; Technology Rough-in:

1. Rough-in shall have one (1) 1" conduit.

D. RI-TECH-W; Technology Rough-in - Wall Phone:

1. Mount on wall +54" or as noted in plans. Rough-in shall have one (1) 1" conduit.

E. RI-TECH-C; Technology Rough-in - Ceiling Flush Mounted:

1. Mount flush in finished ceiling or as noted in plans. Rough-in shall have one (1) 1" conduit.

F. RI-TV; Television Antenna Outlet Box Rough-in:

1. Rough-in shall have one (1) 3/4" conduit.

2.15 FOUNDATION - UNDERGROUND SLEEVES AND SEALS

A. Wall Seals ("Link-Seals"):

1. Where shown on the drawings, raceways passing through foundation walls to an underground condition shall have their annual space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing element consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve.
3. Sleeves shall be at least 2 trade sizes larger than the penetrating raceway.
4. Pressure shall be maintained by stainless steel bolts and accessories. Pressure plates may be of composite materials for Models S and OS.
5. Sealing Elements shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40F to
T	Fire Seals (1 hour)	Silicone	-67F to
FS	Fire Seals (3 hours)	Silicone	-67F to 400F
OS	Oil Resistant / Stainless	Nitrile	-40F to 210F

6. Approved Manufacturers:

    a. Garlock Pipeline Technologies
    b. O-Z/Gedney Company
    c. Calpico, Inc
    d. Innerlynx
    e. Polywater PGKD Series

2.16 RACEWAY SEALS AND SEALANT

A. Duct Sealant: Field applied expandable duct sealant, closed cell field cured, water tight, air tight. Identified for use with electrical cables, conductors, and raceways. Minimum liquid withstanding of 10-feet head of water (5 PSI). Compatible with conductors and raceways, UL94 Flammability Certified.

1. NOT ALLOWED. Duct seal putty, all-purpose construction sealant.

2. Manufacturers:

    a. Polywater FST / AFT Series
    b. Approved equal

B. Duct Seal Bushing: Custom mechanical seal, liquid tight, gas tight, stainless steel hardware. Minimum liquid withstanding of 10-feet head of water (5 PSI). Coordinate product with raceway size, cable quantities, and cable sizes.

1. Manufacturers:

    a. Polywater PHRD / PHSD Series Varia /PHSI Module Series
    b. Jackmoon Commscope DuctPlug Series
    c. CalAm Manufacturing WedgeSeal Series

C. Duct Seal Bushing Alternative Option: Inflatable duct seal system. Capable of withstanding a 10-foot head of water (5 PSI).

1. Manufacturers:

    a. Raychem Rayflate Duct Sealing Systems RDSS
    b. Approved equal

D. Wall Sleeve Duct Seal System: Cast-in-place or Core-Drill two piece push-in- place construction, gasketed seal to prevent entry of water and gases.

1. Cable: Duct Seal Bushing, provide interior sleeve duct seal bushing for each duct entry. Provide duct seal bushings with individual seals for each applicable cable.

2. Manufacturers:

    a. Polywater Varia PHSI Series
    b. Approved equal

2.17 ACCESSORIES

A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control - IsoBacker Pad, SpecSeal - SSP Putty and Pads, 3M #MPP-4S or equal.

B. Sound Barrier Insulation Pads: Mastic, non-hardening, sheet material, minimum 1/8" thickness applied to all five sides of back boxes. Kinetics Noise Control - SealTight Backer Pad, L.H. DOTTIE Co., #68 or equal.

C. Electric Threaded Ball Swivel: Metallic body, box mounted, threaded conduit, 20-degree ball swivel, rated for weight of application, listed. Thomas and Betts, Appleton, Couse-hinds, or equal. Example applications:

1. Rigid pendant mount with sloped ceiling, vibration, or subject to wind.

PART 3 - EXECUTION

3.1 INSTALLATION TRAINING

A. PVC coated rigid metal conduit, phenolic reinforced thermosetting resin conduit (phenolic RTRC), and reinforced thermosetting resin conduit (RTRC) manufacturers shall provide Contractor installation training for field cutting, joint preparation, joint assembly, field bending, and field cut sealing.

3.2 CONDUIT INSTALLATION SCHEDULE AND SIZING

A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the Electrical Code shall be required.

B. Installation Schedule: Refer to drawings.

C. Corrosive Environments: Refer to installation schedule on drawings.

1. Conduits and boxes shall be suitable for the application. Example stainless conduit, PVC coated Rigid Metallic Conduit RMC, Phenolic RTRC, Rigid Non-Metallic (PVC). The use of Rigid Non-Metallic (PVC) conduit in occupied or plenum applications is restricted to areas documented by the engineer with written approval.

D. Fire Rated Assemblies:

1. Listed Fire Rated Assemblies: Phenolic RTRC

E. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to the Electrical Code. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.

F. Minimum Conduit Size (Unless Noted Otherwise):

1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
2. Below Grade 5' or less from Building Foundation: 3/4 inch.
3. Below Grade More than 5' from Building Foundation: 3/4 inch.
4. Telecommunication Conduit: 1 inch.
5. Controls Conduit: 1/2 inch.

G. Conduit Embedded in Slabs above Grade:

1. Embedded installation NOT allowed in elevated slabs with metal composite decks nor structural pour in place slabs less than 6 inches in depth unless specifically noted or shown on drawings otherwise.
2. Maximum size 1-1/4 inch for conduits crossing each other.

H. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.3 CONDUIT ARRANGEMENT

A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.

B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.

C. Conduit arrangement in elevated slabs (restricted to applications specifically noted or shown on drawings):

1. Conduit size shall not exceed one-third of the structural slab thickness. Place conduit between the top and bottom reinforcing with a minimum of 3" concrete cover.
2. Parallel conduits shall be spaced at least 8 inches apart. Exception: Within 18 inches of commonly served floor boxes, junction boxes, or similar floor devices. Arrange conduits parallel or perpendicular to building lines and walls.

D. Conduit shall not share the same cell as structural reinforcement in masonry walls.

E. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.

F. Contractor shall adapt Contractor's work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.

G. Contractor shall cooperate with all contractors on the project. Contractor shall obtain details of other contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by Contractor. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.4 CONDUIT SUPPORT

A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

1. Support wire used to independently support raceway and wiring systems above suspending ceilings shall be supported on both ends, minimum 12 gauge suspended ceiling support wire, and distinguishable from ceiling support systems by color (field paint), tagging, or equivalent means.

B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.

C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.

D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1-1/2" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.

F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.

G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.

J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.

K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the Electrical Code requirements.

L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.

M. Finish:

1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

3.5 CONDUIT INSTALLATION

A. Conduit Connections:

1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360 degrees), including those bends located immediately at the outlet or body.
4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.

a. A third bend is acceptable if:

1) The total run is not longer than (33) feet.
2) The conduit size is increased to the next trade size.

5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications Conduit(s): Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
7. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90-degree equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in roof decking nor installed less than 1.5" below bottom of roof decking.
5. Raceways located in wet/damp locations shall be arranged to drain. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. ; refer to Section 260503 for through penetration firestopping requirements.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20F to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, identified for use with cable and raceway system.
9. Horizontal conduit routing through slabs above grade

a. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3" min. concrete cover. Conduits shall run parallel to each other and spaced at least 8" apart centerline to centerline. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1".
b. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.

c. No conduits are allowed to be routed horizontally through slabs above grade.

10. Do not route conduits across each other in slabs on grade.
11. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40F.
12. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel conduit shall be installed before conduit exits earth. The conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.
15. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3" above finished floor (AFF).
16. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4" below ceiling and as close to the wall as possible.
17. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4" above finished floor (AFF) and as close to the wall as possible.

3.6 CONDUIT TERMINATIONS

A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.

B. Threaded conduits (example RMC, IMC) without threaded termination fittings or hubs shall be threaded for one (1) lock nut on the outside and one (1) opposing lock nut and Malleable Insulated Grounding Bushing MGIB on the inside of the box/enclosure.

C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.

D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the Electrical Code, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.

F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.

G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

3.7 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) OVERHEAD CONDUIT INSTALLATION

A. Conduit shall be installed away from high temperature piping and equipment.

B. Conduit shall be installed to prevent exposure to ultraviolet radiation.

C. Proper allowances shall be made for expansion and/or contraction of the conduit during installation.

D. Expansion fittings shall be installed in any 100' continuous run of conduit and at each 100' thereafter.

E. Supports shall be made from non-corroding materials and spacing shall not be greater than the listing in the Electrical Code, but also shall not exceed the manufacturer's recommendations depending on the expected surface temperature.

3.8 UNDERGROUND CONDUIT INSTALLATION

A. Conduit Connections:

1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

B. Conduit Bends (Lateral):

1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.
2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.

C. Conduit Elbows (vertical):

1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (greater than 600V) and 18 inches for secondary conduits (less than 600V). Increase radius, as required, based on pulling tension calculation requirements.

D. Expansion Fittings at Finished Grade: Provide underground raceways with an expansion fitting after emerging from finished grade and exterior equipment pads. Field locate the expansion fitting above and within 24 inches of finished grade. Raceways extending less than 12 inches above finished grade, transitioning to LFMC within 12 inches of finished grade, and interior concrete building slabs do not require an expansion fitting unless required by code.

E. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.

3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum f'c = 2500 and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
4. Before the Contractor pulls any cables into the conduit, Contractor shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
8. All non-metallic conduit installed underground outside of a slab shall be rigid.

F. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

G. Underground Electrical Lines: For exterior underground service feeder, other power feeders and branch circuits, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches; provide a second plastic line marker to mark each edge of the trench when 16 inches of width is exceeded.

H. Raceway Seal (Exterior to Raceway):

1. All power, telecommunication, electrical conduits and innerducts shall be sealed between the raceway and the building foundation. The raceway penetration shall be sealed liquid-tight, water-tight, non-corrosive.

2. Below Grade Installation Options:

   a. Cast-in-place concrete installation.
   b. Hydraulic cement, hydraulic group, hydraulic epoxy.
   c. Foundation - Underground Sleeves and Seals; refer to Part 2-Products for product information.

3. Above Grade Installation Options:

   a. Masonry grout for masonry applications.
   b. Caulk Sealant, interior/exterior rated, color per architect. Refer to architectural specifications for additional requirements.

I. Raceway Seal (Interior to Raceway, with Cables or Empty):

1. All power, telecommunication, electrical conduits and innerducts, including those with cables, shall be sealed at the building and vault entry. The seal shall prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceways shall also be sealed.

2. Installation Schedule, nominal size:

    a. 2" or less: Duct Seal Bushing or Duct Sealnt
    b. 2-1/2" through 4": Duct Seal Bushing
    c. 5" and 6": Wall Sleeve Duct Seal System

3.9 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

1. Concealed interior locations above ceilings and in hollow studded partitions.
2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
3. Direct contact with concrete except slab on grade.
4. Recessed in stud wall of kitchens and laundries.

B. Cast boxes shall be used in:

1. Exterior locations.
2. Hazardous locations.
3. Exposed interior locations within 8' of the highest platform level.
4. Direct contact with earth.
5. Direct contact with concrete in slab on grade.
6. Wet locations.
7. Kitchens and laundries when exposed on wall surface.

3.10 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Recessed luminaires shall not be used as access to outlet, pull, and junction boxes. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.

D. Locate and install to maintain headroom and to present a neat appearance.

E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

3.11 OUTLET BOX INSTALLATION

A. Do not install boxes back-to-back in walls.

1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.

2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)

D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.

E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.

F. Provide knockout closures for unused openings.

G. Support boxes independently of conduit.

H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.

K. Position outlets to locate luminaires as shown on reflected ceiling drawings.

L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

3.12 PULL AND JUNCTION BOX INSTALLATION

A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

B. Support pull and junction boxes independent of conduit.

C. Do not install boxes back-to-back in walls.

1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

3.13 EXPOSED BOX INSTALLATION

A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.

B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.

C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.

D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.

E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)

F. Wood, plastic, or fiber plugs shall not be used for fastenings.

G. Explosive devices shall not be used unless specifically allowed.

END OF SECTION

SECTION 260548 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Seismic Requirements.

1.2 QUALITY ASSURANCE

A. General:

1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.
2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for seismic restraint.
3. These requirements are beyond those listed in Section 260527 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.
2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

C. Testing Agency: An independent testing agency, acceptable to Authorities Having Jurisdiction, with experience and capability to conduct the testing indicated.

D. Installer: Company specializing in performing the work of this Section.

1.3 REFERENCES

A. International Building Code, Current Adopted Edition.

B. ASHRAE - A Practical Guide to Seismic Restraint.

C. Technical Manual 5-809-10, NAVFAC P-355, Air Force Manual 88-3, Chapter 13.

D. ASCE 7-02, Chapter 9.

E. ASCE 7-05, Chapter 13.

F. ASCE 7-10, Chapter 13.

G. ASCE 7-16, Chapter 13.

1.4 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a Professional Structural Engineer licensed in the state where the project is located experienced in seismic restraint design and installation.
2. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of electrical components with other systems and equipment in the vicinity, including other seismic restraints.
3. Manufacturer's Certifications: Professional Structural Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
4. System Supports/Restraints - Submit for each condition requiring seismic bracing:

    a. Calculations for each seismic brace and detail utilized on the project.
    b. Plan drawings showing locations and types of seismic braces on contractor fabrication/installation drawings.
    c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
    d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

5. Equipment - Submit for each piece of equipment supplied:

    a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified. Equipment certification is to be provided by the manufacturer
    b. Specific details of seismic design features of equipment and maximum seismic loads imparted to the structural support.
    c. Engineering calculations and details for equipment anchorage and support structure.

C. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance to the exception.

1.5 TESTING AND INSPECTION

A. Special Inspection and Testing shall be done in accordance with Chapter 17 of the Building Code.

B. The Owner shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.

C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.

D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.7 DESIGN REQUIREMENTS

A. This project is subject to the seismic bracing requirements of the International Building Code, Current Adopted Edition.

B. The following criteria are applicable to this project:

1. Seismic Use Group: [**I**][**II**][**III**]
2. Occupancy Category: [**I**][**II**][**III**][**IV**]
3. Risk Category: [**I**][**II**][**III**][**IV**]
4. Seismic Importance Factor: I_E = [**1.0**][**1.25**][**1.5**]
5. Seismic Design Category: [**A**][**B**][**C**][**D**][**E**][**F**]
6. Component Amplification Factors (ap) and Component Response Modification Factors (Rp) shall be taken from Table 1621.3 in IBC 2000 for the individual equipment or system being restrained.
7. Component Importance Factors (Ip) shall be taken from Section 1621.1.6 in IBC 2000 for the individual equipment or system being restrained.
8. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

C. Forces shall be calculated with the above requirements and Equation 16-67, 68, & 69 in section 1621.1.4 of IBC 2000, unless exempted by 1621.1.1 .

D. Equipment shall meet International Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

E. All seismic anchorage and bracing shall comply with the St. Louis County Rules & Regulations on Anchorage & Sway Bracing - Mechanical, Electrical & Plumbing (MEP) System Components.

F. All seismic anchorage and bracing shall comply with FM Global Property Loss Prevention Data Sheet 1-11, Fire Following Earthquakes.

1.8 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

1.9 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SUPPLIERS

A. Following is a partial list of manufacturer/supplier contact information for seismic restraints:

1. B-Line Systems, Inc. (800) 851-7415, www.b-line.com.
2. Unistrut Corporation http://www.unistrut.us/
3. Kinetics Noise Control (877) 457-2695, www.kineticsnoise.com.
4. Mason Industries, Inc. www.mason-ind.com.
5. Loos & Co., Inc. (800) 321-5667, www.loosnaples.com.
6. Tolco (909) 737-5599, www.tolco.com
7. ISAT 877.523.6060, www.isatsb.com
8. Vibro-Acoustics (416) 291-7371, https://virs.vibro-acoustics.com/

2.2 SEISMIC DESIGN CRITERIA

A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.

B. Definitions:

1. Stay in Place:

   a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.

2. Remain Operational:

   a. Requirements for "Stay in Place" listed above shall be met.
   b. The following systems and associated equipment are intended not to fail externally or internally and are intended to continue operation following a seismic event:

      1) Life Safety Power
      2) Emergency Power System
      3) Fire Alarm

2.3 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record; refer to submittal requirements.
2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer's submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.
3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.
5. All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code.
6. All seismic restraints and combination isolator/restraints shall have verification of their seismic capabilities witnessed by an independent testing agency.

B. Friction from gravity loads shall not be considered resistance to seismic forces.

C. Housekeeping Pads:

1. Reinforced housekeeping pads shall be provided to handle shear, tension, and compression forces with proper reinforcement, doweling, and attachments connecting the pad to the structural slab.

2.4 SEISMIC RESTRAINT AND CONSTRUCTION OF EQUIPMENT

A. Equipment supplied for the project shall be designed to meet the requirements of lateral forces calculated using the applicable code and method described above.

B. The following is a partial list of equipment that shall be restrained and that shall be constructed to meet seismic forces described in this section:

1. Switchboards, Distribution Panelboards, Panelboards, Load Centers
2. Emergency Feeders
3. Cable tray, Busway, Ductbank
4. Transformers
5. Disconnect Switches
6. Magnetic, Manual, Combination Starters
7. Variable Frequency Drives
8. Automatic/Manual Transfer Switches
9. Interior Luminaires
10. Emergency Luminaires and Exit Signs
11. Emergency Power Supply
12. Engine Generator Systems
13. Uninterruptible Power Supplies
14. Fire Alarm Panel, Initiating and Notification Appliances
15. Area of Rescue Assistance
16. Nurse Call
17. Intercom, Sound System, Clock, TV Distribution
18. Security System

2.5 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless steel.

2.6 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125, Grade A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.7 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inchthick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.

1. Materials for Channel: ASTM A 1011, GR 33.
2. Materials for Fittings and Accessories: ASTM A 635, ASTM A 576, or ASTM A 36.
3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.

1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
2. Wire Rope Cable: Comply with ASTM A 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.

D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of conduit, equipment, etc.

B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.

C. All rigid floor mounted equipment shall have a resilient media between the equipment mounting hole and the anchor bolt in concrete.

D. All seismic restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

E. Installation of seismic restraints shall not cause any change in position of equipment lighting or conduits resulting in stresses or misalignment.

F. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

G. Do not install any equipment or conduit that makes rigid connections with the building unless isolation is not specified.

H. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or conduit due to inadequate space or other unforeseen conditions shall be brought to the Architect/Engineer's attention prior to specific equipment selection.

I. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

J. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.

K. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment or conduit.

L. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.

M. Do not install cables over sharp corners.

N. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.

O. Provide reinforced clevis bolts when required.

P. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.

Q. Post-Installed anchors shall be provided to meet seismic requirements.

R. Vertical conduit risers flexibly supported to accommodate thermal motion and/or conduit vibration shall be guided to maintain conduit stability and provide horizontal seismic restraint.

S. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

T. Conduit crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the conduit, equipment connections, or support connections. Conduit offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent conduit.

U. Do not brace a system to two different structures such as a wall and a ceiling.

V. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

W. Positively attach all roof-mounted equipment to roof curbs. Positively attach all roof curbs to building structure.

X. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.

3.2 SEISMIC RESTRAINT EXCLUSIONS

A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

END OF SECTION

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Adhesive Markings and Field Labels

B. Nameplates and Signs

C. Product Colors

1.2 RELATED SECTIONS AND WORK

A. Section 260500 - Basic Electrical Requirements

B.

1.3 REFERENCES

A. NFPA 70E - Standard for Electrical Safety in the Workplace

B. NFPA 70 - National Electrical Code (NEC)

C. ANSI A13.1 - Standard for Pipe Identification

D. ANSI Z535.4 - Standard for Product Safety Signs and Labels

1.4 QUALITY ASSURANCE

A. Electrical identification products shall be suitable for the environment installed. Identification labels damaged by the environment due to ultraviolet light fading, damp or wet conditions, physical damage, corrosion, or other conditions shall be replaced with labels suitable for the environment.

1.5 SUBMITTALS

A. General: Submit the following in accordance with Division 1 Specification Sections and under provisions of Section 260500.

1. Product Data for each type of product specified.
2. Schedule of nomenclature to be used for identification signs and labels for each piece of equipment including, but not limited to, the following equipment types as specified in Division 26.
3. Samples of each color, lettering style and other graphic representation required for identification materials including samples of labels and signs.
4. Identification required in this section shall apply to equipment furnished in Division 26 and any other applicable Divisions including Division 21/22/23.

PART 2 - PRODUCTS

2.1 ADHESIVE MARKINGS AND FIELD LABELS

A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).

1. Label Size as follows:

a. Raceways: Kroy or Brother labels 1-inch high by 12-inches long (minimum).

2. Color: As specified for various systems.

B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.

D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from -40F to 185F, type 2/2S or type 21/21S based on application. Provide ties in specified colors when used for color coding. Cable ties shall be listed and identified for the application, securement, and support.

F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.

G. Aluminum, Wraparound Marker Bands: 1-inch width, 0.014 inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

H. Brass or Aluminum Tags: 2" by 2" by 0.05-inch metal tags with stamped legend, punched for fastener.

I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.

J. Text Sizes:

1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.

a. Font: Normal 721 Swiss Bold
b. Adhesive Labels: 3/16 inch minimum text height
c. Vinyl / Plastic Laminate Labels: 3/4" inch minimum text height

2.2 NAMEPLATES AND SIGNS

A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners.

B. Text Sizes:

1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.

a. Text Height: 3/8 inch minimum

C. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.

E. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

F. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.3 PRODUCT COLORS

A. Adhesive Markings and Field Labels:

1. All Labels: Black letters on white face
2. Normal Power and General Labels: Black letters on white face
3. Control Labels: Black letters on white face
4. Medium Voltage (greater than 1,000 volts): Black letters on white face
5. Fire Alarm: Red letters on white face
6. Emergency: Red letters on white face

B. Nameplates and Signs:

1. NORMAL POWER: Black letters on white face
2. Control Labels: Black letters on white face
3. EMERGENCY: White letters on red face
4. GROUNDING: White letters on green face.
5. CAUTION or UPS: Black letters on yellow face

C. Raceways and Conduit:

1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:

a. Normal Power and General Distribution: Silver
b. Emergency Power Distribution System:

1) All Emergency: Orange

2) Legally Required Standby: Yellow
3) Optional Standby: Orange
4) Life Safety and Critical Branch: Yellow
5) Equipment Branch: Orange

c. Fire Alarm System: Red
d. Temperature Controls: Refer to mechanical cover sheet for color
e. Ground: Green
f. Low Voltage and Telephone: Purple
g. Clock, Sound, Security System, and Intercom: Black
h. Nurse Call: White

D. Box Covers:

1. Box covers shall be painted to correspond with system type as follows:

a. Normal Power and General: Silver
b. Emergency Power and Distribution:

1) All Emergency: Orange
2) Legally Required Standby: Yellow
3) Optional Standby: Orange
4) Life Safety and Critical Branch: Yellow
5) Equipment Branch: Orange

c. Fire Alarm System: Red
d. Temperature Controls: Refer to mechanical cover sheet for color
e. Ground: Green
f. Low Voltage and Telephone: Purple
g. Clock, Sound, Security System, and Intercom: Black
h. Nurse Call: White

2. Box cover colors shall match conduit colors listed above.

E. Conductor Color Identification: Refer to Part 3 for additional information.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.

B. Exposed Ceilings and Finished Spaces: The project includes exposed ceilings in finished spaces. The installation of colored raceways and labeling may not be aesthetically desirable in finished spaces. The contractor shall coordinate identification requirements in exposed ceilings of finished spaces with the Architect/Engineer prior to installation and ordering of materials.

C. Electrical System Color Chart: This Contractor shall furnish and install framed 8" x 12" charts of the color-coded identification scheme used for the electrical system in all electrical rooms and next to the main fire alarm panel.

D. Install identification devices in accordance with manufacturer's written instruction and requirements of Electrical Code.

E. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

F. Circuit Identification: Tag or label conductors as follows:

1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

G. Apply Danger, Warning, Caution and instruction signs as follows:

1. Install Danger, Warning, Caution or instruction signs where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. 'Danger' indicates a hazardous situation which, if not avoided, will result in death or serious injury. ANSI standard red background, white letters.
3. 'Warning' indicates a hazardous situation which, if not avoided, could result in death or serious injury. ANSI standard orange background, black letters.
4. 'Caution' indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. ANSI standard yellow background, black letters.
5. Emergency Operating Signs: Install, where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

H. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.

I. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

J. Install ARC FLASH WARNING signs on all power distribution equipment per Section 260573.

K. Install ARC FLASH WARNING signs on all switchboards, switchgear, distribution panels, branch panelboards, industrial control panels, and motor control centers.

1. Sample Label:

   ! WARNING
   ARC FLASH AND SHOCK HAZARD

APPROPRIATE PPE REQUIRED
FAILURE TO COMPLY CAN RESULT IN DEATH OR INJURY
REFER TO NFPA 70E

2. Include:

   a. NOMINAL VOLTAGE
   b. Arc Flash Boundary
   c. Available incident energy calculated in the analysis and the corresponding working distance, or the arc flash personal protective equipment (PPE category) for the equipment, but not both.
   d. Date of short circuit assessment, use publication date of drawings or Power System Study report.

L. Circuits with more than 600V: Identify raceway and cable with "DANGER-HIGH VOLTAGE" in black letters 2 (50mm) inches high on orange background at 10'-0 foot intervals.

1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to conduits concealed within wall.
3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

M. Selective Coordination Label: Install caution signs on all switchboards, distribution panels, panelboards, disconnects, and other equipment with selectively coordinated overcurrent protection devices. Sign at a minimum shall contain:

1. CAUTION: OVERCURRENT DEVICES IN THIS ENCLOSURE ARE SELECTIVELY COORDINATED. EQUIVALENT REPLACEMENTS AND TRIP SETTINGS ARE REQUIRED.

N. Underground Electrical Lines: For exterior underground service feeder, other power feeders and branch circuits, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 inches to 8 inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches; provide a second plastic line marker to mark each edge of the trench when 16 inches of width is exceeded.

3.2 SERVICE AND ONSITE POWER SOURCE PLAQUE

A. Product:

1. Nameplates and Signs. (Custom Plaque and Directory)

B. Provide a custom service disconnect and onsite power source plaque, minimum 8 x 8 inches. The plaque shall include an overall pictogram of the facility with the following information. Alternatively, a directory may be used in lieu of a pictogram.

1. Description of each source: Service Disconnect or Onsite Energy Source.
2. Location of disconnect: Floor, room number.
3. Location identification: Arrow, legend, or similar marking in relation to the overall pictogram.
4. Example(s):

   a. SERVICE DISCONNECT. FIRST FLOOR, ELEC ROOM 101 EMERGENCY GENERATOR. EXTERIOR UTILITY YARD PHOTOVOLTAIC SYSTEM. ROOF, ACCESS AT FLOOR 3, STORAGE ROOM 701 SERVICE LADDER.

C. Install a copy of the service disconnect and onsite power source plaque at:

1. Each utility service disconnect. A single plaque may be provided at locations where the disconnects are grouped and within site of each other.
2. Each onsite power source disconnect.
3. Fire pump service disconnect.
4. Non-public side of the main electrical room door(s); on door or adjacent wall.

3.3 FEEDER AND BRANCH CIRCUIT DIRECTORIES

A. Product:

1. Adhesive labels and field markings
2. Nameplates and signs

B. Feeder Directories Branch: Provide each feeder, branch circuit, feeder modification, and branch circuit modification with a typed circuit directory label. Refer to technical equipment specification sections for additional requirements. Include the following with each label:

1. Load Description: Lighting, receptacles, specific equipment, spare, space, or similar description.
2. Location: Room name, number, location.

C. Provide a factory or custom clear plastic sleeve for each branch panel directory and secure to inside panel cover.

3.4 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

A. Product:

1. Adhesive labels and field markings
2. Nameplates and signs

B. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

C. Identification material to be engraved plastic-laminated labels, 1/16-inch minimum thickness with white letters on a red face. Letter and number size to 1/8-inch high.

D. Identification to be engraved directly on the stainless steel coverplates. Letter and number size to 1/8-inch high.

E. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. "C1A #24"). Identification for switch cover plates shall be installed on the inside cover.

3.5 CONDUIT AND EXPOSED CABLE LABELING

A. Product:

1. Adhesive labels and field markings

B. Conduit Identification: Pre-printed, flexible, self-adhesive vinyl labels with legend at 25 foot intervals to identify all conduits run exposed or located above accessible ceilings. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible, or separated by enclosures, walls, partitions, ceilings, and floors. Labels for multiple conduits shall be aligned. Refer to color requirements in Part 2 when applicable in addition to the following:

1. Medium Voltage (greater than 1000 volt): Indicate feeder identification and voltage.
2. 1000 Volt or less Normal/Emergency Power: Indicate feeder identification and voltage.
3. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
4. Fire Alarm: Indicate "FIRE ALARM".
5. Grounding: Indicate "GROUND" and equipment and designation.
6. Security System: Indicate "Security".
7. Telephone System: Indicate "Telephone".

C. Blank conduit ends or outlet boxes for future extension of system shall have permanent identification marker indicating purpose of conduit or box and where the raceway originated.

3.6 CONDUIT AND RACEWAY COLOR BANDING FOR EXISTING CONDITIONS AND REMODELING

A. Existing Conduit and Raceways: Identify existing conduits and raceways within the limits of the project boundary with color banding.

1. Existing conduit and raceways to be color banded: 3/4 inch and larger.
2. The Contractor shall perform a review of the existing conduit, raceway, and system type prior to submitting a bid. The Contractor's review shall include a review of areas with non-finished ceilings and areas with accessible finished ceilings.

B. New Conduit and Raceways: Identify new conduits and raceways with color banding. The following products and materials shall be identified with color banding when required by Part 1 of this specification.

1. Rigid metallic conduit and fittings (RMC)
2. Intermediate metallic conduit and fittings (IMC)
3. Reinforced thermosetting resin conduit (RTRC)
4. Phenolic reinforced thermosetting resin conduit (phenolic RTRC conduit) Example: Fire-rated cable and assemblies
5. Wire and cable installed with or without raceways:

    a. Fire-rated cable and assemblies (including but not limited to MI, fire-rated MC)
    b. Healthcare facilities cable (HFC)
    c. Armored cable (AC)
    d. Metal-clad cable (MC)
    e. Low voltage cabling

C. Instructions:

1. Band exposed or accessible raceways, cables, and bare conductors. Bands shall be pretensioned, snap-around colored plastic sleeves, colored adhesive marking tape, or a combination of the two. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Refer to Part 1 of this specification for specific systems and colors requiring banding.

2. Install bands at changes within 36 inches of direction changes, all wall/floor penetrations, at each junction box, and at 10-foot maximum intervals in straight runs.

3.7 BOX LABELING

A. Products:

1. Adhesive labels and field markings

B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch Kroy tape OR Brother self-laminating vinyl label, letters/numbers color coded same as conduits. In rooms that are painted out, provide labeling on inside of cover.

C. All junction, pull, and connection boxes shall be identified as follows:

1. For power and lighting circuits, indicate system voltage and identity of contained circuits ("120V, 1LA1-3,5,7").
2. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
3. For other wiring, indicate system type and description of wiring ("FIRE ALARM NAC #1").

3.8 CONDUCTOR COLOR CODING

A. Products:

1. All wire and cables shall be color coded by the manufacturer.
2. All wires and cables, 6 AWG or larger, used in motor circuits, main feeders, sub-main feeders, and branch circuits shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel in colors specified below. The tape shall be applied at each conductor termination with two 1-inch tape bands at 6-inch centers. Contractor option to use colored cabling in lieu of the tape at each end for conductor 6 AWG to 500 KCM.

B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.

C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3 inches centers. Tighten to a snug fit, and cut off excess length.

D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.

E. Conductors shall be color coded as follows:

1. 120/240 Volt, 3-Wire:

a. A-Phase - Black
b. B-Phase - Red
c. Neutral - White
d. Ground Bond - Green

2. 208Y/120 Volt, 4-Wire:

    a. A-Phase - Black
    b. B-Phase - Red
    c. C-Phase - Blue
    d. Neutral - White
    e. Ground Bond - Green

3. 480Y/277 Volt, 4-Wire:

    a. A-Phase - Brown
    b. B-Phase - Orange
    c. C-Phase - Yellow
    d. Neutral -Gray
    e. Ground Bond - Green

4. High-Leg ###Y/WWW Volt, 4-Wire:

    a. A-Phase - Refer to voltage, system descriptions.
    b. B-Phase - High-Leg

        1) 208Y/277 Volt, 4-Wire - Orange, Red with orange tracer, Red with permanent orange marking
        2) 480Y/277 Volt, 4-Wire - Orange with permanent "high-leg" marking

    c. C-Phase - Refer to voltage, system descriptions.
    d. Neutral - Refer to voltage, system descriptions.
    e. Ground Bond - Green

5. 120 Volt, 2-Wire Isolated (Ungrounded) Power System:

    a. A-Phase - Orange with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    b. B-Phase - Brown with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    c. Ground Reference - Green

6. 120/208 Volt, 3-Wire, Isolated (Ungrounded) Power System:

    a. A-Phase - Orange with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    b. B-Phase - Brown with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    c. C-Phase - Yellow with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    d. Ground Reference - Green

7. 0 to 1500 Volt, Direct Current DC Power System:

    a. Ungrounded Positive Polarity: Red or black with permanent red stripe marked along the entire length. Provide shrink wrap sleeves at terminations indication (POS, POSITIVE, or POS (+).

b. Ungrounded Negative Polarity: Black. Provide shrink wrap sleeves at terminations indication (NEG, NEGATIVE, or NEG (-).
c. Grounded Conductor in Grounded DC systems (refer to paragraphs a and b above for marking of ungrounded conductors):

1) When Positive Polarity is Grounded: White along entire length. Provide shrink wrap sleeves at terminations indication (POS. POSITIVE, or POS (+).
2) When Negative Polarity is Grounded: White along entire length. Provide shrink wrap sleeves at termination indication (NEG, NEGATIVE, or NEG (-).

8. Grounding Conductors:

a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.
b. Isolated Equipment Ground Conductors: Green with colored distinctive yellow stripe along the entire length of the conductor. Isolated ground for feeders, use colored tape with alternating bands of green and yellow to provide a minimum of three bands of green and two bands of yellow.

9. Cabling for Remote Control, Signal, and Power Limited Circuits:

a. Fire Alarm: Refer to Fire Alarm and Automatic Detection Section 283100 for cable color requirements.
b. Low Voltage Switching: Per manufacturer recommendations and code requirements.
c. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.
d. Nurse Call: Refer to Division 27.
e. Electronic Control: Per manufacturer recommendations and code requirements.
f. Audio/Visual Systems: Refer to Division 27.
g. Structured Cabling: Refer to Division 27.

3.9 CONTROL EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.

D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served.
2. Location of equipment being served if it is not located within sight.
3. Voltage and phase of circuit(s).
4. Panel and circuit number(s) serving the equipment.
5. Method of automatic control, if included ("AUTO CONTROL BY FMCS").
6. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
7. Date of fault current study, refer to one-line diagram

8. Sample Label:

   EXHAUST FAN EF-1 ("LOCATED ON ROOF")
   480V, 3-PHASE
   FED FROM "1HA1-1"
   AUTO CONTROL BY FMCS
   22,000 AMPS AVAILABLE FAULT CURRENT
   DATE OF STUDY: 1 JAN 2017

3.10 EQUIPMENT CONNECTION IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner. The following list of equipment is specifically being listed to receive an equipment connection label; this list does not limit the equipment that shall receive a label:

1. Mechanical heating, ventilation, and air conditioning equipment; chillers, boilers, pumps, air handing ventilation units, condensing units, unit heaters, and similar equipment
2. Plumbing equipment
3. Fire protection equipment including fire pumps
4. Medical gas equipment and equipment skids
5. Elevator
6. Kitchen equipment (hardwired)
7. Industrial machinery

D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served
2. Location of equipment being served if it is not located within sight. Include list of all equipment served, example: split systems with a single disconnect at one location.
3. Voltage and rating of the equipment.
4. Panel and circuit numbers(s) serving the equipment
5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
6. Date of fault current study; refer to one-line diagram
7. Sample Label:

   UNIT HEATER UH-1 ("LOCATED IN STORAGE ROOM 200")
   480V: 3-PHASE
   FED FROM "1HA1-1"
   22,000 AMPS AVAILABLE FAULT CURRENT
   DATE OF STUDY: 1 JAN 2017

3.11 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.

1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
2. Exterior Equipment: The identification material shall be engraved vinyl labels.
3. Labeling shall include:

    a. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Applicable equipment includes components of the life safety and critical branch for healthcare facilities (generators, transfer switches, switchboards, distribution panels, panelboards, etc.).
    b. Equipment type and contract documents designation of equipment.
    c. Voltage of the equipment.
    d. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
    e. Special Application Condition (when applicable): High-Leg B, Corner Grounded B, Ungrounded System, Impedance Grounded System, Main-Tie-Main, Multiple Supply/Source.
    f. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").
    g. Sample Label:

        DISTRIBUTION PANEL DP-H1
        480Y/277V
        FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELEC ROOM)

4. Provide the following on a separate label, installed below the label above:

    a. Available fault current; refer to one-line diagram or panel schedules
    b. Date of fault current study; refer to one-line diagram
    c. Sample Label:

        22,000 AMPS AVAILABLE FAULT CURRENT
        DATE OF STUDY: 1 JAN 2017

5. Enclosed or Guarded Barriers - Marking:

    a. The barriers associated with line-side components that remain energized within de-energized equipment shall be marked with an appropriate factory or field applied label. Example, WARNING - ENERGIZED LINE-SIDE COMPONENTS.

C. Service Equipment Label: A separate nameplate for the service entrance equipment and include:

1. SERVICE DISCONNECT
2. Nominal system voltage, service wire size, quantity, material, distance
3. Maximum available fault current; refer to one-line diagram for values
4. Clearing time of overcurrent protection devices based on available fault current. Refer to calculations and report from Section 260573 for value.
5. Date of fault current study; refer to one-line diagram
6. Date of label

7. Sample Label:

   SERVICE DISCONNECT
   480Y/277V, 6 SETS 4#750KCM CU, 75FT
   39,800 AMPS AVAILABLE FAULT CURRENT
   0.07 SECOND CLEARING TIME
   DATE OF STUDY: 1 JAN 2026
   DATE OF LABEL: 4 JUL 2026

D. Arc Energy Reduction Label:

1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.

   a. Label: "This equipment is designed with a system listed below".
   b. Applicable Systems:

      1) Zone-selective interlocking system for selective coordination and arc energy reduction
      2) Differential relaying system for selective coordination and arc energy reduction
      3) Arc energy reducing maintenance switch
      4) Energy reducing active arc flash mitigation system

E. Adjustable-Trip Over Current Protection Label:

1. Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with adjustable trip settings. Provide label separate from load identification label.

   a. Label:

      1) Long-time delay:
      2) Long-time pickup:
      3) Short-time delay:
      4) Short-time pickup:
      5) Instantaneous:
      6) Ground fault delay:
      7) Ground fault:

   b. Sample Label:

      Long-time delay: 10.0
      Long-time pickup: 1.0
      Short-time delay: 0.15
      Short-time pickup: 5.0
      Instantaneous: 2.0
      Ground fault delay: 0.25
      Ground fault: 50.0

F. Nominal System Voltage Label:

1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

G. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1"). Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with feeder wire size, feeder wire quantity, conductor material and distance in feet. Provide label separate from load identification label and adjustable trip settings label.

1. Sample Labels for Feeders:

4#3/0 CU & 1#6 CU GND, 125FT
4#250KCM AL & 1#6 GND CU, 125FT
2 SETS 4#400KCM CU & 1#1 GND CU, 125FT

H. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 260500 for other requirements.

3.12 GROUNDING AND BONDING

A. Products:

1. Nameplates and Signs.

B. Grounding Electrode Interdependence. Provide warning identification where the removal of a grounding connection in power source or distribution equipment interrupts the grounding electrode connection to other power sources or equipment.

1. Sample:

a. WARNING. SHOCK HAZARD IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED. OTHER ENERGIZED POWER SOURCE(S) DEPENDENT ON THESE CONNECTIONS.

3.13 INDUSTRIAL CONTROL PANEL IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all industrial control panels and similar equipment. Labels shall be visible on the exterior of the gear and correspond to the one-line and/or schematic diagram nomenclature.

1. Interior equipment: The identification material shall be engraved plastic-laminated labels.
2. Labeling shall include:

a. Equipment type and contract documents designation of equipment.
b. Manufacturer / Assembler of industrial control panel
c. Voltage, phase, frequency, full load current of each supply circuit
d. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.

e. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").
f. Sample Label:

INDUSTRIAL CONTROL PANEL ICP-1
ABC COMPANY
480V, 3PHASE, 60HZ, 60A (PANEL E1-1 LOCATED IN ELEC 123)
120V, 1PHASE, 60HZ, 20A (PANEL E2-1 LOCATED IN ELEC 123)
22,000 SHORT CIRCUIT RATING

C. Nominal System Voltage Label:

1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used shall be permanently posted on the interior of the door or cover of the industrial control panel.

D. Schematic Diagram: Provide a laminated copy of the industrial control panel schematic wiring diagram. Post the diagram on the inside cover of the control panel.

E. Service Equipment Label: Refer to Electrical Distribution Equipment - Service Equipment Label of this specification if applicable for additional requirements.

3.14 TRANSFORMER EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label.

C. Labeling shall include:

1. Equipment type and contract documents designation of equipment
2. Name of the upstream equipment.
3. Voltage and rating of the equipment.
4. Location of the upstream equipment if it is not located within sight.
5. Sample Label:

TRANSFORMER TR-15
480V: 208Y/120V 15KVA
FED FROM SWITCHBOARD "SB-1" (LOCATED IN ELEC 123)

3.15 DC VOLTAGE EQUIPMENT IDENTIFICATION

A. Products:

1. Names and signs

B. Provide identification on the front of all DC voltage equipment, storage batteries, disconnects. The identification nameplate shall be engraved plastic-laminate label.

C. Label shall include:

1. Equipment type and contract documents designation of equipment.
2. Name of upstream equipment and location of the upstream equipment if it is not located within sight.
3. Nominal equipment voltage and rating.
4. Available fault current (from batteries if applicable).
5. Date of fault current study; refer to one-line diagram.
6. Sample Label:

   STORAGE BATTERY SB-1
   600 VOLT DC, 50 KVA
   39,800 AMPS AVAILABLE FAULT CURRENT
   DATE OF STUDY: 1 JAN 2017

3.16 ELECTRICAL WORKING CLEARANCE IDENTIFICATION

A. Products:

1. Safety Yellow paint and custom stencils

B. Provide custom identification of electrical equipment working clearances in mechanical, electrical, storage, janitorial, and similar non-public areas.

C. Identification shall include a painted rectangular box (on the finished floor) in front of the electrical equipment to define the code-required working clearance. Provide additional diagonal stripping inside the rectangle box. All painted stripping shall be safety yellow paint with 3 inch wide stripes.

1. Width of area: Width of equipment or as required by code
2. Depth of area: Depth as required by code

3.17 SERIES RATING IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Upstream devices of series rated components not enclosed in a single NEMA type enclosure shall be identified with a nameplate reading "CAUTION - SERIES RATED SYSTEM - IDENTICAL COMPONENT REPLACEMENT REQUIRED".

C. Downstream devices of series rated components not enclosed in a single NEMA type enclosure shall be identified with a nameplate reading "CAUTION - SERIES RATED SYSTEM - ADDITIONAL SERIES COMBINATION RATING: XX,XXX RMS SYMMETRICAL AMPERES" where XX,XXX shall be the series combination rating.

3.18 DWELLING UNIT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Emergency Disconnect (exterior), provide EMERGENCY DISCONNECT label on exterior emergency disconnect, red background, white letters, 1/2" high letters, or as required by code. The identification nameplate shall be engraved plastic-laminate label.

3.19 POLE IDENTIFICATION

A. Product:

1. Adhesive labels and field markings
2. Nameplates and signs

B. Lighting poles, bollards and overhead distribution poles shall be individually identified with a unique number, for maintenance purposes. Apply the vinyl label number above the hand hole cover or 24" above grade. Bollards may be identified with a number applied inside the luminaire that is visible from the exterior.

END OF SECTION

SECTION 260933 - LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Lighting Control Overview

B. Electrical Plan Symbols

C. Device Color and Coverplates

D. Standalone Line and Low Voltage Lighting Controls

1. Wall switches and wall dimmers
2. Sensors (occupancy, vacancy, daylighting, photocell, auxiliary power packs, etc.)

E. Room-Based Lighting Controls (specification grade, commonly distributed controllers, occasionally networked, 'intelligent' controls)

F. Network-Based Lighting Controls (specification architectural grade, networked, intelligent, commonly centralized and/or distributed components)

G. Nurse Call Lighting Controller (SW-NLC)

H. Automatic Load Control Relays

1. Automatic Load Control Relay, Individual Luminaire - Integral (ALCR3)
2. Automatic Load Control Relay (ALCR20)

I. Directly Controlled Luminaire Systems (DCLS)

J. Digital Addressable Lighting Interface (DALI)

K. DC Lighting Control System

L. Time Clock Switches (Standalone)

M. Branch Circuit Emergency Lighting Transfer Switch (BCELTS)

1.02 RELATED SECTIONS

A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of directly comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

1. Specification Section 262416 Panelboards (panelboard enclosure and interior bussing used for lighting control panels)

2. Specification Section 262821 Contactors

3. Specification Section 265119 LED Lighting
4. Specification Section 265215 Emergency Lighting Inverter
5. Electrical Drawings: Electrical Coversheet, plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.03 RELATED WORK

A. Section 019100 - Commissioning

B. Direct Digital Control System (DDCS) control schemes, diagrams, and scope of work for HVAC Interface with Lighting Control requirements.

C. Section 274100 - Audio/Visual System

1.04 QUALITY ASSURANCE

A. Manufacturers shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. All components and assemblies are to be factory pre-tested prior to delivery and installation.

1.05 REFERENCES

A. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

B. FS W S 896 Switch, Toggle

C. NEMA WD 1 - General Color Requirements for Wiring Devices

D. NEMA WD 7 - Occupancy Motion Sensors

E. NFPA 70 - National Electrical Code (NEC)

F. UL Standard 916 Energy Management Equipment

G. UL 924 - Emergency Lighting and Power Equipment

H. UL 20 - Standards for General-Use Snap Switches

I. UL 98 - Enclosed and Dead-Front Switches

J. UL 917 - Clock Operated Switches

K. UL 1008 - Transfer Switch Equipment

L. UL 1472 - Solid-State Dimming Controls

1.06 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, component replacement instructions, warranty, system software requirements.

C. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form. Sensor coverage patterns shall have a 20% overlap.

D. Submit a list of devices and equipment that will be installed for each sequence of operation.

E. Submit project specific control wiring diagrams showing all equipment, line voltage, and control wiring requirements for all components including, but not limited to, dimmers, relays, low voltage switches, automatic sensors, control stations, and communication interfaces and programming instructions for each sequence of operation. Include network cable specification and end-of-line termination details, if required.

F. Programming Sequences: Provide a copy of the initial lighting control programming sequences in narrative and manufacturer/vendor format.

G. Lighting Control Stations: The manufacturer/vendor shall provide control station shop drawings showing arrangement of controls, dimensioned elevations, wiring diagram, and recommended backboxes. Label each applicable submittal with the applicable Sequence Of Operation SOO description. Submit data sheets on the switches, dimmers, sensors, buttons, etc. contained in the control station.

H. Nameplate Labels and Custom Engraving: Submit sample label/engraving text for review for each applicable Lighting Sequence Of Operation SOO. Include reference to applicable SOO description. Provide stencil templates for each device requiring stenciling.

I. Coordinate integration with mechanical and/or other trades.

J. Network / Internet Connected Equipment: These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ('Network Capability'). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be constructed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner. Provide Owner written consent and instructions as a submittal.

1.07 EXTRA STOCK

A. Provide extra stock under provisions of Section 260500.

B. Sensors, Controls, Power Supplies, and Relays: Five (5) percent of quantity installed. Minimum of two (2) of each configuration and type.

C. Relays and Dimmer Modules: Five (5) percent of quantity installed. Minimum of two (2) of each size and type.

D. Control Stations: One (1) of each configuration and type, except for LCD (SW-LDC) touch screens and portable PCS (SW-PCS) control stations requiring factory setup prior to installation.

E. Handheld Lighting Control Programming Stations: Provide two (2) lighting control programming stations when a proprietary controller is available and applicable to the specific lighting control system.

F. Web App for Owner Provided Devices: Assist Owner with the download and setup of the web application programming tool on ten (10) Owner provided cellphones, tablets, and similar devices when available and applicable to the specific lighting control system.

G. Commissioning Dongles: Provide ten (10) spare commissioning dongle devices for room controller, sensor, and relay programming when applicable to the specific lighting control system.

H. Lighting Control Software / Web Application Shortcut: Provide installation of software or setup of web app shortcuts on two (2) Owner provided computers when available and applicable to the specific lighting control system.

1.08 PROJECT RECORD DOCUMENTS

A. Submit project record documents under provisions of Section 260500.

B. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit emergency, operation, and maintenance data under provisions of Section 260500. Data shall also include the following:

1. Schedule for routine maintenance, inspection, and calibration of all lighting control devices and system components. Recommended schedule for inspection and recalibration of sensors.
2. Complete narrative describing intended operation and sequence for each control scenario and system component, updated to reflect all changes resulting from commissioning of systems. Narrative shall indicate recommended settings for devices where applicable.
3. Replacement part numbers for all system components.

B. Identify installed location and labeling for each luminaire controlled by automated lighting controls.

C. Submit software operating and maintenance manuals, program software backup on compact disc or compatible media with data files, device address list, and a printout of software application and graphic screens, where applicable.

1.010 SYSTEM DESCRIPTION

A. Performance Statement: The specification section and lighting design documents describe the minimum material quality, required features, and operational performance requirements of the lighting control system. The documents do not convey every component, relay, wire, and equipment connection required. The Contractor and lighting control manufacturer/vendor are solely responsible for determining all system components, wiring, and programming required for a complete and operational system based on the performance based requirements of the documents.

B. Lighting Sequence Of Operation (SOO): The Sequence Of Operation (SOO) describes the required lighting control operation and performance in each space. The Sequence Of Operation descriptions are included on the drawings.

C. Drawings: The drawings include the Sequence Of Operation (SOO), luminaire schedule, location of control devices, sensors, and identification of control zones, and branch power circuiting. Control wiring and manufacturer/vendor specific components are NOT shown, but shall be submitted with the shop drawing submittals.

D. Integrating the Existing Lighting Control System: Provide all items, components, devices, hardware, software, programming, expansion components, conduit, wiring etc. needed to integrate Lighting Control system with the new lighting control system. This includes, but is not limited to, additional room controllers, network controllers, individual system components, power supplies, etc. The existing lighting control system shall be integrated such that the existing system's functionality, integrity, control sequences, master control stations, etc shall be equivalent to pre-construction conditions, unless noted otherwise. The functionality and integrity shall be maintained during construction.

1.011 MOCKUP AND SAMPLES OF SUBMITTED DEVICES

A. Provide and install luminaires with power and control connections in mockup rooms as identified in Division 1. Submitted and approved luminaires and controls in mockup may be reused as part of complete work if in original condition.

B. Provide one (1) sample of each submitted lighting control device interface. Submitted and approved samples may be reused as part of complete work if in original condition.

1.012 COMMISSIONING

A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative Architect/Engineer. Project closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 1 for detailed commissioning requirements.

B. The Contractor shall provide all services necessary for compliance with the IECC Section C408 Commissioning. The commissioning shall include, but not be limited to, a commissioning plan, preliminary commissioning report, construction documents, manuals, final commissioning report, and lighting system functional testing.

C. This project will have selected building systems commissioned. The Contractor is responsible to execute commissioning. The commissioning process, equipment, and systems to be commissioned are defined in Division 1.

D. The Contractor shall notify the Architect/Engineer and Owner's Representative ten (10) working days prior to scheduled commissioning date.

E. The commissioning process requires meeting attendance. Refer to Division 1 for meeting requirements.

F. The system shall be functionally tested by a factory-authorized engineer and comply with the Sequence of Operation prior to system commissioning. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system.

1.013 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.

B. Automatic (occupancy, vacancy), daylight sensors, and controls shall have a five (5) year warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LIGHTING CONTROL OVERVIEW

A. Lighting Control System: As defined in the System Description, the design documents describe the operational performance requirements of the lighting control system. The Lighting Control System has been categorized into the following groups. Refer to the Electrical Symbol Key, this specification section, and the drawings to determine the appropriate lighting control category when more than one is applicable to the project:

1. Standalone Lighting Control Devices: Independent (standalone) devices traditionally operating at line or low voltage, field configurable with other standalone devices to provide an overall lighting control system.
2. Room-Based Lighting Controls: Integrated system comprised of switch stations, sensors, room controllers, control panels, and accessories, operating at line and/or low voltage, configured as an integrated overall 'intelligent' lighting control system. Lighting control zones and power circuits commonly align.
3. Network-Based Lighting Controls: Integrated system comprised of switch stations, sensors, room controls, control panels, dimmer racks, and accessories, operating at line and/or low voltage, configures as an integrated overall 'intelligent' lighting control system for advanced architecturally based lighting control systems. Lighting control zones commonly associated with one or more branch power circuits within the same control zone.
4. Theatrical Lighting Controls: Not covered in this specification. Lighting control system commonly associated with theatrical productions, performances, and large scale venues.

B. All system components and materials of similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications. Lighting control switches, systems, and components shall be listed.

C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space, unless otherwise noted.

D. Emergency Lighting Override Control: Lighting control equipment coupled with remote emergency power sources (external to luminaire) require ALCR devices for emergency (life safety) compliance. An emergency lighting control bypass is required for every individual lighting control zone-circuit but not shown on plans. Refer to this specification for ALCR and BCELTS descriptions. Refer to the sequence of operation lighting control descriptions on the plans for additional requirements. Refer to UL 924, UL 1008.

E. Emergency Night Lighting: "NL" tag indicates luminaire is unswitched for night light. Luminaire is connected ahead of all lighting controls. Luminaire operates continuously 24/7.

2.02 ELECTRICAL PLAN SYMBOLS

A. Refer to Electrical Coversheet for Electrical Symbols list and device specification tag.

1. Standalone Lighting Control Devices: Control station commonly defined by an alpha character with subscripts.

    a. Example symbol "S", tagged "SW-1P", description "switch- single pole switch".
    b. Example Control Designation: a, b, c (when required to clarify design intent).

2. Room-Based Lighting Controls: Control station commonly defined by a rectangle symbol.

    a. Example Control Station: symbol "#B", tagged "SW-LV", description "Lighting Control Station".
    b. Example Panel/Rack/Cabinet: tagged "LCPR#", description Room-Based lighting control panel/rack/cabinet.
    c. Example Control Designations: a, b, c

3. Network-Based Lighting Controls: Control station commonly defined by a rectangle symbol.

    a. Example symbol "#B", tagged "SW-#B", description "Lighting Control Station".
    b. Example Panel/Rack/Cabinet: tagged "LCPN", description "Network- Based lighting control panel/rack/cabinet".
    c. Example Control Designations: z1, z2, z3

4. Sensors, Relays, Accessories: Common plan symbols are used for automatic (occupancy, vacancy), and daylighting sensors. The control designations (a, b, c or z1, z2, z3) and identification of a standalone or #B type control station in the space defines the basis-of-design intent category of the lighting control sensors and accessories.

    a. Example, a standalone automatic sensor SW-OC-## or SW-VC-## device is the basis of design when shown in the same room as a standalone S (SW-1P) single pole light switch with or without a, b, c control designations.
    b. Example, a Room-Based Lighting automatic sensor SW-OC-## or SW-VC-## device is the basis of design when shown in the same room as a #B (SW-#B) lighting control station with or without a, b, c control designations.
    c. Example, a Network-Based Lighting automatic sensor SW-OC-## or SW-VC-## device is the basis of design when shown in the same room as a #B (SW-#B) lighting control station with z1, z2, z3 control designations.

5. Additional System Requirements:

    a. W = Wireless with Battery

        1) Provide a visual or audio indicator to notify users of impending battery failure.

2.03 DEVICE COLOR AND COVERPLATES

A. All switches and lighting controls shall be complete with coverplates that match material and color of the wiring device coverplates in the space. When the coverplate is proprietary to the device/manufacturer and do not match the wiring device coverplates, the architect shall select the coverplate color and materials from the standard coverplate options.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 260553.

D. Plate-securing screws shall be metal with head color matching the wall plate finish.

E. Antimicrobial: Switch touch surfaces shall have an antimicrobial additive that suppresses the growth of harmful bacteria, mold, mildew, and fungi; color/material selection by architect.

1. Manufacturers:

    a. Cooper 7621 CuVerro
    b. Leviton A5621

2. Install antimicrobial switch and coverplates in the following areas:

    a. Intensive Care Unit ICU
    b. Neonatal Intensive Care Unit NICU
    c. Cath Lab
    d. Medical Imaging (Xray, MRI, CT, etc.)
    e. Operating Rooms OR
    f. Emergency Room ER and Trauma Rooms
    g. Patient Exam and Treatment Rooms
    h. Patient Rooms
    i. Public, Private, Patient Toilets and Restrooms

F. Where indicated on drawings, provide compatible wire guards for devices to protect against damage and vandalism. Wire guards shall be constructed of durable coated steel wire.

2.04 STANDALONE LINE AND LOW VOLTAGE LIGHTING CONTROLS

A. Standalone Lighting Control System Description: The standalone lighting control system includes individual devices, components, and accessories for lighting controls.

B. The lighting control system manufacturer shall be responsible to assure coordination and compatibility between all system devices, components, and accessories.

C. Global System Typography: The system shall be provided with the following global system characteristics. When multiple exclusive options are listed the manufacturer/vendor may submit a system based on either criterion unless otherwise noted. When the drawings identify a specific option (typically identified with a subscript) provide the specific option as scheduled on the drawings.

1. Automatic Sensor Control Devices, Component, and Accessories: Occupancy.

D. Overview:

1. Wall Switches and Wall Dimmers:

a. UL listed with integral air-gap switch for on/off control, integral EMI/RFI suppression, non-viewable heat sink, dimmer to match device color.
b. Dimmer compatibility and wiring with the load being controlled shall be verified by Contractor prior to purchase and installation.

E. **SW-1P**; Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
2. Manufacturers:

a. Hubbell HBL1221
b. Leviton 1221-2
c. Pass & Seymour PS20AC1
d. Cooper AH1221

3. Single throw, 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
4. Manufacturers:

a. Hubbell DS120
b. Leviton 5621
c. Pass & Seymour 2621
d. Cooper 7601

F. **SW-1P-060**; Local Timer Spring-Wound Switch:

1. Spring-wound switch, 125-volt, 20-amp rated. 0 to 60-minute off delay.
2. Manufacturers:

a. Paragon SWPD60M
b. Tork A560M
c. Mark-Time 9008

G. **SW-1P-ADJ;** Local Timer User Adjustable Switch:

1. User adjustable timeout, 120/277-volt, 800/1200 watt rating. No minimum load requirement. Flashes lights one minute before timeout.
2. Manufacturers:

a. Watt Stopper TS-400
b. Hubbell Automation TD200

H. **SW-1P-DJ;** Door Jamb Push Button Switch:

1. Door jamb switch, 120V 3A Single pole, momentary, metal pushbutton, with jamb box, and cover plate. Light on when door is open
2. Manufacturers:

a. Leviton 1865
b. Pass & Seymour 1200

c. Hubbell, Cooper

I. **SW-1P-EM;** Emergency Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Red handle, side and back wired. Switch shall have with illuminated handle that is illuminated when load is off.
2. Manufacturers:

a. HBL1221R
b. Leviton 1221-2R
c. Pass & Seymour PS20AC1-RED
d. Cooper AH1221RD

3. Manufacturers:

a. Pass & Seymour 2625RED

J. **SW-1P-K;** Key Lock Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Side and back wired. Provide key to Owner.
2. Manufacturers:

a. Hubbell HBL1221L
b. Leviton 1221-2L
c. Pass & Seymour PS20AC1-L
d. Cooper AH1221L (only available in brown)

K. **SW-1P-LH;** Lighted Handle Single Pole Switch:

1. Single throw,120 volt, 20-amp maintained contact. Toggle handle. Light on when contact open (switch off). Side and back wired.
2. Manufacturers:

a. Hubbell HBL1221ILC
b. Leviton 1221-LHC (120 Volt only)
c. Pass & Seymour PS20AC1-CSL
d. Cooper 2221LTW

L. **SW-1P-M;** Three-Position Momentary Center Off Switch:

1. Switch, 120/277-volt, 20-amp. Three position, two circuit. Center off toggle spring return handle.
2. Manufacturers:

a. Hubbell HBL1557
b. Leviton 1257
c. Pass & Seymour 1251
d. Cooper 1995

M. **SW-1P-PL;** Red Pilot Light Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle. Pilot light on when contact closed (switch on). Side and back wired.

2. Manufacturers:

    a. Hubbell HBL1221PL
    b. Leviton 1221-PLR
    c. Pass & Seymour PS20AC1-RPL
    d. Cooper AH1221PL

N. **SW-1P-WP;** Weatherproof Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired. Provide with weatherproof coverplate.
2. Manufacturers:

    a. Hubbell1221/HBL1795
    b. Leviton 1221-2
    c. Taymac MM180
    d. Pass & Seymour PS20AC1/CA1-GL
    e. Cooper 2221

O. **SW-2P;** Two Pole Switch:

1. Single throw, two pole, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
2. Manufacturers:

    a. Hubbell HBL 1222
    b. Leviton 1222-2
    c. Pass & Seymour PS20AC2
    d. Cooper 2222

3. Single throw, two pole, 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
4. Manufacturers:

    a. Hubbell DS220
    b. Leviton 5622
    c. Pass & Seymour 2622
    d. Cooper 7622

P. **SW-2P-K;** Key Lock Two Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Side and back wired. Provide key to Owner.
2. Manufacturers:

    a. Hubbell HBL1222L
    b. Leviton 1222-2L
    c. Pass & Seymour PS20AC2-L
    d. Cooper AH1222L (only available in brown)

Q. **SW-3W;** Three-way Switch:

1. Single throw, 120/277 volt, 20 amp. Toggle handle, side and back wired.
2. Manufacturers:

a. Hubbell 1223
b. Leviton 1223-2
c. Pass & Seymour PS20AC3
d. Cooper AH1223

3. Single throw, 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
4. Manufacturers:

a. Hubbell DS320
b. Leviton 5623
c. Pass & Seymour 2623
d. Cooper 7623

R. **SW-3W-EM;** Emergency Three-way Switch:

1. Single throw, 120/277 volt, 20 amp. Red toggle handle, side and back wired.
2. Manufacturers:

a. Hubbell 1223R
b. Leviton 1223-2R
c. Pass & Seymour PS20AC3-RED
d. Cooper AH1223RD

S. **SW-3W-K;** Key Lock Three Way Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Side and back wired. Provide key to Owner.
2. Manufacturers:

a. Hubbell HBL1223L
b. Leviton 1223-2L
c. Pass & Seymour PS20AC3-L
d. Cooper AH1223L (only available in brown)

T. **SW-4W;** Four-way Switch:

1. Single throw, 120/277 volt, 20 amp. Toggle handle, side and back wired.
2. Manufacturers:

a. Hubbell 1224
b. Leviton 1224-2
c. Pass & Seymour PS20AC4
d. Cooper AH1224

U. **SW-4W-EM;** Four-way Switch - Emergency Switch:

1. 120/277 volt, 20 amp. Red toggle handle, side and back wired.
2. Manufacturers:

a. Hubbell HBL1224R
b. Leviton 1224-2R
c. Pass & Seymour PS20AC4-RED
d. Cooper AH1224RD

V. **SW-4W-K;** Four Way Switch - Key Lock Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Side and back wired. Provide key to Owner.
2. Manufacturers:

    a. Hubbell HBL1224L
    b. Leviton 1224-2L
    c. Pass & Seymour PS20AC4-L
    d. Cooper AH11224L (only available in brown)

W. **SW-1P-EX;** Explosion Proof Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle. Suitable for use in Class I, Divisions 1 and 2, Groups B, C, and D areas; Class II, Divisions 1 and 2, Group E, F, and G areas; Class III.
2. Manufacturers:

    a. Emerson Appleton EDS Series
    b. Eaton Crouse Hinds EDS Series
    c. Hubbell Killark FXS Series

X. **SW-2P-EX;** Explosion Proof Double Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle. Suitable for use in Class I, Divisions 1 and 2, Groups B, C, and D areas; Class II, Divisions 1 and 2, Group E, F, and G areas; Class III.
2. Manufacturers:

    a. Emerson Appleton EDS Series
    b. Eaton Crouse Hinds EDS Series
    c. Hubbell Killark FXS Series

Y. **SW-3W-EX;** Explosion Proof Three-Way Switch:

1. Class I, Divisions 1 and 2, Groups B, C, and D areas; Class II, Divisions 1 and 2, Group E, F, and G areas; Class III.
2. Manufacturers:

    a. Emerson Appleton EDS Series
    b. Eaton Crouse Hinds EDS Series
    c. Hubbell Killark FXS Series

Z. **SW-4W-EX;** Explosion Proof Four-Way Switch:

1. Class I, Divisions 1 and 2, Groups B, C, and D areas; Class II, Divisions 1 and 2, Group E, F, and G areas; Class III.
2. Manufacturers:

    a. Emerson Appleton EDS Series
    b. Eaton Crouse Hinds EDS Series
    c. Hubbell Killark FXS Series

AA. **SW-A-TPCO;** Three Position-Center Off Switch:

1. 120/277-volt, 20-amp, 2 pole maintained contact. Toggle handle, side and back wired.
2. Manufacturers:

    a. Hubbell HBL1386
    b. Leviton 1286
    c. Pass & Seymour 1226
    d. Cooper 2226

BB. **SW-COMB;** Combination Lighting Control Fan Switch and GFCI Receptacle:

1. Single throw, single pole switch, and NEMA 5-20 GFCI receptacle mounted in common gang backbox with common faceplate.
2. Manufacturers:

    a. Switch: Refer to (SW-1P)

    b. Receptacle: Refer to Specification Section 262726 (REC-DUP-GFI)

CC. **SW-O;** Dual Technology Automatic Sensor with Wall Switch (Standalone):

1. Wall switch with manual on/auto/off. 120/277 VAC load rating of 0-800 W for ballast, LED or tungsten. 5-, 15-, 20-minute adjustable OFF delay. Dual technology ultrasonic/acoustic and PIR coverage of minor motion in 12' x 15' pattern and occupancy detection in area based on half-step walking motion. Sensitivity adjustments separate for each sensing technology.
2. Manufacturers:

    a. Watt Stopper DW-300 Series
    b. Hubbell LHMTS
    c. Leviton ODSMT Series
    d. Sensor Switch WSX-PDT SA Series (acoustic approved when listed in above description)
    e. Cooper OWN Series

DD. **SW-O2;** Dual Technology Automatic Sensor with Dual Button Wall Switch (Standalone):

1. Multi-relay wall switch with manual on/auto/off for two separate loads. 120/277 VAC load relay rating of 0-800 W for ballast, LED or tungsten. 5-, 15-, 20-minute adjustable OFF delay. Dual technology ultrasonic/acoustic and PIR coverage of minor motion in 12' x 15' pattern and occupancy detection in area based on half-step walking motion. Sensitivity adjustments separate for each sensing technology.
2. Manufacturers:

    a. Watt Stopper DW-300 Series
    b. Hubbell LHMTD
    c. Leviton OSSMD Series
    d. Sensor Switch WSX-PDT 2P Series
    e. Cooper ONW Series

EE. **SW-D;** Dimmer (Standalone):

1. Contractor / vendor to provide dimmer based on rating required, compatible with wiring, lighting load being controlled. Verify compatibility with luminaire prior to light control prior to purchase and installation.
2. Incandescent Dimmer Single Pole, 120 volt, linear slider operator with positive off. Mounted in dedicated backbox.

    a. Ratings/Manufacturers:

        1) 600 Watt:
            a) Lutron N-600
            b) Lightolier MP600
            c) Pass & Seymour CD700

        2) 1,000 Watt:
            a) Lutron N-1000
            b) Lightolier MP1000
            c) Pass & Seymour CD1100

        3) 1,500 Watt:
            a) Lutron N-1500
            b) Lightolier MP1500
            c) Pass & Seymour CD1600

        4) 2,000 Watt:
            a) Lutron N-2000
            b) Lightolier MP2000
            c) Pass & Seymour CD2000

3. Electronic Driver Dimmer, 120 or 277 volt per application, 0-10 V control, decora style linear slide operator with positive off, IEC 60629 compliant. Mounted in dedicated backbox.

    a. Manufacturers: Compatible with Luminaire Driver

4. Fluorescent Ballast Dimmer, 120 volt, linear slide operator with positive off, 16 amp minimum rating.

    a. Manufacturers:

        1) Lutron NF-10
        2) Lightolier MP1500F

5. Alternative Dimmer, 120 or 277 volt per application, rating per application, linear slide operator with positive off. Mounted in dedicated backbox.

    a. Manufacturers: Compatible with Luminaire Driver

FF. **SW-D3;** Dimmer Three-Way (Standalone)

1. Contractor / vendor to provide dimmer based on rating required, compatible with wiring, lighting load being controlled. Verify compatibility with luminaire shop drawings prior to light control prior to purchase and installation. Three-way dimming with S3 three-pole toggle switch configuration.

2. Incandescent Dimmer(s) Single Pole, 120 volt, linear slider operator with positive off. Mounted in dedicated backbox.

    a. Ratings/Manufacturers:

        1) 600 Watt:
            a) Lutron N-603P
            b) Lightolier MP600 MPR-3
            c) Pass & Seymour CD1100

        2) 1,000 Watt:
            a) Lutron N-1003P
            b) Lightolier MP1000 MPR-3
            c) Pass & Seymour CD1103P

        3) 1,500 Watt:
            a) Lutron N-1503P
            b) Lightolier MP1500 MPR-3
            c) Pass & Seymour CD11603P

        4) 2,000 Watt:
            a) Lutron N-2003P
            b) Lightolier MP2000 MPR-3
            c) Pass & Seymour CD2000

3. Electronic Driver Dimmer, 120 or 277 volt per application, 0-10 V control, decora style linear slide operator with positive off, IEC 60629 compliant. Mounted in dedicated backbox.

    a. Manufacturers: Compatible with Luminaire Driver

4. Alternative Dimmer, 120 or 277 volt per application, rating per application, linear slide operator with positive off. Mounted in dedicated backbox.

    a. Manufacturers: Compatible with Luminaire Driver

GG. **SW-DML;** Dimmer - Multi-Location (Standalone)

1. Contractor / vendor to provide dimmer based on rating required, compatible with wiring, lighting load being controlled. Verify compatibility with luminaire shop drawings prior to light control prior to purchase and installation. Three-way dimming with dimming control at both user locations.
2. Dimmer. Multi-location dimming control, 120/277 volt, 0-10 V control. Mounted in dedicated backbox.

    a. Ratings/Manufacturers: Compatible with Luminaire Driver

        1) Lutron (sole specification. May be submitted separately and exempt from requirement to match manufacturer/brand of other project devices).

HH. **SW-DO;** Dimmer - Automatic Sensor Dual Technology (Standalone):

1. Contractor / vendor to provide dimmer based on rating required, compatible with wiring, lighting load being controlled. Verify compatibility with luminaire shop drawings prior to light control prior to purchase and installation.

2. Occupancy Dimmer with manual on/auto/off, dual technology ultrasonic/acoustic and PIR120/277 volt on/auto/off, 0-10 V control. 120/277 V - 700 watt electronic ballast rated. Mounted in dedicated backbox.

    a. Ratings/Manufacturers: Compatible with Luminaire Driver

        1) Lutron Maestro Series
        2) Acuity nLight Series
        3) Hubbell LightHawk Series
        4) Sensor Switch WSX D Series
        5) Cooper OSW/VSW Series

II. **SW-LS;** Daylight Level Sensor and Controller (Standalone):

1. Contractor / vendor to provide daylight sensor based on sequence of operation requirements. Verify compatibility with luminaire shop drawings and luminaire driver prior to lighting control prior to purchase and installation.
2. Subscripts: Subscripts are used to define the device type:

    a. (BLANK) = Dimming Control
    b. S = Switched Control
    c. W = Wireless w/ Battery
    d. # = Special Function

3. Daylight level sensor, 120/277 volt, one or multi-zone per application, on/off/0-10 volt dimming control per application, 10-200 footcandle sensor range, adjustable deadband to prevent cycling and 0-30 minute adjustable time delay. Initial Settings: Refer to Sequence of Operation.
4. Sensor shall detect changes in ambient light level and provide triggering of lighting groups in area based on sequence of operation.
5. Sensor shall be configurable via DIP switches at device or via handheld wireless remote programming unit. Settings shall include:

    a. Ambient sensitivity range between 10-200 foot-candles.
    b. Time delay of 5 to 300 seconds.
    c. Trigger setpoints with deadband adjustment.

6. Sensor shall provide on/off setpoints in quantity as specified on drawings and as shown in the sequence of operation.
7. Sensor shall be ceiling- or wall-mounted for range and viewing angle meeting application requirements as outlined in the sequence of operation.
8. Output signal from sensor shall be linear with light level.

9. Manufacturers:

    a. Watt Stopper LS-301 (dimming one zone)
    b. Sensor Switch N-CMADC (dimming one zone)
    c. Hubbell Automation DLC7 (dimming one zone)
    d. Watt Stopper LCD-203/LS-290C (dimming three zone)
    e. Sensor Switch N-CMADC (dimming three zone)
    f. Hubbell Automation LUXSTATDCM/LUXSTATLS (dimming three zone)
    g. LC&D Micro GR/2404 IDIM/Pcell (dimming three zone)
    h. Watt Stopper LS-102 (on/off one zone)
    i. Sensor Switch CM-PC (on/off one zone)
    j. Hubbell Automation DLCPC Series (on/off one zone)

k. Cooper PPS-4 (on/off one zone)
l. Watt Stopper LCO-203/LS-290C (on/off three zone)
m. Sensor Switch N-CMPC (on/off three zone)
n. Hubbell Automation LUXSTATOCM/LUXSTATLS (on/off three zone)
o. LC&D Micro GR/2404 iDH/Pcell (on/off three zone)

JJ. **SW-LS-PC;** Exterior Photo Sensors (Standalone):

1. Contractor / vendor to provide sensor based on sequence of operation requirements. Verify compatibility with lighting control system prior to purchase and installation.
2. Subscripts: Subscripts are used to define the device type:

    a. (BLANK) = Standalone Device
    b. #R = Room-Based Lighting Control Device
    c. #N = Network-Based Lighting Control Device

3. Exterior photocell sensor, 120/277 volt, 1800 VA minimum standard SPST formed contact zero-crossing closure, ambient sensor range 5 - 1,500 foot-candles, adjustable setpoint, adjustable deadband, adjustable time delay, weatherproof enclosure with threaded base for box installation and toolless twist-lock removable/replaceable photo eye assembly, -30°F to +130°F operation. Provide with lens cover that can be applied for system testing during daylight conditions.
4. Installation: Mount sensor to face North-East.
5. Manufacturers Standalone:

    a. Paragon Twistlock Series
    b. Tork Turnlock Series
    c. Intermatic LC4546 Series

6. Manufacturers Room-Based or Network-Based:

    a. Manufacturer of Room-Based or Network-Based system.

KK. **SW-OC-# and SW-VC-#;** Automatic Sensors (Standalone):

1. Combination Devices: Subscripts identify combination type devices when applicable. The contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device. Manufacturer verified layouts shall include a 20% overlap of coverage patterns.
2. Subscripts: Subscripts are used to define the device type.

    a. Blank (or D) = Dual Technology
    b. A = Ultrasonic two-sided corridor coverage
    c. P = Passive infrared
    d. P2 = Passive infrared 100 degree coverage
    e. U = Ultrasonic 360 degree coverage
    f. HA = Highbay aisle coverage
    g. HB = Highbay
    h. W = Wireless with battery, 10 year minimum

3. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.

a. Operation - Occupancy: Occupancy sensors turn lights 'on' when covered area is occupied and turn lights 'off' with a time delay when unoccupied, unless otherwise indicated.
b. Operation - Vacancy: Vacancy sensors require a manual switch operation to turn lights 'on' with a time delay when occupied to turn lights 'off'.
c. Time Delay 'Off': Field adjustable with a minimum range of 1-20 minutes.
d. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
e. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13-amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by Electrical Code.
f. Mounting:

1) Sensor: Suitable for mounting in any position on a standard outlet box.
2) Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.
3) Time Delay and Sensitivity Adjustments: Recessed and concealed.

4. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.
5. Bypass Switch: Override the on function in case of sensor failure.
6. Power Supply and Child Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.
7. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.
8. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.

a. **(A);** Ultrasonic Two-Sided Corridor Coverage Automatic Sensor: Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.

1) Manufacturers:

a) Watt Stopper WT-2250 Series
b) Hubbell OMNI-US or ATU Series
c) Cooper OAC-U Series

b. **Blank (or D);** Dual Technology 360 Degree Coverage Automatic Sensor: Combination of PIR and ultrasonic or acoustic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Integrated ambient light level sensor (2 to 200 FC range), adjustable sensitivity and time delay, integrated isolated relay contact. Sensor shall control all circuits in area, unless noted otherwise.

1) Manufacturers:

a) Watt Stopper DT 300/200 Series
b) Hubbell OMNI-DT2000 / LODTRP / ATD2000C Series
c) Cooper OAC-DT Series

d) Leviton OSC-MOW / OSM12 Series
e) Sensor Switch CM PDT 10 / WvpDT 16 series (acoustic)

c. **(P);** Passive Infrared, 360 Degree Coverage Pattern Ceiling Mount Automatic Sensor: Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise.

1) Manufacturers:

a) Watt Stopper CI Series
b) Sensor Switch CM-9
c) Hubbell Automation Omni-IR
d) Leviton OSC Series
e) Cooper OAC-P Series

d. **(P2);** Passive Infrared, 100 Degree Coverage, Ceiling/Wall, Automatic Sensor: Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise.

1) Manufacturers:

a) Watt Stopper WPIR Series
b) Sensor Switch CM-9
c) Hubbell LOIRWV or ATD1600W

e. **(U);** Ultrasonic 360 Degree Coverage, Ceiling Mounted, Automatic Sensor: Detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage. 20' x 20' Hand Motion Coverage Pattern. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated 1-amp relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.

1) Manufacturers:

a) Watt Stopper WT-1100 Series
b) Hubbell OMNI-US or ATU Series
c) Leviton OSC Series
d) Cooper OAC-U Series

f. **(HA);** Highbay Aisle Coverage Automatic Sensor: 20' to 40' mounting height. Minimum 1.3:1 walking motion coverage pattern to height ratio. Adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all luminaires in area.

1) Manufacturers:

a) Watt Stopper HB-300 Series
b) Hubbell FHB 140 or HMHB Series
c) Leviton OSFHU
d) Greengate OEF-P

g. **(HB);** Highbay Automatic Sensor: 20' to 40' mounting height. Minimum 1.3:1 walking motion coverage pattern to height ratio. Adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all luminaires in area.

1) Manufacturers:

a) Watt Stopper HB-300 Series
b) Hubbell FHB 140 or HMHB series
c) Leviton OSFHU
d) Cooper OEF-P Series

h. **(W);** Wireless with Battery, Automatic Feature: 10 year minimum.

2.05 ROOM-BASED LIGHTING CONTROL SYSTEM ('INTELLIGENT CONTROLS)

A. Manufacturers: Manufacturers as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.

1. Acuity Controls nLight Series
2. Cooper / Intelligent Lighting Controls ILC WaveLinx / EVO (room-based system) Series
3. Current Automation NX Series
4. Legrand Watt Stopper DLM Series
5. Lutron

B. Room-Based Lighting Control System Description: The room-based lighting control system is a distributed network of devices, components, and accessories for lighting controls and integrated control with other systems. The system includes system room controllers (network hubs), control stations, sensors (occupancy, vacancy, daylighting, etc.), switching/dimming modules, programming, 365/7 day scheduling, and associated wiring.

C. The lighting control system manufacturer shall be responsible to assure coordination and network compatibility between all system devices, components, and accessories.

D. Global System Typography: The system shall be provided with the following global system characteristics. When multiple exclusive options are listed the manufacturer/vendor may submit a system based on either criterion unless otherwise noted. When the drawings identify a specific option (typically identified with a subscript) provide the specific option as scheduled on the drawings. (Example, a control station (SW-#B) shown with a "W• " subscript on the plans shall be provided in a wireless configuration regardless if the following specification descriptions allow both low voltage or wireless network.)

1. System Controllers (Room Controllers): Room-based controllers located above accessible ceilings.
2. Interior Lighting Control System Network Connectivity for System Devices, Components, and Accessories: Low voltage cabling.
3. Exterior (Site) Lighting Control System Network Connectivity for System Devices, Components, and Accessories: Physical low voltage cabling.
4. Power Source for System Devices, Components, and Accessories: AC power pack supply.
5. Automatic Sensor Control Devices, Components, and Accessories: Occupancy.

E. Lighting Control System Programming Protocol: Manufacturer's protocol.

F. Lighting Control System (Room-Based Controller):

1. Lighting Control System Room-Based Controller: Provide with data network to all lighting control system components, devices, and accessories. Provide network interface with other systems via BACnet IP communication or alternative protocol acceptable to the other system. System communication protocol shall be compatible with the building automation system.

G. Time Clock and Scheduling: Provide 24 astronomical hour-based scheduling for interior lighting controls.

H. Room-Based System Controllers (Room Controllers): Distributed room-based controller, integral switching relays and dimmers, network connected.

1. Installation: Provide a dedicated controller for each space; not shared with adjacent rooms. Locate the controller near the associated wall controller, near the entry door when applicable, and above the finished accessible ceiling. As an alternative, the controller may be mounted above the finished accessible ceiling of the adjacent space when the associated ceiling space is not accessible. Example, located in adjacent corridor.

I. Programming and Commissioning Dongle (Removable Style): Provide and permanently install a programming dongle for each room controller when a field removable dongle type device is required for programming and commissioning of the system. The programming dongle shall be permanently installed to allow for ease of programming the controller without above ceiling access.

J. Interior Lighting - Wireless Network: A wireless mesh network is an acceptable lighting control option when included in the list of acceptable Global System Typography descriptions listed above. Provide and field coordinate wireless antennas (or room controllers) based on manufacturer requirements and field conditions. The system shall allow room controllers, control stations, sensors, and other components of the system to remain functional based on previous programing criteria if the wireless network is lost. Example, Wireless lighting control networks are commonly configured between sensors, control stations, devices, components, and other accessories and room controllers or system antennas. Room controllers and system antennas are commonly connected via low-voltage cabling or a mesh wireless network. Wireless systems without a mesh network protocol are not acceptable.

K. Control Devices: All automatic sensors (ultrasonic, PIR, dual technology, daylighting, photocell, timers), control stations, and other system components shall be provided with the system and designed to operate on system network. Sensors shall be powered from power supplies, modules, packs, or Power Over Ethernet POE. Refer to Standalone Line and Low Voltage Lighting Controls section of this specification for sensor performance descriptions (not duplicated in this section).

L. Power Supplies (Modules, Packs, etc.): Provide power supplies for control devices. Power supply shall provide physical separation of 120/277 volt line voltage wiring and low voltage control wiring. Provide supplementary power supplies when required for multiple control devices. Provide switch or dimmed control as required by the Sequence Of Operation SOO.

1. Installation: Install adjacent to wall room controller when applicable, near the entry door when applicable, and above the finished accessible ceiling. As an alternative, the controller may be mounted above the finished accessible ceiling of the adjacent space when the associated ceiling space is not accessible. Provide low voltage wiring to applicable control devices and control stations.

M. Device Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20A, 125-volt AC for tungsten filaments and 20 A, 277-volt AC for electronic ballasts, minimum 50,000 cycles at rated capacity. Provide supplemental relays when required. (Example, occupancy sensor control of receptacle outlets or VAV/TAB HVAC units located in the same space.)

1. Receptacle Outlet Control: Provide auxiliary relay to control receptacle outlets located in the control space. Refer to the drawings and sequence of operation schedule for requirements.
2. Building Automation Interface: Provide auxiliary relay to report occupancy status of each individual space to the building automation system. Refer to the drawings and sequence of operation schedule for requirements.

N. **SW-LCPR-#**; Room-Based Lighting Control Panel (LCPR-#):

1. Room-Based type controllers are the preferred basis-of-design. Centralized wall or floor mounted panels may be required pending manufacturer specific product offerings. Panel is shown on floor plans for possible physical space planning purposes. Contractor shall coordinate final mounting location with available space and approved shop drawings. Refer to approved shop drawings for additional information.
2. Control Panel Configuration: Group mounted individual control zones (relay switch, dimmer, other), non-overcurrent protection type, with lighting control network-based communication. Overcurrent protection of circuits provided by scheduled panels and circuits shown on drawings. Panels configurations with branch overcurrent protection, main circuit breaker, main bus, and a single feeder-based power source are not acceptable in the base bid unless otherwise noted. The contractor may submit a voluntary alternate for a single feeder-based power source type lighting control panel with bid for consideration. The voluntary alternate must include provisions for the required feeder and associated post bid design modifications.
3. Dimmer / Relay capacity: Refer to plans for quantity required. The minimum quantity shall be 4.
4. Dimmer / Relay Modules: Match load types and sequence of operation descriptions.
5. Cabinet: Steel with hinged, locking door. Barriers separate low-voltage and line-voltage components.

O. **SW-#B**; Lighting Control Station, Default Dimming Control Raise/Lower/Fade: The lighting control station shall comply with the performance requirements of the lighting sequence of operation. The control station may consist of switches, pushbuttons, sliders, dimming functions, etc. Provide a common coverplate for lighting control stations.

1. #B: The '#' indicates the minimum quantity of unique lighting control scenes when shown plus raise/lower and lights 'off' scene. Refer to the Lighting Sequence Of Operation (SOO) for the minimum quantity of scenes required (when a number is not designated) and a description of each control scene.
2. Subscripts:

    a. (BLANK) = Dimming Control (Default)
    b. S = Switch Control
    c. W = Wireless w/ battery
    d. # = Unique ID when applicable

3. Manufacturer: Room-Based Lighting Controller Manufacturer:

a. Dimming (Blank) or Switch (S) Control Station: Modular, momentary pushbutton, with addressable capabilities to control the scene or luminaires assigned to the switch. The switch shall be able to actuate the functions based on the described sequence of operation and intended functions.

1) Preset/fader stations shall operate using programmable buttons and/or faders as indicated on drawings.
2) Raise, Lower, Integral Fader Control: Provide control station with manual raise and lower fader control for each control zone of lighting control. Manual raise/lower shall be separate buttons from scene control; hold and dim scene control buttons not acceptable. Faders may be physical sliders or up/down buttons. Fader range shall provide continuous even dimming matching full range of dimmer specification.
3) Integral Pilot Light or LED: Indicate that controls are active or powered by being on continuously when powered or when pushbuttons are actuated.
4) Labeling of buttons and faders shall be engraved/screened by manufacturer, using approved text returned with shop drawing submittals.
5) Station control components shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via direct or network connection. Function options include: preset selection, manual mode, record mode, station lockout, raise/lower, macro, cue, and room join/separate.
6) Multiple stations (shown in same space): When multiple control stations are shown in the same space the sequence of operation shall be the same at all locations unless noted otherwise.
7) Multiple stations (movable partitions in same space): When multiple control stations are shown in the same space with movable partitions the sequence of operations shall be the same at all locations unless noted otherwise. A wall partition switch shall monitor the status of the movable partitions and automatically associated the control station(s) with the appropriate space based on the status of the wall partition.

b. (W) Wireless Control Station - Portable:

1) Portable wireless IR or Bluetooth transmitter for remote control of lighting control panel. Transmitter shall have a minimum of four (4) scene controls with engraved names below each button.
2) Infrared receiver shall be recess mounted with an integral LED to indicate when signal has been received. Receiver shall operate reliably within a 40-foot distance.
3) Provide with docking station at space entry location shown on plans.

P. Global Operational Sequences:

1. Fire Alarm and Automatic Detection Sequence: A fire alarm system 'alarm' or 'drill' shall initiate an override of the local lighting control. The lighting in the following spaces shall be overridden to 100 percent "on" in the following areas: Corridors, hallways, stairways, spaces equipped with exit signs, main entrance, other egress paths, and occupancy spaces of Assembly. Provide provisions to add additional spaces to this applicable list as directed by the Authority Having Jurisdiction AHJ or Engineer.
2. Mass Notification Sequence initiated by the fire alarm:.

3. Intrusion Detection or Security Sequence: An intrusion detection or security system 'alarm' shall initiate an override of the local lighting control. Lighting in the area associated with the intrusion shall be overridden to 100 percent "o".[Exterior site lighting shall be overridden to 100 percent "o.][Main entrance/lobby lighting shall be overridden to 100 percent "o**".**]

Q. Additional Network-Based Characteristics for Room-Based Control Systems: The following network-based lighting control system characteristics and capabilities shall be provided with the room-based lighting control system. The following ADDITIONAL requirements supplement the system description included above.

1. Additional Remote / Cloud System Access Requirements: Remote 365/7 day scheduling, holiday, and custom event scheduling.
2. Additional System Controllers (Room Controllers) Options for Networks: Room-based controllers located above accessible ceilings.
3. Additional Time Clock and Scheduling Requirements: Astronomical based scheduling for exterior site controls. Provide 365/7 day scheduling, with holiday events, with custom events, with on/off master override.
4. Additional NETWORK: Room-Based Lighting Control with Network:

    a. The independent room-based control systems shall be connected via a system network. The following requirements supplement the room-based requirements listed above.
    b. Monitoring and Reporting: Provide monitoring and historical reporting of system events and components via password secured server or cloud-based interface.
    c. Master Remote Control: Provide control of devices, components, accessories for scheduling timeouts, and light blink notifications.

5. Additional Workstation: Provide lighting master control station with computer-based workstation with keyboard and mouse. Install master workstation in location shown on drawings or as coordinated with the owner.
6. Additional Master Lighting Control System / Room-Based Controllers / Centralized Control Panels - Network Mesh and Independent Operation: The system network shall allow distributed room-based controllers and centralized control panels to continue local control station functionality and previously scheduled events if disconnected from the master system network. Sensors, wall stations, devices, components, and accessories supported by the local room controllers and centralized control panels shall also remain functional based on previously programmed criteria.
7. Additional Centralized Relay / Dimming / Contact Controllers: Wall or floor mounted cabinets, integral switching relays and dimmers, integral main circuit breaker disconnect, integral UL924 relay to bypass lighting controls during an emergency condition, remote fire alarm override, network connected.

    a. Installation: Install in locations shown on plans or coordinate with other equipment in electrical rooms, janitor closets, and similar back-of-house support spaces when not shown on the plans.

8. **SW-WG**; Exterior Site Lighting - Wireless Network: A wireless mesh network is an acceptable lighting control option when included in the list of acceptable Global System Typography descriptions listed above. Provide each applicable exterior site luminaire with a wireless receiver/repeater to establish a wireless mesh network. Wireless systems without a mesh network protocol are not acceptable.

a. Installation: Provide a manufacturer wireless antenna and gateway. Coordinate the gateway and antenna mounting locations based on manufacturer requirements and distance limitations to site luminaires. Provide a weather-proof penetration when a roof mounted antenna is required.

9. Additional Custom Graphical Digital Twin: Provide master lighting control system with a custom digital twin representation of the facility floor plans. Include all spaces, room names, and representation of luminaires, sensors and other components. Provide password protected access to the digital twin via physical server, master station, or cloud-based access. The master interface shall provide the following features:

a. Remote monitoring and reporting of occupancy, luminaire status, and lighting control system component status.
b. Manual override on/off of lighting space-by-space.
c. Management (programming and adjustment) of 365/7 day scheduling, holiday scheduling, and event scheduling.

2.06 NETWORK-BASED LIGHTING CONTROL SYSTEM; LCD (SW-NETW) CONTROL STATIONS

A. Manufacturers: Manufacturers as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.

1. Electronic Theater Controls ETC
2. Lehigh
3. Lutron
4. Crestron
5. Strand (by Signify)

B. Network-Based Lighting Control System Description: The Network-Based lighting control system is a network of devices, components, and accessories for lighting controls and integrated control with other systems. The system includes system controller (server or cloud-based), room controllers (network hubs), control stations, sensors (occupancy, vacancy, daylighting, etc.), switching/dimming modules, programming, 365/7 day scheduling, and associated wiring.

C. The lighting control system manufacturer shall be responsible to assure coordination and network compatibility between all system devices, components, and accessories.

D. Global System Typography: The system shall be provided with the following global system characteristics. When multiple exclusive options are listed the manufacturer/vendor may submit a system based on either criterion unless otherwise noted. When the drawings identify a specific option (typically identified with a subscript) provide the specific option as scheduled on the drawings. (Example, a control station (SW-NETW) shown with a "RLF" subscript on the plans shall be provided in a raise lower fader configuration regardless if the following specification descriptions allow both low voltage or wireless network.)

1. Remote / Cloud System Access: Remote 365/7 day scheduling, holiday, and custom event scheduling.
2. System Controllers (Room Controllers): Distributed controllers located above accessible ceilings.
3. Interior Lighting Control System Network Connectivity for System Devices, Components, and Accessories: Low voltage cabling.
4. Exterior (Site) Lighting Control System Network Connectivity for System Devices, Components, and Accessories: Physical low voltage cabling.

5. Power Source for System Devices, Component, and Accessories: AC power pack supply.
6. Automatic Sensor Control Devices, Components, and Accessories: Occupancy.

E. Lighting Control System Programming Protocol: Manufacturer's protocol..

F. Lighting Control System (Physical Server, Central Station, or Cloud-Based Access):

1. Lighting control system with physical server, central station, or cloud-based access. Provide with data network to all lighting control system components, devices, and accessories. Provide network interface with other systems via BACnet IP communication or alternative protocol acceptable to the other system. System communication protocol shall be compatible with the building automation system.
2. Time clock and scheduling: Provide 24 hour-based astronomical scheduling for interior lighting controls and astronomical based scheduling for exterior site controls. Provide 365/7 day scheduling, with holiday events, with custom events, with on/off master override.
3. Monitoring and reporting: Provide monitoring and historical reporting of system events and components via password secured server or cloud-based interface.
4. Master Remote Control: Provide control of devices, components, accessories for scheduling timeouts, and light blink notifications.
5. Workstation: Provide lighting master control station with computer-based workstation with keyboard and mouse. Install master workstation in location shown on drawings or as coordinated with the owner.

G. Master Lighting Control System / Distributed Room Controllers / Centralized Control Panels - Network Mesh and Independent Operation: The system network shall allow distributed room controllers and centralized control panels to continue local control station functionality and previously scheduled events if disconnected from the master system network. Sensors, wall stations, devices, components, and accessories supported by the local room controllers and centralized control panels shall also remain functional based on previously programmed criteria.

H. Room-Based System Controllers (Room Controllers): Distributed room-based controller, integral switching relays and dimmers, network connected.

I. Programming and Commissioning Dongle (Removable Style): Provide and permanently install a programming dongle for each room controller when a field removable dongle type device is required for programming and commissioning of the system. The programming dongle shall be permanently installed to allow for ease of programming the controller without above ceiling access.

J. Centralized Relay / Dimming / Contact Controllers: Wall or floor mounted cabinets, integral switching relays and dimmers, integral main circuit breaker disconnect, integral UL924 to bypass lighting controls during an emergency condition, remote fire alarm override, network connected.

1. Installation: Install in locations shown on plans or coordinate with other equipment in electrical rooms, janitor closets, and similar back-of-house support spaces when not shown on the plans.

K. Interior Lighting - Wireless Network: A wireless mesh network is an acceptable lighting control option when included in the list of acceptable Global System Typography descriptions listed above. Provide and field coordinate wireless antennas (or room controllers) based on manufacturer requirements and field conditions. The system shall allow room controllers, control stations, sensors, and other components of the system to remain functional based on previous programing criteria if the wireless network is lost. Example, Wireless lighting control networks are commonly configured between sensors, control stations, devices, components, and other accessories and room controllers or system antennas. Room controllers and system antennas are commonly connected via low-voltage cabling or a mesh wireless network. Wireless systems without a mesh network protocol are not acceptable.

L. **SW-WG**; Exterior Site Lighting - Wireless Network: A wireless mesh network is an acceptable lighting control option when included in the list of acceptable Global System Typography descriptions listed above. Provide each applicable exterior site luminaire with a wireless receiver/repeater to establish a wireless mesh network. Wireless systems without a mesh network protocol are not acceptable.

M. Custom graphical digital twin: Provide master lighting control system with a custom digital twin representation of the facility floor plans. Include all spaces, room names, and representation of luminaires, sensors and other components. Provide password protected access to the digital twin via physical server, master station, or cloud-based access. The master interface shall provide the following features:

1. Remote monitoring and reporting of occupancy, luminaire status, and lighting control system component status.
2. Manual override on/off of lighting space-by-space.
3. Management (programming and adjustment) of 365/7 day scheduling, holiday scheduling, and event scheduling.

N. Control Devices: All automatic sensors (ultrasonic, PIR, dual technology, daylighting, photocell, timers), control stations, and other system components shall be provided with the system and designed to operate on system network. Sensors shall be powered from power supplies, modules, packs, or Power Over Ethernet POE. Refer to the Standalone Line and Low Voltage Lighting Controls section of this specification for sensor performance descriptions (not duplicated in this section).

O. Power Supplies (Modules, Packs, etc.): Provide power supplies for control devices. Power supply shall provide physical separation of 120/277 volt line voltage wiring and low voltage control wiring. Provide supplementary power supplies when required for multiple control devices. Provide switch or dimmed control as required by the Sequence Of Operation SOO.

1. Installation: Install adjacent to wall room controller when applicable, near the entry door when applicable, and above the finished accessible ceiling. As an alternative, the controller may be mounted above the finished accessible ceiling of the adjacent space when the associated ceiling space is not accessible. Provide low voltage wiring to applicable control devices and control stations.

P. Device Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20A, 125-volt AC for tungsten filaments and 20A, 277-volt AC for electronic ballasts, minimum 50,000 cycles at rated capacity. Provide supplemental relays when required. (Example, occupancy sensor control of receptacle outlets or VAV/TAB HVAC units located in the same space.

Q. Receptacle Outlet Control: Provide auxiliary relay to control receptacle outlets located in the control space. Refer to the drawings and sequence of operation schedule for requirements.

R. Building Automation Interface: Provide auxiliary relay to report occupancy status of each individual space to the building automation system. Refer to the drawings and sequence of operation schedule for requirements.

S. Central Lighting Control Features and Functions:

1. Dimming system presets shall be programmable via preset/fader station directly at the control panel, or via network-based workstation software. Dimming presets shall have discrete fade times with 0.1 second resolution, programmable from zero to 24 hours, and shall be selectable via button, fader, clock event, macro or network interface.
2. Clock events shall be activated by calendar schedule, by day type and/or specific day programming, including every day, weekday, weekend, S, M, T, W, H, F, S, Holiday. Clock events shall also be activated by astronomical events, which will compensate for daylight savings time and will have programmable setback periods relative to sunrise and sunset.
3. The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, specification grade line voltage type wall switches, photocell, web-based software or other devices connected to programmable inputs in a lighting control panel.
4. Channels for grouping relays shall be provided, each with an associated pushbutton to toggle the channel ON/OFF and a terminal block for a separate dry contact input. Any number of relays in the panel can be assigned to each channel, with overlapping allowed. Channels shall be set up via communication line communications and networking. Each channel pushbutton shall provide LED status indication. The panel shall also have the ability to assign functions to relays independently of the channels. Panels shall be addressable with DIP switches or other local means to set panel address.
5. System shall accept any type of switch input, including momentary or maintained.
6. System shall support by relay or zone the "blink warning" function. System shall be capable of flashing lights Off/On prior to the lights being turned Off. The warning interval time between the flash and the final lights off signal shall be definable for each zone. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time shall be locally and remotely programmable and shall not exceed two (2) hours.
7. System shall provide temporary override conditions for each relay or dimmer so that lights can always be turned on.
8. All programming and scheduling shall be able to be done locally at the parent lighting control panel and remotely via the Internet. Remote connection to the lighting control system shall provide real-time control and real-time feedback. Lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go offline, all system programming uploaded to the lighting control system shall continue to operate as intended.
9. All programs, schedules, time of day, etc., shall be held in non-volatile memory for a minimum of two (2) years at power failure. At restoration of power, lighting control system shall implement programs required by current time and date.

T. Building Automation System BAS Protocol Interface: Provide BACnet-over-IP interface to building controls system or a Direct Digital Controls native protocol interface to read, control and monitor status of all lighting zones in real time.

U. Telephone Override Interface: A voice-prompted telephone override interface module shall accept up to three (3) phone lines and allow up to three (3) simultaneous phone calls. Voice-prompted menu and up to 999 unique passcodes shall be standard with each interface module. Override time shall be a maximum of 120 minutes.

V. Ethernet Connection Port - Interoperability:

1. System shall include an Ethernet port for connection to Owner's TCP/IP network, permitting remote management of system from local or wide area network connection.
2. Contractor shall coordinate with technology vendor to provide an Ethernet connection to (LCP) panel as specified by manufacturer.

W. RS232 / RS485 Interface for Audio/Visual Interface - Control Interface Stations:

1. Control interface stations shall provide an interface for PC and/or A/V connection to lighting control system.
2. Stations shall utilize RS-232 or RS485 standard protocol and shall be appropriate DIN-style connector.

X. **SW-LCPN-#**; Network-Based Lighting Control Panel / Rack / Cabinet (LCPN-#):

1. Refer to drawings for schedule of Network-Based lighting control panel configuration, voltage, and ratings.
2. 120/208277/480 volt, 3 - phase, 4-wire, Insert amp main circuit breaker, with plug-in dimmer/circuit breaker and relay switch/circuit breaker modules.
3. Dimmer / Relay Capacity: Refer to schedule
4. Manufacturer: Network-Based Lighting Controller manufacturer
5. Dimming / Switched Relay Performance Requirements
6. Dimmers: Refer to Dimmer controlled Zone(s) for additional requirements
7. Switched Relay: Refer to Switched Relay Controlled Zone(s) for additional requirements

Y. Cabinet: Steel with hinged, locking door. Barriers separate low-voltage and line-voltage components.

1. System Power Supply: Transformer and full-wave rectifier with filtered DC output for panel, controllers, and control devices.

Z. **SW-#B**; Lighting Control Station, default dimming control raise/lower/fade. The lighting control station shall comply with the performance requirements of the lighting sequence of operation. The control station may consist of switches, pushbuttons, sliders, dimming functions, etc. Provide a common coverplate for lighting control stations.

1. Refer to the Lighting Sequence Of Operation (SOO) for the minimum quantity of scenes required and a description of each control scene. Refer to Network-Based lighting control station schedules on drawings for station configuration requirements.
2. Subscripts:

    a. (BLANK) = Dimming Control (Default)
    b. S = Switch Control
    c. W - Wireless w/ Battery
    d. # = Unique ID when applicable

3. Manufacturer: Network-Based Lighting Controller manufacturer
4. Dimming (BLANK) or Switch (S) stations: Modular, momentary pushbutton, with addressable capabilities to control the scene or luminaires assigned to the switch. The switch shall be able to actuate the functions based on the described sequence of operation and intended functions.

a. Preset/fader stations shall operate using programmable buttons and/or faders as indicated on drawings.
b. Raise, Lower, Integral Fader Control: Provide control station with manual raise and lower fader control for each control zone of lighting control. Faders may be physical sliders, up/down buttons, or graphical touch screen format. Fader range shall match full range of dimmer specification.
c. Integral Pilot Light or LED: Indicate that controls are active or powered by being on continuously when powered or when pushbuttons are actuated.
d. Labeling of buttons and faders shall be engraved/screened by manufacturer, using approved text returned with shop drawing submittals.
e. Station control components shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via direct or network connection. Function options include: preset selection, manual mode, record mode, station lockout, raise/lower, macro, cue, and room join/separate.
f. Multiple Stations (shown in same space): When multiple control stations are shown in the same space the sequence of operation shall be the same at all locations unless noted otherwise.
g. Multiple Stations (movable partitions in same space): When multiple control stations are shown in the same space with movable partitions the sequence of operations shall be the same at all locations unless noted otherwise. A wall partition switch shall monitor the status of the movable partitions and automatically associated the control station(s) with the appropriate space based on the status of the wall partition.

AA. **SW-LCD**; LCD Lighting Control Station:

1. Refer to the Lighting Sequence Of Operation (SOO) for the minimum quantity of scenes required and a description of each control scene. Refer to Network Based lighting control station schedules on drawings for station configuration requirements.
2. Subscripts:

    a. (BLANK) = Dimming Control (Default)
    b. S = Switch Control
    c. # = Unique ID when applicable

3. Manufacturer: Network Based Lighting Controller manufacturer.

4. Dimming (BLANK) or Switch (S) Stations: Modular, momentary pushbutton, with addressable capabilities to control the scene or luminaires assigned to the switch. The switch shall be able to actuate the functions based on the described sequence of operation and intended functions.

5. Backlit color liquid crystal display (LCD) shall operate using buttons, faders, and other images on separate programmable control pages via touchscreen interface.
6. Raise, Lower, Integral Fader Control: Provide control station with manual raise and lower fader control for each control zone of lighting control. Faders may be physical sliders, up/down buttons, or graphical touch screen format. Fader range shall match full range of dimmer specification.
7. LCD station contrast and brightness shall be adjustable. It shall be possible to program the station to dim during periods of inactivity.
8. LCD stations shall support import of bitmap image files to customizable pages.
9. Permanently installed stations shall be either fully or semi-recessed in manufacturer-furnished backbox and trim assembly, with no visible fasteners or hardware.

10. Portable stations shall nest into permanent wall docking station furnished by manufacturer, and shall not require user to connect any umbilicals or plugs when inserting or removing the portable device. Docking station shall provide charging and communication with portable device when docked.

BB. **SW-PCS**; (PCS) Portable Control Station Lighting Control Station:

1. Refer to the Lighting Sequence Of Operation (SOO) for the minimum quantity of scenes required and a description of each control scene. Refer to Network Based lighting control station schedules on drawings for station configuration requirements.
2. Subscripts:

    a. (BLANK) = Dimming Control (Default)
    b. S = Switch Control
    c. # = Unique ID when applicable

3. Manufacturer: Network Based Lighting Controller manufacturer.

4. Dimming (BLANK) or Switch (S) Stations: Modular, momentary pushbutton, with addressable capabilities to control the scene or luminaires assigned to the switch. The switch shall be able to actuate the functions based on the described sequence of operation and intended functions.
5. Portable control console with minimum 10-foot cable and interface plug.
6. Raise, Lower, integral fader control: Provide control station with manual raise and lower fader control for each control zone of lighting control. Faders may be physical sliders, up/down buttons, or graphical touch screen format. Fader range shall match full range of dimmer specification.
7. Connector station receptacle, flush mounted, to allow portable console to communicate with lighting control system. Mounts in industry standard backbox.

CC. Global Operational Sequences:

1. Fire Alarm and Automatic Detection Sequence: A fire alarm system 'alarm' or 'drill' shall initiate an override of the local lighting control. The lighting in the following spaces shall be overridden to 100 percent "on" • in the following areas: Corridors, hallways, stairways, spaces equipped with exit signs, main entrance, other egress paths, and occupancy spaces of Assembly. Provide provisions to add additional spaces to this applicable list as directed by the Authority Having Jurisdiction AHJ or Engineer.
2. Mass Notification Sequence initiated by the Fire Alarm:.
3. Intrusion Detection or Security Sequence: An intrusion detection or security system 'alarm' shall initiate an override of the local lighting control. Lighting in the area associated with the intrusion shall be overridden to 100 percent "on"• .Exterior site lighting shall be overridden to 100 percent "on"• . Main entrance / lobby lighting shall be overridden to 100 percent "on"..
4. Demand Response DR - Automated Utility Demand Response: A demand response signal originating from the Facility Management Control System FMCS (Building Automation System BAS) shall initiate an override of the local lighting control. The Demand Response signal will originate from the public utility, to the FMCS, to the centralized lighting control system.

    a. The lighting control system shall automatically reduce illumination lighting levels between 15 - 50%. Refer to the lighting sequence of operations and plans for a list of spaces associated with the demand response control and the reduction quantity.
    b. Demand Response shall NOT apply to: Emergency lighting, life safety lighting, egress lighting for corridors and stairways, assembly spaces with an architecturally listed occupancy of 50 or more.

5. Automatic Demand Response ADR - Automated Utility Demand Response: A demand response signal shall initiate an override of the local lighting control.

    a. The lighting control system shall automatically reduce illumination lighting levels between 15 - 50%. Refer to the lighting sequence of operations and plans for a list of spaces associated with the demand response control and the reduction quantity.
    b. Demand Responsive Controls Communication:

        1) The demand response signal will originate from the public utility, to the FMCS, to the centralized lighting control system or a certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification.
        2) All demand responsive controls shall be capable of communicating using one or more of the following: Wi-Fi, ZigBee, BACnet, Ethernet, or hard-wiring.

    c. Demand Response shall NOT apply to: Emergency lighting, life safety lighting, egress lighting for corridors and stairways, assembly spaces with an architecturally listed occupancy of 50 or more.

        1) When communications are disabled or unavailable, all demand responsive controls shall continue to perform all other control functions provided by the control.

DD. Dimming / Relay Performance Requirements:

1. The component's maximum current rating shall be at least two times the dimmer's/relay's rated operating current.
2. Capable of withstanding repetitive in-rush current of 50 times operating current without impacting lifetime of dimmer/relay. Design and test dimmers/relays to withstand line-side surges without impairment to performance.
3. Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.

EE. Dimmer Controlled Zone(s):

1. Provide branch circuit breaker for each relay module. Circuit breakers shall be fully magnetic so that trip current is not affected by ambient temperature. Circuit breakers shall be rated for 100 percent switching duty.
2. Each dimmer module shall use a solid-state relay (SSR) consisting of two SCRs in an inverse parallel configuration, and all required gating circuitry on the high-voltage side of an integral opto-coupled control voltage isolator.
3. Toroidal filters shall limit objectionable harmonics, reduce lamp filament sing, and limit RF interference on line and load conductors. Rise times ranging from 200 to 500 microseconds shall be available depending upon model number selected.
4. Power efficiency for standard dimmers shall be at least 96 percent at full load, with a no-load loss of three (3) volts RMS.
5. Plug-in modules shall contain a magnetic circuit breaker and a relay rated to withstand hot patching of loads without tripping.
6. Each dimmer to incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.
7. Control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable.
8. Each dimmer to be assigned a load type that will provide a proper dimming curve for the specific light source.

9. Possess ability to have load types assigned per circuit, configured in field.
10. Minimum and maximum light levels user adjustable on output-by-output basis.
11. Line Voltage Dimmers: Meet following load-specific requirements
12. Magnetic Low Voltage (MLV) Transformer
13. Contain circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472, Section 5.11.
14. Dimmers using unipolar load current devices (such as FETs or SCRs) to include DC current protection in the event of a single device failure.
15. Electronic Low Voltage (ELV) Transformer
16. Dimmer to operate electronic low voltage transformers via reverse phase control. Alternately, forward phase control dimming may be used if dimming equipment manufacturer has recommended specific ELV transformers being provided.
17. Neon and Cold Cathode Transformers
18. Magnetic Transformers: UL listed for use with normal (low) power factor magnetic transformers.
19. Electronic Transformers
20. Must be supported by the ballast equipment manufacturer for control of specific ballasts being provided.
21. Fluorescent Electronic Dimming Ballast
22. Refer to Section 265100 for dimming ballast specifications and performance.

FF. Low Voltage Dimming Modules: Meet the following requirements

1. Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.
2. Single low voltage dimming module; capable of controlling following light sources:

    a. 0-10V analog voltage signal
    b. DSI digital communication
    c. DALI broadcast communication IEC 60929
    d. PWM IEC 60929

GG. Switched Relay Controlled Zone(s):

1. Circuit Breaker: Provide branch circuit breaker for each relay module. Circuit breakers shall be fully magnetic so that trip current is not affected by ambient temperature. Circuit breakers shall be rated for 100 percent switching duty.
2. Relays: Mechanically latched unless otherwise indicated; split-coil, momentary-pulsed type, rated 20A, for tungsten filaments and NEMA for electronic ballast rated. Rated for 1,000,000 ON/OFF cycles at rated capacity.
3. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
4. Fully rated output continuous duty for inductive, capacitive, and resistive loads.

HH. Plug-in modules shall contain a magnetic circuit breaker and a relay rated to withstand hot patching of loads without tripping.

2.07 NURSE CALL LIGHTING CONTROLLER

A. **SW-NLC;** Low voltage nurse call lighting controller for control of patient bed lighting through the pillow speaker and bed side controls.

1. Multi-voltage input, compatible with nurse call system. Functionality to control two (2) separate lighting loads using a stepped / sequenced format as follows:

Lighting Load	Load A	Load B
Step 1:	On	Off
Step 2:	Off	On
Step 3:	On	On
Step 4:	Off	Off

2. Manufacturers:

    a. Curbell LC-060
    b. Healthcare Lighting LVC1200
    c. Kenall LVC Series

2.08 AUTOMATIC LOAD CONTROL RELAY (ALCR) (INDIVIDUAL LUMINAIRE - INTEGRAL)

A. This section includes information related to factory and field installed ALCR devices intended for individual luminaires.

B. **ALCR3;** Automatic Load Control Relay ALCR, 120/277 volt, dry/damp listed, 32F to 113F operating temperature, plenum NEMA 1 rated, test button with visual indicator, remote test and fire alarm control, listed for factory or field installation within luminaire, UL924 listed latest edition, Electrical Code Article 700 compliant.

1. Rating: 3 Amp LED driver, ballast, or incandescent.
2. Lighting Control Coordination: Provide ALCR device compatible with designated lighting zone controls. Example: Switched, 0-10 volt dimming, DALI control, 2 wire dimming, or DMX.
3. Operation:

    a. ALCR device shall allow the same local lighting control devices to control both the normal lights and emergency designated lighting. Devices that require separate local lighting controls for the normal and designated emergency lighting are NOT allowed.
    b. ALCR device shall monitor the normal power circuit and shunt/bypass the local lighting controls upon loss of power, remote test switch, or fire alarm override to provide full lumen output for designated emergency lighting.
    c. ALCR device shall return designated emergency lighting to local lighting control after a 15-minute delay upon return of normal power or remote test/fire alarm override release.
    d. Performance Equivalent by Other Components: A limitation of equivalent comparable products may require some of the required functions of the ALCR device to be provided by an alternative component of the lighting control system. The following functions may be performed by alternative components of the lighting control system when the device is listed for the required function and compatible with the lighting control system.

        1) Remote test switch / fire alarm override interface.
        2) The 15-minute time delay upon return of normal power or remote test/fire alarm override release.

    e. Accessory - Remote Test Switch: Provide a remote button test switch for all (ALCR3) devices associated with the same lighting control zone. The test switch shall be a single gang type switch compatible with the ALCR device and allow the remote fire alarm override to function.

        1) Test Switch Mounting:

a) Finished Spaces (ceiling height 10 feet or less): Flush mount device in finished ceiling adjacent to one of the emergency lights.
b) Finished Spaces (ceiling height greater than 10 feet): Flush mounted in wall. Refer to Architect/Engineer for location.
c) Unfinished Spaces: Adjacent and aligned with local wall-mounted lighting controls.

4. Manufacturers:

a. LVS Controls EPC-2-FM (switched)
b. LVS Controls EPC-2-D-FM Series (0-10V dimming)
c. LVS Controls EPC Series (alternative lighting control)
d. Iota ETS-step (switched)
e. Iota ETC-DR (0-10V dimming)
f. Iota ETC Series (alternative lighting control)
g. Lighting control manufacturer

2.09 AUTOMATIC LOAD CONTROL RELAY (ALCR)

A. **ALCR20;** Automatic Load Control Relay ALCR, 120/277 volt, dry/damp listed, 32F to 113F operating temperature, plenum NEMA 1 rated, test button with visual indicator, remote test and fire alarm control, UL924 listed latest edition, Electrical Code Article 700 compliant.

1. Rating:

a. 20 amp (16 A permitted) LED driver and ballast.
b. 10 A (1,200 watt) incandescent.

2. Lighting Control Coordination: Provide ALCR device compatible with designated lighting zone controls. Example: switched, 0-10 volt dimming, DALI control, 2 wire dimming, or DMX.
3. Operation:

a. ALCR device shall allow the same local lighting control devices to control both the normal lights and emergency designated lighting. Devices that require separate local lighting controls for the normal and designated emergency lighting are NOT allowed.
b. ALCR device shall monitor the normal power circuit and shunt/bypass the local lighting controls upon loss of power, remote test switch, or fire alarm override to provide full lumen output for designated emergency lighting.
c. ALCR device shall return designated emergency lighting to local lighting control after a 15-minute delay upon return of normal power or remote test/fire alarm override release.
d. Equivalent Facilitation and Performance: A limitation of equivalent comparable products may require some of the required functions of the ALCR device to be provided by an alternative component of the lighting control system. The following functions may be performed by alternative components of the lighting control system when the device is listed for the required function and compatible with the lighting control system:

1) Remote test switch / fire alarm override interface.
2) The 15-minute time delay upon return of normal power or remote test/fire alarm override release.

e. Accessory - Remote Test Switch: Provide a remote button test switch. The test switch shall be a single gang type switch compatible with the ALCR device and allow the remote fire alarm override to function.

1) Test Switch Mounting:

a) Finished Spaces (ceiling height 10 feet or less): Flush mount device in finished ceiling adjacent to one of the emergency lights.
b) Finished Spaces (ceiling height greater than 10 feet): Flush mounted in wall. Refer to Architect/Engineer for location.
c) Unfinished Spaces: Adjacent and aligned with local wall-mounted lighting controls.
d) Option: ALCR device(s) with a test button, visual indicator, and flush mounting plate may be installed in the location of the remote test switch in lieu of providing a separate remote test switch.

4. Manufacturers:

a. LVS Controls EPC-2 (switched)
b. LVS Controls EPC-2-D Series (0-10V dimming)
c. LVS Controls EPC-DMX (DMX) EPC Series (alternative lighting control)
d. Iota ETS-20 (switched)
e. Iota ETC-20-DR (0-10V dimming)
f. Iota ETC Series (alternative lighting control)
g. Myers Emergency Power Systems RLY-SW-2 (switched)
h. Myers Emergency Power Systems RLY-DIM-2D (0-10V dimming)
i. Myers Emergency Power Systems RLY Series (alternative lighting control)
j. Nine24 Inc ELCR-R (switched)
k. Nine24 ELCR-Z10 (0-10V dimming)
l. Nine24 ELCR Series (alternative lighting control)
m. Lighting control manufacturer

2.010 DIRECTLY CONTROLLED LUMINAIRE SYSTEMS (DCLS)

A. Directly Controlled Luminaire System, integral control of luminaires by integrated lighting control systems. Listed for emergency lighting control applications.

B. Directly Controlled Emergency Luminaire (DCEL). A luminaire scheduled to provide normal and emergency illumination. External emergency power source. Listed.

C. Emergency Lighting Control Device (ELCD). Integral part of the lighting control system is used to directly control luminaires designated as emergency service. Listed.

D. Directly Controlled Luminaire (DCL). A luminaire scheduled to provide normal and emergency illumination. Internal emergency power source. Example, Switched Emergency SE luminaire with integral battery. Listed.

2.011 DIGITAL ADDRESSABLE LIGHTING INTERFACE (DALI) SYSTEM

A. Manufacturers: Manufacturers as listed below meet the qualifications as outlined within this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.

1. Starfield Controls, Inc.
2. Tridonic Inc.

B. System Description: The lighting control system shall consist of digital lighting control network connecting DALI-compliant digital addressable ballasts, control modules, and lighting control devices directly with a system server / central control station. Individually addressable electronic ballasts, control modules, and control devices are operated from signals received through DALI-compliant bus from a variety of DALI-compliant digital controllers and interfaces and programmed through the system server / central control station. System includes all associated network bus and wiring, DALI controllers and interfaces, panels, photocells, switches, dimmers, time clock, and occupancy sensors. System shall utilize DALI-compliant ballast and dimming modules provided with light fixtures.

C. Control Devices: All automatic sensors (ultrasonic, IR, and dual technology type), photocells, switches, and timers shall be provided with system and be DALI compliant. Devices shall be designed to operate on system network. Supplemental DALI-compliant signal repeaters and controllers shall be provided as required. This equipment shall be identified in shop drawing submission.

D. System shall include server / central station with DALI operating software, data network, and BACnet IP communication with other systems as described. System communication protocol shall be compatible with the building automation system.

E. System server / central station shall provide programmable operation of lights connected via system bus and controlled with system devices. System software shall provide control of DALI ballast, control modules and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.

F. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between relay modules, network hubs, and control system server/ central station such that system performs as described. Server shall be provided with monitor, keyboard, and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.

2.012 DC LIGHTING CONTROL SYSTEM; LCDC (SW-DC) LIGHTING CONTROL STATIONS

A. Manufacturers: Manufacturers as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.

1. GE Medical Systems
2. Medical Power Systems LCC
3. Lutron
4. Approved equal

B. DC Lighting Control System for Magnetic Resonance Imaging (MRI) applications. Comply with manufacturer's electrical noise levels requirements.

C. Dimming control panel, 120 volt, direct current output one independently dimmable circuit(s). Provide with main and output circuit breakers. Field coordinate location of panel in MRI equipment room.

D. In case of control system failure, supervisory circuit shall shut down power to load. Automatically detect and compensate for lamp failures to maintain consistent DC voltage level.

E. Lamps: Free from audible noise and flicker throughout entire dimming range.

F. **SW-DC;** DC Lighting Control Station, default dimming control. The lighting control station shall comply with the performance requirements of the lighting sequence of operation. The control station may consist of switches, pushbuttons, sliders, dimming functions, etc. Provide a common coverplate for lighting control stations.

1. Refer to the Lighting Sequence Of Operation (SOO) for the minimum quantity of scenes required and a description of each control scene. Refer to Network-Based lighting control station schedules on drawings for station configuration requirements.
2. Subscripts:

    a. (BLANK) = Dimming Control (Default)
    b. S = Switch Control
    c. # = Unique ID when applicable

3. Manufacturer: Manufacturers as listed below meet the qualifications as outlined within this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.
4. Low voltage station compatible with DC dimming system to provide remote ON/OFF and two preset scenes. Adjustable fade rate 0-59 seconds. Power failure memory restores lighting to scene selected prior to loss of power.

G. Electrical Contractor shall provide isolation transformers as required to comply with the shielding manufacturer's recommendations.

2.013 TIME CLOCK SWITCHES (STANDALONE)

A. **SW-TC;** Time Clock Switch, astronomical digital control, 7 day or 365/7 day schedule with holiday schedule, 2 channel, 120/277 Volt, 15 amp SPDT Contact, on/off override, indoor/outdoor enclosure, IECC / ASHRAE 90.1 battery backup compliance, UL Listed.

B. Manufacturers:

1. Paragon Timex Series
2. Tork DWZ Series
3. Intermatic ET 8000 Series

2.014 BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH (BCELTS)

A. **BCELTS;** Branch Circuit Emergency Lighting Transfer Switch (BCELTS), 120/277 volt, dry/damp listed, 32F to 113F operating temperature, plenum NEMA 1 rated, test button with visual indicator, remote test and fire alarm control, UL1008 listed, UL924 listed latest edition, Electrical Code Article 700 compliant.

1. Rating: 20 amp (16 A permitted) LED driver, ballast, incandescent.
2. Lighting Control Coordination: Provide BCELTS device compatible with designated lighting zone controls. Example: Switched, 0-10 volt dimming, DALI control, 2 wire dimming, or DMX.
3. Operation:

a. BCELTS device shall allow the same local lighting control devices to control both the normal lights and emergency designated lighting. Devices that require separate local lighting controls for the normal and designated emergency lighting are NOT allowed.
b. BCELTS device shall monitor the normal power circuit, shunt/bypass the local lighting controls, and transfer the load from the normal circuit to the emergency circuit upon loss of power, remote test switch, or fire alarm override to provide full lumen output for designated emergency lighting.
c. BCELTS device shall return designated emergency lighting to local lighting control after a 15-minute delay upon return of normal power or remote test/fire alarm override release.
d. Equivalent Facilitation and Performance: A limitation of equivalent comparable products may require some of the required functions of the BCELTS device to be provided by an alternative component of the lighting control system. The following functions may be performed by alternative components of the lighting control system when the device is listed for the required function and compatible with the lighting control system.

    1) Remote test switch / fire alarm override interface.
    2) The 15-minute time delay upon return of normal power or remote test/fire alarm override release.

e. Accessory - Remote Test Switch: Provide a remote button test switch. The test switch shall be a single gang type switch compatible with the BCELTS device and allow the remote fire alarm override to function.
f. Test Switch Mounting:

    1) Finished Spaces (ceiling height 10 feet or less): Flush mount device in finished ceiling adjacent to one of the emergency lights.
    2) Finished Spaces (ceiling height greater than 10 feet): Flush mounted in wall. Refer to Architect/Engineer for location.
    3) Unfinished Spaces: Adjacent and aligned with to local wall mounted lighting controls.
    4) Option: BCELTS device(s) with a test button, visual indicator, and flush mounting plate may be installed in the location of the remote test switch in lieu of providing a separate remote test switch.

4. Manufacturers:

    a. LVS Controls EPC-D-F-ATS Series
    b. Bodine Signify GTD20A
    c. Current Dual Lite ATSD/BCCR Series
    d. Lighting control manufacturer
    e. Approved equal

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION MEETING

A. Schedule a pre-construction meeting with the controls representative, installing contractor, Architect/Engineer, and Owner to explain the proposed lighting control system and integration with other systems as when applicable per the design documents.

3.02 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts existing conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings.

B. All wiring shall be installed in conduit. Class II low voltage control wiring may be open wiring and shall maintain 6 inch spacing from electronic ballast and other RFI/EMI sources.

C. Low Voltage Cabling (less than 100 volts): Low voltage lighting control cabling shall be plenum listed. Low voltage cables in non-accessible areas shall be installed in conduit. Low voltage lighting control cable may be installed without conduit in accessible areas using the following types of cable supports. Cable support types/systems shall comply with the warranty requirements of the low voltage cable manufacturer.

1. J-hooks; batwing type.
2. Bridle rings with saddle supports.
3. Low voltage cable batwings supported by independent luminaire support systems (luminaire support cabling); use of batwings on ceiling support systems not allowed.
4. Listed cable ties. Low voltage cabling secured to exterior of luminaire power raceway.

D. All branch load circuits shall be live tested before connecting the loads to the lighting control panel.

E. Lighting Control Station Wiring: Provide the grounded (neutral) conductor portion of the branch circuit with the line voltage phase conductors at each lighting control station.

F. Lighting Control Panel Directories: Provide a typewritten directory for each lighting control panel indicating relay/dimmer and description of load controlled.

3.04 INTEGRATION WITH OTHER SYSTEMS

A. The Room-Based lighting control system interacts, is controlled by, or controls the following other systems per the design documents and lighting sequence of operations descriptions. The contractor shall provide the necessary communication gateways, relays, cabling, and programming to interact with the following systems.

1. Building Automation System
2. Fire Alarm and Automatic Detection System
3. Security and Intrusion Detection System
4. Audio/Visual Systems
5. Shade Raise/Lower Controls

3.05 BRANCH CIRCUIT POWER WIRING FOR CONTROLLERS

A. Branch circuit power for the following lighting control system components shall be provided from the following branches. Lighting control power shall originate from the same branch circuits serving the controlled luminaires:

1. Lighting Control System (Physical Server, Central Station, or Cloud-based Access): Emergency (Electrical Code Article 700)
2. Room controllers, lighting control power supplies, devices, components, and accessories when an associated (ALCR) device is applicable to the lighting control sequence of operation: Emergency (Electrical Code Article 700)
3. Room controllers, lighting control power supplies, devices, components, and accessories when an associated (BCELTS) device is applicable to the lighting control sequence of operation: The load side of the BCELTS device normal and emergency/life safety pending the status of the BCELTS.
4. The contractor shall coordinate the branch circuit power source required with the Engineer when required for unique lighting control system devices, components, and accessories.

3.06 LOW VOLTAGE LIGHTING CONTROL CABLING

A. Control Cable Raceway Routing: All wiring shall be installed in conduit.

B. Control Cabling Installed with Line Voltage Wiring: When low voltage control cabling is installed with line-voltage wiring, the control wiring shall be, copper conductors, minimum 16 AWG or per manufacturer, with cable insulation equal to the line-voltage rating (voltage, temp rating, etc.) and comply with Specification Section 260513 "Wire and Cable."

C. Network Cabling: As required by manufacturer.

D. Splices and Taps: Tapping or wire trap connectors shall be used to splice all Class 1 and Class 2 control wiring. Twist-on, wire-nut type connectors are not allowed.

3.07 AUTOMATIC LOAD CONTROL RELAYS (ALCR20, ALCR3) AND BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH (BCELTS)

A. Field install per manufacturer requirements.

B. Remote Test Switch: Provide connection to remote test switch.

C. Fire Alarm Override: Provide connection to addressable fire alarm relay.

3.08 SUPPORT SERVICES

A. System Startup:

1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.

B. Pre-Program, Testing, Training Coordination:

1. The construction documents and sequence of operations define the original design intent of the lighting controls as coordinated between the owner and the design team. The definition of the scope is intended to identify the hardware and programming flexibility required prior to programming, system testing, and owner training.
2. The final system programming, control station labels, scene presets, dimmer presets, dimmer range limits, fade times, etc. are subject to on site coordination between the design team, owner, contractor, and manufacturer. Contractor/manufacturer programming of the system prior to an onsite coordination with the owner and design team shall not be considered final programming nor commissioning.
3. The contractor and manufacturer shall provide on site representatives to provide final programming including preset, scene, switch labeling, and other programming adjustments based on owner and design team onsite observation and verbally requested adjustments as part of the based bid scope of work.
4. The contractor shall document onsite requested changes and update operation and maintenance manuals to match final programming.

C. Testing:

1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.
2. Programming of initial zones, schedules, lighting levels, control station groups, and sensor settings shall be performed by a factory-authorized technician. Lighting Control Sequence of Operation shall serve as a basis for programming, However, all final decisions regarding groups and schedules shall be at the direction of the Owner. The following procedures shall be performed at a minimum:

    a. Confirm automatic sensor placement, sensitivity, and time delay settings to meet specified performance criteria.
    b. Confirm daylight sensor placement, sensitivity, deadband, and delay settings to meet specified performance criteria.
    c. Confirm that schedules and time controls are configured to meet specified performance criteria and Owner's operating requirements.
    d. Confirm control station labeling, presets, switch labels, and scenes.

3. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.
4. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.

    a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.
    b. Mask occupancy/vacancy sensors where necessary to prevent nuisance switching from adjacent areas.

D. Training:

1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.
2. Training duration shall be no less than three (3) days, with one (1) day being scheduled at least two (2) weeks after initial training.

E. Documentation:

1. Manufacturer shall provide system documentation including:

a. System one-line showing all panels, number and type of control stations and sensors, communication line, and network or building automation system BAS interface unit.
b. Drawings for each panel showing hardware configuration and numbering.
c. Panel wiring schedules.
d. Typical diagrams for each component.

3.09 SYSTEM COMMISSIONING

A. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 010900, General Commissioning, for further details.

B. Mask sensors where necessary to prevent nuisance switching from adjacent areas.

C. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 010900, General Commissioning, for system verification tests and commissioning requirements.

D. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 010900, General Commissioning, for Contractor training requirements.

END OF SECTION

SECTION 262000 - SERVICE ENTRANCE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Arrangement with Utility Company for permanent electric service.

B. Underground service entrance

1.02 RELATED SECTIONS AND WORK

A. Refer to the One-Line Diagram for additional information.

1.03 QUALITY ASSURANCE

A. Install service entrance in accordance with Utility Company's rules and regulations.

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 260500.

B. Submit Utility Company prepared drawings (if applicable).

1.05 SYSTEM DESCRIPTION

A. System Voltage: 480Y/277 volts, three phase, four-wire, 60 Hertz.

PART 2 - PRODUCTS

2.01 METERING EQUIPMENT

A. Meter: Furnished by the Utility Company.

B. Meter Base: Furnished by the Contractor, as approved by the Utility Company. (Manufacturers: Milbank, Superior, Duncan, or Anchor).

C. Exterior Mounted Metering Cabinets: Furnished and installed by the Contractor to Utility Company's specifications. Conduit and conductors between metering cabinets and instrumentation shall be by the Contractor. Connections as required by the Utility Company.

2.02 IDENTIFICATION

A. Provide a permanent plaque or sign denoting all services, feeders, and branch circuits supplying the building or structure and the area served by each. Install plaque or sign at each service disconnecting means.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Make arrangements with Utility Company to obtain permanent electric service to the Project.

B. Primary distribution equipment and pad-mounted transformers shall be furnished and installed by the Utility Company.

C. Primary conductors shall be furnished, installed, and terminated by the Utility Company. Primary conduit shall be furnished and installed by the Contractor, as shown on the drawings, to the Utility Company's requirements.

D. Underground: Install service entrance conduits in concrete envelope from Utility Company's pad mounted transformer to meter cabinet and building service entrance equipment. Utility Company will connect service conductors to transformer secondary lugs.

E. Overhead: Install a rigid metal weather head and service entrance conductors. Service entrance conductors shall have a 3' drip loop beyond the weather head. Overhead service shall comply with NEC 230 Part II.

F. Concrete Pad for Transformer: Furnished and installed by the Contractor to Utility Company's specifications.

END OF SECTION

SECTION 262200 - DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Dry type two winding transformers **(TR-#)**

B. Dry type buck and boost transformers **(TR-#)**

C. Dry type isolation transformers **(TR-#)**

1.02 REFERENCES

A. NEMA - ST 1 - Specialty Transformers

B. NEMA ST 20 - Dry Type Transformers for General Applications

C. ANSI/IEEE C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers

D. ANSI/IEEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers

E. Department of Energy 10 CFR Part 431 - Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.

F. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers

G. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

1.03 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 35, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions of Section 260500.

B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.

C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.01 DRY TYPE TWO WINDING TRANSFORMERS

A. Acceptable Manufacturers:

1. Square D 7400 EX##T / SK300##KB Series
2. Eaton V48M / H48M / B48M Series
3. ABB 9T Series
4. Hammond SG / SMK Series
5. Siemens 3F3 Series

B. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.

C. Insulation system and average winding temperature rise for rated KVA as follows:

Ratings	Class	Rise (degree C)
Less than 15	185	As shown on the drawings
or higher	220	As shown on the drawings

D. Case temperature shall not exceed 40C rise above ambient at its warmest point.

E. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

F. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.

G. Sound Levels: Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
Equivalent Winding kVA Range	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

I. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.

J. Coil Conductors: Continuous windings with terminations brazed or welded.

K. Enclosure: NEMA ST 20; Type 1. Provide lifting eyes or brackets.

L. Isolate core and coil from enclosure using vibration-absorbing mounts.

M. Nameplate: NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.02 DRY TYPE BUCK AND BOOST TRANSFORMERS

A. Acceptable Manufacturers:

1. Square D
2. Eaton
3. ABB
4. Hammond
5. Siemens
6. ACME

B. Dry Type Buck and Boost Transformers: ANSI/NEMA ST 1; factory-assembled, dry type two winding buck and boost transformers; ratings as shown on the drawings.

KVA Rating	Insulation Class	Temperature Rise (degree C)
0.25-2	185	80
3-7.5	220	115

C. Insulation system and average winding temperature rise for rated KVA as follows:

KVA Rating	Insulation Class	Temperature Rise (degree C)
0.25-2	185	80
3-7.5	220	115

D. Mounting: Wall or as shown on drawings.

E. Coil Conductors: Continuous windings.

F. Enclosure: ANSI/NEMA ST 1; Type 1.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data.

2.03 ISOLATION TRANSFORMERS

A. Acceptable Manufacturers:

1. Square D
2. Eaton
3. ABB
4. Hammond
5. Siemens
6. ACME

B. Isolation transformers: ANSI/NEMA ST1; factory-assembled, dry type two winding; ratings as shown on drawings.

C. Mounting: Wall or as shown on drawings.

D. Coil Conductors: Continuous windings.

E. Enclosure: ANSI/NEMA ST 1; Type 1.

F. Isolate core and coil from enclosure using vibration-absorbing mounts.

G. Nameplate: Include transformer connection data.

KVA Rating	Insulation Class	Temperature Rise (degree C)
1-9	185	115
10-500	220	130

	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
Equivalent Winding kVA Range	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

2.04 ACCESSORIES

A. Provide REQUIRED accessories as described below. Provide SCHEDULED accessories when listed with plan schedules. Refer to plan schedules for additional requirements.

B. Electronic Isolation Shield:

1. Provide electrostatic winding shield with separate insulated grounding connection as shown on the drawings. REQUIRED

C. Barriers: Provide finger safe barriers for lineside uninsulated and ungrounded terminations and components which remain energized when the main disconnecting device is 'open'. REQUIRED

D. Barriers (Service Equipment): Provide solid barriers for lineside uninsulated and ungrounded terminations and components which remain energized when the main disconnecting device is 'open'. REQUIRED

E. Transformer Disconnect Lockable Hasp: Provide circuit breakers, fused switches, and disconnects serving transformers with a lockable padlock hasp capable of being locked in the open/closed position. REQUIRED

PART 3 - EXECUTION

3.01 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount transformers on four 3”x3”x1/2” thick, 50 durometer rubber vibration isolating pads suitable for isolating the transformer noise from the building structure.

D. Ventilated transformers: Provide factory label on horizontal surface to prohibit storage on top, front, or adjacent to transformer.

E. Install primary, secondary, and grounding electrode conductors using factory or field fabricated enclosure entries. Conductors shall not be routed through ventilated openings.

3.02 FIELD QUALITY CONTROL

A. Check for damage and tight connections prior to energizing transformer.

B. Measure primary and secondary voltages and make appropriate tap adjustments. Adjustments shall be made at completion of project and at approximately 6 months following project acceptance when requested by the Owner.

END OF SECTION

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Main and distribution switchboards:

1.02 RELATED SECTIONS AND WORK

A. Refer to the Electrical Distribution Diagram and Electrical Schedules for size, rating, and configuration.

B. Section 260913 - Energy Metering and Management System

C.

1.03 REFERENCES

A. ANSI C12 - Code for Electricity Metering

B. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments

C. ANSI C57.13 - Requirements for Instrument Transformers

D. NEMA AB 1 - Molded Case Circuit Breakers

E. NEMA KS 1 - Enclosed Switches

F. NEMA PB 2 - Dead Front Distribution Switchboards

G. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or less

1.04 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

C. Selective Coordination Study: Submit study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.

D. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.

E. Submit manufacturer's instructions under provisions of Section 260500.

1.05 SPARE PARTS

A. Keys: Furnish four each to the Owner.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Section 260500.

B. Deliver in 48-inch maximum width shipping splits, unless approved otherwise by both the Contractor and Architect/Engineer, individually wrapped for protection, and mounted on shipping skids.

C. Store and protect products under provisions of Section 260500.

D. 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.

E. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 260500.

B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

PART 2 - PRODUCTS

2.01 GENERAL

A. Approved Manufacturers:

1. Square D Class 2700 QED-2, I-Line, Powerstyle
2. ABB ReliaGear SB
3. Siemens
4. Eaton

2.02 RATINGS

A. Definitions:

1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. Refer to Section 260553 for additional requirements.
2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

B. The switchboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.03 SWITCHBOARD CONSTRUCTION AND RATINGS

A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB2, and complete from incoming line terminals to load-side terminations.

B. Switchboard electrical ratings and configurations as shown on the drawings.

C. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials used.

D. Main Section Devices: Individually mounted and compartmented.

E. Distribution Section Devices: Individually mounted.

F. Auxiliary Section Devices: Individually mounted and compartmented.

G. Bus Material: Aluminum with tin plating, sized in accordance with NEMA PB 2.

H. Bus Connections: Bolted, accessible from front only for maintenance. Plug-on connections may be utilized with Architect/Engineer's pre-approval by addenda.

I. Bus bars shall be fully isolated, braced for minimum ampere rms symmetrical rating as indicated on drawings.

J. The bus shall extend the full height of the distribution sections to provide space for future breakers.

K. Provide a 1 X 1/4-inch copper ground bus through the length of the switchboard.

L. Provide metering transformer compartment for Utility Company's use. Compartment size, bus spacing and drilling, door, and locking and sealing requirements shall be in accordance to Section 262000 and Utility Company specifications.

M. Enclosure shall be NEMA PB 2; Type 1 - General-Purpose. Sections shall align at front and rear. Provide removable panel access or hinged door with flush lock and all keyed alike. Door hardware shall provide swing clear operation (180-degree swing).

N. Switchboard Height: NEMA PB 2; 92 inches, excluding floor sills, lifting members and pull boxes.

O. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

P. Pull Box: Same construction as switchboard, size as shown on the drawings. Top and sides shall be removable. Insulating, fire-resistive bottom with separate openings for each circuit to pass into switchboard.

Q. Pull Section: Same construction as switchboard, size as shown on the drawings. Depth and height to match switchboard. Arrange as shown on the drawings.

R. Future Provisions: In addition to the spare devices shown, provide a minimum of 15 inches of fully equipped space for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on the drawings.

S. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

2.04 SWITCHING, OVER-CURRENT PROTECTIVE DEVICES, AND ARC ENERGY REDUCTION

A. Fusible Switch Assemblies (600 Amperes and Smaller): Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class 'R' fuses, type as specified, with Class 'R' rejection clips.

B. Fusible Switch Assemblies (800 Amperes and Larger): Bolted pressure contact switches. Fuse Clips: Designed to accommodate Class L fuses.

C. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole.

D. Solid State Molded Case Circuit Breakers: (All breakers identified on plans as solid-state with 2500 ampere frame sizes and below.) Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with restricted access and a sealable clear cover. Provide stationary mounting. Provide breaker interrupting ratings as indicated on the plans.

E. Solid-State Insulated Case Circuit Breakers: (All breakers identified on plans as solid state with frame sizes above 2500 ampere.) Provide insulated case switch with two-step stored energy closing. Provide manual charging handle, and electric charging motor where indicated as electrically operated. Provide with rating plug as required on drawings and electronic circuits for true rms current sensing, timing, and tripping for fully adjustable time current characteristics including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip settings shall be field programmable with restricted access and a sealable clear cover. Ground fault sensing shall be summation type integral to breaker. Provide stationary mounting. Provide breaker interrupted ratings as indicated on the plans.

F. Arc Energy Reduction:

1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1200 amps or larger.
2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch in the first section of the electrical equipment.

3. The following selective coordination and arc energy reduction system options are acceptable:

    a. Zone-selective interlocking with permanent arc energy reduction
    b. Differential relaying with permanent arc energy reduction
    c. Listed energy-reducing active arch flash mitigating system

2.05 INSTRUMENTS AND SENSORS

A. Current Transformers: ANSI C57.13; 5 ampere secondary, bar or window type, with single secondary winding, unless otherwise required for application, and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13; 120-volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

C. Ground Fault Sensor: Zero sequence type.

D. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

E. Double-ended Equipment Ground Fault Protection: Provide a modified differential ground fault protection scheme.

F. Energy Metering and Management System: Refer to Section 260913.

1. Provide integral Digital Power Meters DPM with harmonic analysis and Digital Energy Meters DEM when scheduled and shown on the plans.
2. Provide individual Circuit Breaker Metering CBM when scheduled and shown on the plans.

    a. The scheduled circuit breaker shall be provided with integral metering. Provide a separately integrated meter when the scheduled circuit breaker is not integral meter functional.

2.06 CAPTURED KEY INTERLOCK SWITCH

A. KIRK; Captured Key Interlock Switch: Keyed switch, captured key style for interlock operation, corrosion resistant construction, flip style protective cover. Refer to plans for lock quantities, keyed-alike relationships, and additional information.

B. Key: Custom heavy duty, non-snap under hand force, corrosion resistant, with key-ring / lanyard hole. Keys shall not be reproducible to prevent copying.

C. Approved Manufacturers:

1. Kirk Key (HD Key Series)
2. Allen Bradley Bolt Interlock Series
3. Haake HST Series

D. Main-Tie-Main Configuration: Provide a trapped key mechanical interlocking scheme to prevent the tie breaker from being closed while the two main breakers are closed. The opening of one of the main breakers will lock out the breaker in an open position, then allow the transfer of the key to the tie breaker and allow the closing of the tie breaker.

2.07 ACCESSORIES

A. Provide REQUIRED accessories as described below. Provide SCHEDULED accessories when listed with plan schedules. Refer to plan schedules for additional requirements.

B. Barriers: Provide finger safe barriers for lineside uninsulated and ungrounded terminations and components which remain energized when the main disconnecting device is 'OPEN'. REQUIRED

C. Barriers (Service Equipment): Provide solid barriers for lineside uninsulated and ungrounded terminations and components which remain energized when the main disconnecting device is 'OPEN'. REQUIRED

D. Transformer Disconnect Lockable Hasp: Provide circuit breakers, fused switches, and disconnects serving transformers with a lockable padlock hasp capable of being locked in the open/closed position. REQUIRED

E. Custom Voltage Indicator:

1. Custom flashing LED voltage indicator permanently mounted in exterior equipment face when scheduled. Provide with visual indication for phase loss, release of store energy, and ground fault indications. The indicator shall be installed complete, fully potted, hardwired to the line side of the main disconnect as scheduled (refer to equipment schedule), and installed per manufacturer requirements. Match #-phase, #-wire of equipment. 600Volts AC, 1000Volts DC, 50/60/400Hz, -20C to +55C operational ambient temp, UL recognized, listing shall meet or exceed equipment environmental enclosure rating. SCHEDULED
2. Labeling:
    a. Provide standard factory label and warning for equipment exterior.
    b. Provide the appropriate custom label per the equipment schedule.
        1) Scheduled (LINE SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LINE SIDE OF MAIN DISCONNECT.
        2) Scheduled (LOAD SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LOAD SIDE OF MAIN DISCONNECT.
3. Manufacturers:
    a. Grace Technologies R-3W/R-3W2 Series
    b. iGard AVT Series

F. Custom Voltage Test Station:

1. Voltage test station permanently mounted in exterior equipment face when scheduled. Voltage test station provides remote testing with a volt meter for the presence or absence of voltage. The maximum available current at the test port shall be 5mA.Test station shall be installed complete, fully potted, hardwired to the line side or load site of the main disconnect, and installed per manufacturer requirements. 600 Volt AC, 600 VDC, 50/60/400Hz, -20C to +55C operational ambient temp, UL recognized, NEMA 4X / IP 65, polycarbonate cover. SCHEDULED
2. Labeling:
    a. Provide standard factory label and warning for equipment exterior.
    b. Provide the appropriate custom label per the equipment schedule.

1) Scheduled (LINE SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LINE SIDE OF MAIN DISCONNECT.
2) Scheduled (LOAD SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LOAD SIDE OF MAIN DISCONNECT.

3. Manufacturers:

a. Grace Technologies R-3MT-KIT-H/R-3MT-KIT-F
b. iGard VTi Series

G. Custom Voltage Indicator and Test Station:

1. Combination Voltage Indicator and Test Station. The indicator and test station shall be installed complete, fully potted, hardwired to the line side or load side of the main disconnect, and installed per manufacturer requirements. 600 Volt AC, 600Volt DC, 50/60/400Hz, -20C to +55C operational ambient temp, UL recognized, NEMA 4X / IP 65, polycarbonate cover. SCHEDULED
2. Voltage Indicator. Custom flashing LED voltage indicator permanently mounted in exterior equipment face when scheduled. Provide with visual indication for phase loss, release of store energy, and ground fault indications. The indicator shall be installed complete, fully potted, hardwired to the load side of the main disconnect, and installed per manufacturer requirements.
3. Test Station. Voltage test station, CAT III & IV rated for low voltage systems up to 600 Volts AC and 600 Volts DC systems of 50/60/400Hz.
4. Labeling:

a. Provide standard factory label and warning for equipment exterior.
b. Provide the appropriate custom label per the equipment schedule.

1) Scheduled (LINE SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LINE SIDE OF MAIN DISCONNECT.
2) Scheduled (LOAD SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LOAD SIDE OF MAIN DISCONNECT.

5. Manufacturers:

a. Grace Technologies P-S11S21-M3RX/ P-S11S21-M3RX-V Series
b. iGard i-AVT Plus Series

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install switchboard in locations shown on the drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Install fuses in each switch.

3.02 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each. Test voltage shall be 1000 volts, and minimum acceptable value for insulation resistance is 2 megohms.

C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.

D. Physically test key interlock systems to ensure proper function.

3.03 ADJUSTING AND CLEANING

A. Adjust all operating mechanisms for free mechanical movement.

B. Touch up scratched or marred surfaces to match original finish.

C. Provide time/current trip curves for all adjustable protection devices that require setting. Also provide curves and equipment information for associated new and existing fixed devices that require coordination with new protection devices. Submit time/current curves in hard copy or electronic format.

D. Adjust trip and time delay settings to values as scheduled, or as instructed by the Architect/Engineer.

E. Where two levels of ground fault are provided, test ground fault circuit breakers to prove selective coordination in accordance with manufacturer's directions. Provide testing documentation with Operating & Maintenance Manual submittals.

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Service and distribution panelboards: **DP-#**, **DP-#**

B. Lighting and appliance branch circuit panelboards: **Panel '###'**

C. Fusible branch circuit panelboards: **Panel '###'**

D. Load centers: **Panel '###'**

1.02 RELATED SECTIONS AND WORK

A. Refer to the Electrical Distribution Diagram and Electrical Schedules for size, rating, and configuration.

B. Section 260913 - Energy Metering and Management System

C.

1.03 REFERENCES

A. NEMA AB 1 - Molded Case Circuit Breakers

B. NEMA FU 1 - Low voltage cartridge fuses

C. NEMA KS 1 - Enclosed Switches

D. NEMA PB 1 - Panelboards

E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less

F. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment

G. UL 248 - Low-Voltage Fuses

H. UL 67 - Panelboards

1.04 SUBMITTALS

A. Submit shop drawings for equipment and component devices under provisions of Section 260500.

B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Selective Coordination Study: Submit study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.

D. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.

E. Refurbished branch panel enclosure documentation for new branch panelboards installed in existing enclosures.

F. Submit manufacturer's instructions under provisions of Section 260500.

1.05 SPARE PARTS

A. Keys: Furnish four (4) each to the Owner.

B. Fuses: Furnish 10% or a minimum of three (3) spare fuses of each type and rating installed to the Owner.

C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

PART 2 - PRODUCTS

2.01 RATINGS

A. Definitions:

1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 260553 for additional requirements.
2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.02 MAIN AND DISTRIBUTION PANELBOARDS

A. General

1. Manufacturers:

a. Square D QMB, I-Line
b. ABB ReliaGear neXT
c. Siemens F2, P4
d. Eaton PRL4, PRL5

B. Panelboards: NEMA PB 1; type as shown on the drawings.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with concealed trim clamps and hinged trim on door to allow access to wiring gutters without removal of trim and flush lock. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.

G. Minimum Integrated Short Circuit Rating: 100,000 amperes rms symmetrical for 240-volt panelboards; 50,000 amperes rms symmetrical for 480-volt panelboards, or as shown on the drawings.

H. Fusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

I. Fuse Clips (Switches 600 Amperes and Smaller): Provide with Class 'R' rejection clips. Fuse Clips (601 Amperes and Larger): Designed to accommodate Class 'L' fuses.

J. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

K. Molded Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.

L. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

M. Solid State Molded Case Circuit Breakers: (All breakers identified on plans as solid-state with 1200 ampere frame sizes and below.) Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with restricted access and a sealable clear cover.

N. Arc Energy Reduction:

1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1200 amps.
2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch in the first section of the electrical equipment.

O. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

2.03 BRANCH CIRCUIT PANELBOARDS

A. General

1. Manufacturers:

a. Square D NQ, NF
b. ABB ReliaGear Series

c. Siemens P1
d. Eaton PRL1, PRL2

B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.

G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.

H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.

J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

K. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

L. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

2.04 COLUMN WIDTH PANELBOARDS

A. General

1. Manufacturers:

a. Square D NQ, NF
b. ABB A Series
c. Siemens P1
d. Eaton PRL1-LX, PRL2-LX

B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.

G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.

H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

I. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

2.05 FUSIBLE BRANCH CIRCUIT PANELBOARDS

A. General

1. Manufacturers:

a. Bussmann
b. Littelfuse
c. Siemens SQSCP
d. Mersen MFCP

B. Provide cabinet front with concealed hinge and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

C. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

D. Overcurrent protective devices shall be UL listed, with voltage, amperage, number of poles, and short-circuit current rating as shown on the panelboard schedule. Multi-pole branch circuit switches shall use a common yoke to connect/disconnect all poles of the multi-pole branch circuit.

E. Fuse holder shall be finger-safe with trim installed. Fuses shall only be removable when terminals are not energized.

F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future fuse units.

G. All multiple-section panelboards shall have the same dimensional backbox and cabinet front size.

H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

I. Branch fuse disconnect shall have visible ON/OFF indication, blown fuse indicating lights, and permanently installed lockout means.

2.06 LOAD CENTERS

A. General

1. Manufacturers:

    a. Square D
    b. ABB
    c. Siemens
    d. Eaton

B. Load Centers: Circuit breaker load center.

C. Enclosure: General-Purpose.

D. Provide pull ring and latch on door. Finish in manufacturer's standard gray enamel.

E. Provide load centers with bus ratings as shown on the drawings.

F. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical.

G. Molded Case Circuit Breakers: Provide plug-on circuit breakers with integral thermal and instantaneous magnetic trip in each pole, with common trip handle for all poles. Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings.

H. Do not use tandem circuit breakers.

I. Energy Metering and Management System: Refer to Section 260913.

1. Provide integral Digital Power Meters DPM with harmonic analysis and Digital Energy Meters DEM when scheduled and shown on the plans.
2. Provide individual Circuit Breaker metering CBM when scheduled and shown on the plans.

    a. The scheduled circuit breaker shall be provided with integral metering. Provide a separately integrated meter when the scheduled circuit breaker is not integral meter functional.

2.07 ACCESSORIES

A. Provide REQUIRED accessories as described below. Provide SCHEDULED accessories when listed with plan schedules. Refer to plan schedules for additional requirements.

B. Barriers: Provide finger safe barriers for lineside uninsulated and ungrounded terminations and components which remain energized when the main disconnecting device is 'open'. REQUIRED

C. Barriers (Service Equipment): Provide solid barriers for lineside uninsulated and ungrounded terminations and components which remain energized when the main disconnecting device is 'open'. REQUIRED

D. Transformer Disconnect Lockable Hasp: Provide circuit breakers, fused switches, and disconnects serving transformers with a lockable padlock hasp capable of being locked in the open/closed position. REQUIRED

E. Custom Voltage Indicator:

1. Custom flashing LED voltage indicator permanently mounted in exterior equipment face when scheduled. Provide with visual indication for phase loss, release of store energy, and ground fault indications. The indicator shall be installed complete, fully potted, hardwired to the line side or load side of the main disconnect as scheduled (refer to equipment schedule), and installed per manufacturer requirements. Match #-phase, #-wire of equipment. 600Volts AC, 1000Volts DC, 50/60/400Hz, -20C to 55C operational ambient temp, UL recognized, listing shall meet or exceed equipment environmental enclosure rating. SCHEDULED
2. Labeling:

    a. Provide standard factory label and warning for equipment exterior.
    b. Provide the appropriate custom label per the equipment schedule.

        1) Scheduled (LINE SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LINE SIDE OF MAIN DISCONNECT.
        2) Scheduled (LOAD SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LOAD SIDE OF MAIN DISCONNECT.

3. Manufacturers:

    a. Grace Technologies R-3W/R-3W2 Series
    b. iGard AVT Series

F. Custom Voltage Test Station:

1. Voltage test station permanently mounted in exterior equipment face when scheduled. Voltage test station provides remote testing with a volt-meter for the presence or absence of voltage. The maximum available current at the test port shall be 5mA.Test station shall be installed complete, fully potted, hardwired to the line side or load site of the main disconnect, and installed per manufacturer requirements. 600 Volt AC, 600 VDC, 50/60/400Hz, -20C to +55C operational ambient temp, UL recognized, NEMA 4X / IP 65, polycarbonate cover. SCHEDULED
2. Labeling:

    a. Provide standard factory label and warning for equipment exterior.
    b. Provide the appropriate custom label per the equipment schedule.

        1) Scheduled (LINE SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LINE SIDE OF MAIN DISCONNECT.
        2) Scheduled (LOAD SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LOAD SIDE OF MAIN DISCONNECT.

3. Manufacturers:

    a. Grace Technologies R-3MT-KIT-H/R-3MT-KIT-F
    b. iGard VTi Series

G. Custom Voltage Indicator and Test Station:

1. Combination Voltage Indicator and Test Station. The indicator and test station shall be installed complete, fully potted, hardwired to the line sideorload side of the main disconnect, and installed per manufacturer requirements. 600 Volt AC, 600Volt DC, 50/60/400Hz, -20C to +55C operational ambient temp, UL recognized, NEMA 4X / IP 65, polycarbonate cover. SCHEDULED

2. Voltage Indicator. Custom flashing LED voltage indicator permanently mounted in exterior equipment face when scheduled. Provide with visual indication for phase loss, release of store energy, and ground fault indications. The indicator shall be installed complete, fully potted, hardwired to the load side of the main disconnect, and installed per manufacturer requirements.
3. Test Station. Voltage test station, CAT III & IV rated for low voltage systems up to 600 Volts AC and 600 Volts DC systems of 50/60/400Hz.
4. Labeling:

    a. Provide standard factory label and warning for equipment exterior.
    b. Provide the appropriate custom label per the equipment schedule.

        1) Scheduled (LINE SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LINE SIDE OF MAIN DISCONNECT.
        2) Scheduled (LOAD SIDE). DANGER. VOLTAGE INDICATOR INSTALLED ON LOAD SIDE OF MAIN DISCONNECT.

5. Manufacturers:

    a. Grace Technologies P-S11S21-M3RX/ P-S11S21-M3RX-V Series
    b. iGard i-AVT Plus Series

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.

B. Height: 6 feet to handle of highest device.

C. Provide filler plates for unused spaces in panelboards.

D. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

E. Stub five (5) empty one-inch conduits to accessible location above ceiling out of each recessed panelboard and panelboards installed in electrical closets less than 36" deep.

F. Install fuses in fusible switch assemblies.

3.02 REFURBISHED ENCLOSURES - NEW PANELBOARDS

A. Existing panelboard enclosures may be reused to house new panelboards pending documented verification of the following provided with the applicable new equipment submittals.

1. New branch panelboard is listed for the existing enclosure or application.
2. Existing enclosure and new equipment is field evaluated by the manufacturer or nationally recognized testing laboratory for the available fault current, condition, and application.
3. Authority Having Jurisdiction AHJ approval.

3.03 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

END OF SECTION

SECTION 262716 - CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hinged cover enclosures

B. Cabinets

C. Terminal blocks and accessories

1.02 REFERENCES

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

B. ANSI/NEMA ICS 1 - Industrial Control and Systems

C. ANSI/NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems

D. ANSI/NEMA ICS 6 - Enclosures for Industrial Control Equipment and Systems

1.03 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Shop Drawings for Equipment Panels: Include wiring schematic diagram, wiring diagram, outline drawing and construction diagram as described in ANSI/NEMA ICS 1.

C. Include cabinets and enclosures in composite electronic coordination files. Refer to Section 260500 for coordination drawing requirements.

PART 2 - PRODUCTS

2.01 HINGED COVER ENCLOSURES

A. Construction: NEMA 250; Type 1 3R 4, 14 gauge steel.

B. Finish: Manufacturer's standard polyester powder paint finish.

C. Covers: Continuous hinge with stainless steel hinge pin. Covers longer than 24 inches shall have 3-point latching.

D. Locks: Flush 1/4 turn cylinder key latch.

E. Provide interior white painted metal panel for mounting terminal blocks and electrical components.

2.02 CABINETS

A. Cabinet Boxes: Galvanized steel with removable endwalls.

B. Cabinet Fronts: Steel, flush type with concealed trim clamps, concealed hinge and flush lock keyed to match branch circuit panelboard; finish in gray baked enamel.

2.03 TERMINAL BLOCKS AND ACCESSORIES

A. Terminal Blocks: ANSI/NEMA ICS 4; UL listed.

B. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw connectors, rated 300 volts.

2.04 FABRICATION

A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.

B. Provide conduit hubs on enclosures.

C. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum.

B. Provide accessory feet for free-standing equipment enclosures.

C. Install trim plumb.

END OF SECTION

SECTION 262723 - INDOOR SERVICE POLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Indoor service poles

1.02 REFERENCES

A. NEMA WD 1 - General Requirements for Wiring Devices

1.03 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Indicate materials, finishes, receptacle and connector configuration, and attachment details.

C. Submit manufacturer's installation instructions under provisions of Section 260500.

1.04 EXTRA MATERIAL

A. Provide 5 each replacement receptacle and telephone connector devices under provisions of Section 260500.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 260500.

B. Include adjustment information and recommended care for finishes.

PART 2 - PRODUCTS

2.01 INDOOR SERVICE POLES

A. Indoor Service Pole: Free standing surface metal raceway section with fittings, with integral pre-wired convenience receptacles and separate raceway for tele/data cable. Verify length with ceiling height to extend above accessible ceilings.

B. Material: Steel main body and coverplates.

C. Finish: As selected by the Architect.

D. Convenience Receptacles: NEMA WD 1; Type 5-20R configuration, two per pole. Pre-wired receptacle with No. 12 AWG copper conductor to outlet box attached to pole top, above ceiling. Leave 6-inch leads.

E. Tele/Data Wiring Raceway: Adequate for six (6) Cat 6 data cables. Include full size opening at top of pole. Provide knockouts at 18 inches above floor for mounting two (2) decorative style covers.

F. Top Clamp: Concealed above ceiling, minimum 6" above finished ceiling suitable for securing pole to inverted "T" grid suspension member. Include trim plate to enclose openings cut in ceiling panel.

G. Foot: Suitable for positive anchoring to carpet floor, unless otherwise indicated on the drawings.

H. Manufacturers:

1. Wiremold 25DTP series
2. Hubbell HBLPP1 series
3. Thomas & Betts PP1 series

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that installation of ceiling suspension system and other work above finished ceiling are completed.

3.02 INSTALLATION

A. Neatly cut openings in ceiling panels.

B. Attach foot and top clamp in accordance with manufacturer's instructions.

C. Install trim plate to enclose ceiling panel opening.

D. Install poles plumb.

E. Adjust installation of service pole to suit final partition and furniture locations.

F. Provide nameplate identification per Section 260553.

G. Test receptacles for proper polarity, ground continuity, and compliance with requirements. Refer to Section 262726 for additional information.

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Device plates and box covers

B. Modular connectors

C. Receptacles (REC-#)

D. Countertop and furniture receptacle assemblies (REC-#)

E. Floor boxes and floor box with service fitting (FB-#)

F. Pedestal style box (REC-PED-##)

G. Poke-through fittings (PT-#)

H. Pendant cord/connector devices

I. Cord and plug sets

J. Cord reel (CR-#)

1.02 RELATED SECTIONS

A. Section 260538 - Underfloor Ducts.

B. Section 260933 - Lighting Control Systems.

1.03 QUALITY ASSURANCE

A. Provide similar devices from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Electrical Code, by a testing agency to Authorities Having Jurisdiction and marked for intended use.

C. Comply with the Electrical Code.

1.04 REFERENCES

A. DSCC W-C-896F - General Specification for Electrical Power Connector

B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet

C. NEMA WD 1 - General Color Requirements for Wiring Devices

D. NEMA WD 6 - Wiring Devices - Dimensional Requirements

E. NFPA 70 - National Electrical Code (NEC)

F. UL 498 - Standard for Attachment Plugs and Receptacles

G. UL 943 - Standard for Ground Fault Circuit Interrupters

H. UL 1691 - Standard for Single Pole Locking-Type Separable Connectors

1.05 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

C. Provide a non-returnable sample of each countertop and furniture-mounted receptacle assembly as part of the submittal process.

1.06 EXTRA STOCK

A. Base Stock: Provide one complete set of color-coded single pole locking-type separable cables with factory connectors for feeder application. Provide adequate parallel cables for each respective phase, neutral, and equipment ground.

B.

1.07 COORDINATION

A. Receptacles for Owner Furnished Equipment: Match plug configurations.

B. Cord and Plug Sets: Match equipment requirements.

C. Coordinate installation of receptacle assemblies in countertops and furniture with the Contractor providing the countertop or furniture. Contractor shall coordinate penetrations and conduit routing in countertops and furniture with drawings and other obstacles below the installation surface.

PART 2 - PRODUCTS

2.01 DEVICE COLOR

A. All switch, receptacle, and outlet colors shall be verified with Architect, unless indicated otherwise.

2.02 COVERPLATES

A. All switches, receptacles, and outlets shall be complete with the following:

1. Unbreakable thermoplastic/thermoset plastic and match device color coverplates in finished spaces where walls are finished.
2. Decorator Grade - Public: Decorator thermoset plastic and match device color wallplates in public finished spaces where walls are finished.

a. Manufacturer:

1) Leviton Decora

2) Hubbell Decorator
3) Cooper Decorator
4) or approved equal

3. Decorator Grade - Screwless: Decorator snap-on nylon or polycarbonate wallplates with sub-base in public finished spaces; match device color.

a. Manufacturer:

1) Leviton 803##
2) Hubbell RCW
3) Cooper PJS
4) Pass & Seymour SWP
5) or approved equal

4. #302 stainless steel coverplates in unfinished spaces for flush boxes.
5. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 260553.

D. Plate securing screws shall be metal with head color matching the wall plate finish.

E. Hospital Grade: Coverplate touch surfaces shall have an antimicrobial additive that suppresses the growth of harmful bacteria, mold, mildew, and fungi. Cover plate color shall match the device color.

1. Manufacturers:

a. Cooper CuVerro
b. Leviton 84 series

F. Where indicated on drawings, provide compatible wire guards for devices to protect against damage and vandalism. Wire guards shall be constructed of durable coated steel wire.

2.03 MODULAR CONNECTORS

A. Devices listed below are traditional wired devices. Contractor option to provide equivalent modular connector-type devices (Hubbell Snap Connect, Pass & Seymour Plug Tail, Leviton Lev-Lock, Copper ArrowLink) where applicable.

B. Wiring devices with modular wiring type quick connectors shall comply with the following in addition to the above:

1. Wired with #12 THHN Cu, stranded or solid, 3 or 4 wire as required for device, minimum 6" lead length.
2. Connector contacts shall be crimped or welded.

2.04 RECEPTACLES

A. Refer to Electrical Symbols List for device type.

B. Devices that are shaded on the drawings shall be red.

C. Devices that are shaded on the drawings shall be red and shall have an illuminated face or indicator light to indicate that there is power to the device.

D. REC-DUP: NEMA 5-20R Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap.

a. Manufacturers:

1) Hubbell 5352A
2) Leviton, 5362-S
3) Pass & Seymour 5362
4) Cooper 5352

2. Decorator Grade: Provide decorative style duplex receptacles in public spaces where walls are finished.

a. Manufacturers:

1) Hubbell DR20
2) Leviton 16362
3) Pass & Seymour 26342
4) Cooper 6352

3. Spec Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and brass back strap.

a. Manufacturers:

1) Hubbell 5352
2) Leviton 5362-S
3) Pass & Seymour 5362
4) Cooper 5362

4. Heavy Duty: 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap with integral ground contacts.

a. Manufacturers:

1) Hubbell 5362
2) Leviton 5362
3) Pass & Seymour 5362A
4) Cooper AH5362

5. Hospital Grade: 125-volt, 20 amp, 3-wire grounding type hospital grade with impact resistant thermoplastic face and one-piece nickel-plated brass back strap with integral ground contacts.

a. Manufacturers:

1) Hubbell HBL8300
2) Leviton 8300

3) Pass & Seymour 8300
4) Cooper AH8300

E. REC-DUP-GFI: NEMA 5-20R Ground Fault Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, listed.

a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
b. Manufacturers:

1) Hubbell GF20L
2) Leviton GFNT2
3) Pass & Seymour 2097
4) Cooper SGF20

2. Hospital Grade: 125-volt, 20 amp, 3-wire grounding type hospital grade with test and reset buttons in impact resistant thermoplastic face, listed.

a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
b. Manufacturers:

1) Hubbell GFRST83
2) Leviton GFNT2-HG
3) Pass & Seymour 2097HG
4) Cooper SGFH20

F. REC-DUP-GFI-R: Remote Ground Fault Device:

1. Ground fault device for remote downstream receptacles. 125-volt, 20 amp. Test and reset buttons in impact resistance thermoplastic face, listed.

a. Manufacturers:

1) Hubbell GFBF20
2) Leviton 6895
3) Pass & Seymour 2085
4) Cooper VGFD20

G. REC-DUP-W: NEMA 5-20R Weatherproof While-In-Use Ground Fault Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, weather resistant WR listed. Provide extra-duty NEMA 3R rated while-in-use clear outlet box hood.
2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.

a. Manufacturers:

1) Hubbell:

a) GFRTW20 with clear housing RW57300

2) Leviton GFWT2 with clear housing 5977-CL
3) Pass & Seymour 2097TRWR with clear housing WIUC10-C

4) Cooper WRSGF20 with clear housing WIU-1

H. REC-DUP-WP: NEMA 5-20R Weatherproof While-NOT-In-Use Ground Fault Duplex Receptacle with gasketed NEMA 4X cover:

1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, weather resistant WR listed. Provide extra-duty NEMA 4X rated while-not-in-use metallic outlet box hood.
2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.

a. Manufacturers:

1) Hubbell:

a) GFRTW20 with gasketed NEMA 4X while-NOT-in-use metallic cover.

2) Leviton GFWT2 with gasketed NEMA 4X while-NOT-in-use metallic cover.
3) Pass & Seymour with gasketed NEMA 4X while-NOT-in-use metallic cover.
4) Cooper WRSGF20 with gasketed NEMA 4X while-NOT-in-use metallic cover.

I. REC-DUP-O: NEMA 5-20R 2121 Occupancy Controlled Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and brass back strap. Top half of duplex shall be split circuit wired and controlled by remote relay. Occupancy controlled receptacle shall have permanent NEMA approved and Electrical Code compliant marking on face of device.

a. Manufacturers:

1) Hubbell BR20C1
2) Leviton 5362-1P
3) Pass & Seymour 5362SCCH*
4) Eaton 5362CH

2. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and brass back strap. Top and bottom of duplex controlled by remote relay. Controlled receptacle shall have permanent NEMA approved and Electrical Code compliant marking on face of device.

a. Manufacturers:

1) Hubbell BR20C2
2) Leviton 5362-2P
3) Pass & Seymour 5362CD*
4) Eaton 5362CD

J. REC-DUP-XP: NEMA 5-20R Explosion Proof Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type, Class 1, Division 1 rated. Spring-loaded cover with gasket. Mount in cast box with threaded openings.

a. Manufacturers:

1) Appleton EFSC175
2) Crouse-Hinds ENRC21201

3) Killark UGR5-20231

K. REC-DUP-IL: NEMA 5-20R Illuminated Face Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type hospital grade with impact resistant thermoplastic face and one-piece nickel-plated brass back strap with integral ground contacts.
2. Device shall be red.
3. Devices shall have an illuminated face or indicator light to indicate that there is power to the device.

a. Manufacturers:

1) Hubbell HBL8300ILR
2) Leviton 8300-HLR
3) Pass & Seymour 8300IL
4) Eaton AH8300LT

L. REC-ISO: NEMA 5-20R Isolated Ground Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with orange impact resistant thermoplastic face. Orange coverplate with 'Isolated Ground' stenciled in black.

a. Manufacturers:

1) Hubbell IG20
2) Leviton 5362-IG
3) Pass & Seymour IG5362
4) Cooper IG5362

2. Hospital Grade: 125-volt, 20 amp, 3-wire grounding type hospital grade with orange impact resistant thermoplastic face.[Orange][Stainless] coverplate with 'Isolated Ground' stenciled in black.

a. Manufacturers:

1) Hubbell IG-8300
2) Leviton 8300-IG
3) Pass & Seymour IG8300
4) Cooper IG8300

M. REC-ISO-SUR: NEMA 5-20R Isolated Ground and Surge Suppression Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with orange impact resistance thermoplastic face, light, and alarm. Orange coverplate with 'Isolated Ground' stenciled in black.

a. Manufacturers:

1) Hubbell IG5362OSA
2) Leviton 5380-IG
3) Pass & Seymour IG5362-OSP
4) Cooper IG5362RNS

2. Hospital Grade: 125-volt, 20 amp, 3-wire grounding type hospital grade with orange impact resistance thermoplastic face, light, and alarm.[Orange][Stainless] coverplate with 'Isolated Ground' stenciled in black.

    a. Manufacturers:

        1) Hubbell IG8362OSA
        2) Leviton 8380-IG
        3) Pass & Seymour IG8300-OSP
        4) Cooper IG8300HG_S

N. REC-ISO-SUR-QUAD: NEMA 5-20R Double Duplex Isolated Ground and Surge Suppression Receptacle:

1. Consists of two duplex isolated ground and surge suppression receptacles, double gang box, plaster ring and faceplate.

    a. Manufacturers:

        1) Refer to Isolated Ground and Surge Suppression Receptacle above.

O. REC-USB: NEMA 5-20R Receptacle with USB Charger:

1. Standard Grade Type A USB: 125-volt, 20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Type A USB charging rated at 5VDC 3.0A minimum. Mounted in double gang backbox.

    a. Manufacturers:

        1) Hubbell USB20X2
        2) Leviton ####
        3) Pass & Seymour TR5362USB
        4) Cooper TR7766

2. Standard Grade Type C USB: 125-volt, 20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face.

    a. One Type A USB charging rated at 5VDC 3.0A minimum and one Type C USB charging rated at 5VDC 5.0A. Mounted in double gang backbox.
    b. Two Type C USB charging rated at 5VDC 5.0A. Mounted in double gang backbox.

    c. Manufacturers:

        1) Hubbell USB USB20C5
        2) Leviton ####
        3) Pass & Seymour TR5362USB
        4) Cooper TR7766

3. Hospital Grade: 125-volt, 20-amp, hospital grade tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. USB charging rated at 5VDC 3.0A minimum. Mounted in double gang backbox.

    a. Manufacturers:

1) Hubbell USB8300
2) Leviton T5832-HG
3) Pass & Seymour TR8300USB
4) Cooper 7766

P. REC-USB-O: NEMA 5-20R Receptacle with USB Charger:

1. Standard Grade Type A USB: 125-volt, 20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Type A USB charging rated at 5VDC 3.0A minimum. Top half of duplex shall be split circuit wired and controlled by remote relay. Controlled receptacle shall have permanent NEMA approved and Electrical Code compliant marking on face of device. Mounted in double gang backbox.
2. Label alternative (when factory label is not available). Provide custom field applied permanent controlled receptacle label, NEMA and Electrical Code compliant marking on device coverplate. Label shall be permanent adhesive, durable, weatherproof, removable only by vigorous scrapping and likely damage to coverplate.

    a. Manufacturers:

        1) Hubbell USB20X2
        2) Leviton ####
        3) Pass & Seymour TR5362USBCD
        4) Cooper TR7766

3. Standard Grade Type C USB: 125-volt, 20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Top half of duplex shall be split circuit wired and controlled by remote relay. Controlled receptacle shall have permanent NEMA approved and Electrical Code compliant marking on face of device.
4. Label alternative (when factory label is not available). Provide custom field applied permanent controlled receptacle label, NEMA and Electrical Code compliant marking on device coverplate. Label shall be permanent adhesive, durable, weatherproof, removable only by vigorous scrapping and likely damage to coverplate.

    a. One Type A USB charging rated at 5VDC 3.0A minimum and one Type C USB charging rated at 5VDC 5.0A. Mounted in double gang backbox.
    b. Two Type C USB charging rated at 5VDC 5.0A. Mounted in double gang backbox.
    c. Manufacturers:

        1) Hubbell USB20C5
        2) Leviton ####
        3) Pass & Seymour TR5362USBCD
        4) Cooper TR7766

Q. REC-AFGF: NEMA 5-20R Duplex Receptacle with Arc Fault Circuit Interrupter, Ground Fault Circuit Interrupter, and Tamper Resistant:

1. 125-volt, 20 amp, 3-wire grounding type specification grade, arc fault circuit interrupter, ground fault circuit interrupter, tamper resistant receptacle with test and reset buttons in impact resistant thermoplastic face, listed.

    a. Device shall perform self-test of GFCI circuitry in accordance with UL-943.
    b. Manufacturers:

1) Hubbell AFGF
2) Leviton AGTR2
3) Pass & Seymour AFGF202
4) Cooper TRAFGF20A

R. REC-ARC: NEMA 5-20R Receptacle with Arc Fault Circuit Interrupts:

1. 125-volt, 20 amp, 3-wire grounding type specification grade, arc fault circuit interrupter receptacle and tamper resistant with test and reset buttons in impact resistant thermoplastic face.

a. Manufacturers:

1) Hubbell AFR20
2) Leviton AFTR2
3) Pass & Seymour AF202
4) Cooper TRAFCI20

S. REC-SIM-520R: NEMA 5-20R Simplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.

a. Manufacturers:

1) Hubbell HBL5361
2) Leviton 5361
3) Pass & Seymour 5361
4) Cooper 5361

T. REC-SIM-530R: NEMA 5-30R Simplex Receptacle:

1. 125-volt, 30 amp, 3-wire grounding type, phenolic face.

a. Manufacturers:

1) Hubbell HBL9308
2) Leviton 5371
3) Pass & Seymour 3802
4) Cooper 5716N

U. REC-SIM-550R: NEMA 5-50R Simplex Receptacle:

1. 125-volt, 50 amp, 3-wire grounding type, phenolic face.

a. Manufacturers:

1) Hubbell HBL9360
2) Cooper 1253

V. REC-SIM-620R: NEMA 6-20R Simplex Receptacle:

1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL5461
2) Leviton 5461
3) Pass & Seymour 5871
4) Cooper 5461

W. REC-SIM-630R: NEMA 6-30R Simplex Receptacle:

1. 250-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL9330
2) Leviton 5372
3) Pass & Seymour 3801
4) Cooper 5700N

X. REC-SIM-650R: NEMA 6-50R Simplex Receptacle:

1. 250-volt, 50 amp, 2-pole, 3-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL9367
2) Leviton 5374
3) Pass & Seymour 3804
4) Cooper 5709N

Y. REC-SIM-720R: NEMA 7-20R Simplex Receptacle:

1. 277-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell
2) Leviton
3) Pass & Seymour 7621

Z. REC-SIM-730R: NEMA 7-30R Simplex Receptacle:

1. 277-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL9315
2) Leviton 9730-A
3) Pass & Seymour
4) Cooper 5795N

AA. REC-SIM-750R: NEMA 7-50R Simplex Receptacle:

1. 277-volt, 50 amp, 2-pole, 3-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL9365
2) Leviton 9750-A
3) Pass & Seymour
4) Cooper

BB. REC-SIM-1420R: NEMA 14-20R Simplex Receptacle:

1. 125/250-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL8410
2) Pass & Seymour 3820
3) Cooper 5759

CC. REC-SIM-1430R: NEMA 14-30R Simplex Receptacle:

1. 125/250-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face. Flush mounted at +24 AFF.

a. Manufacturers:

1) Hubbell HBL9430A
2) Leviton 278
3) Pass & Seymour 3864
4) Cooper 5744N

DD. REC-SIM-1450R: NEMA 14-50R Simplex Receptacle:

1. 125/250-volt, 50 amp, 3-pole, 4-wire grounding type with thermoplastic face. Flush mounted at +4" AFF.

a. Manufacturers:

1) Hubbell HBL9450A
2) Leviton 279
3) Pass & Seymour 3894
4) Cooper 5754N

EE. REC-SIM-1460R: NEMA 14-60R Simplex Receptacle:

1. 125/250-volt, 60 amp, 3-pole, 4-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL9460A
2) Leviton 9460
3) Pass & Seymour
4) Cooper 9460N

FF. REC-SIM-1520R: NEMA 15-20R Simplex Receptacle:

1. 250-volt, 20 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.

    a. Manufacturers:

        1) Hubbell HBL8420
        2) Leviton
        3) Pass & Seymour
        4) Cooper

GG. REC-SIM-1530R: NEMA 15-30R Simplex Receptacle:

1. 250-volt, 30 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.

    a. Manufacturers:

        1) Hubbell HBL8430A
        2) Leviton 8430
        3) Pass & Seymour 5740
        4) Cooper 8430N

HH. REC-SIM-1550R: NEMA 15-50R Simplex Receptacle:

1. 250-volt, 50 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.

    a. Manufacturers:

        1) Hubbell HBL8450A
        2) Leviton 8450
        3) Pass & Seymour 5750
        4) Cooper 8450N

II. REC-SIM-1560R: NEMA 15-60R Simplex Receptacle:

1. 250-volt, 60 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.

    a. Manufacturers:

        1) Hubbell HBL9460A
        2) Pass & Seymour 5760
        3) Cooper 8460N

JJ. REC-SIM-L520R: NEMA L5-20R Simplex Receptacle, Locking Type:

1. 125-volt, 20 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.

    a. Manufacturers:

        1) Hubbell
        2) Leviton
        3) Pass & Seymour L520
        4) Cooper CWL520R

KK. REC-SIM-L530R: NEMA L5-30R Simplex Receptacle Locking Type:

1. 125-volt, 30 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.

    a. Manufacturers:

        1) Hubbell
        2) Leviton
        3) Pass & Seymour L530
        4) Cooper CWL530R

LL. REC-SIM-L620R: NEMA L6-20R Locking Type Simplex Receptacle:

1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.

    a. Manufacturers:

        1) Hubbell HBL2320
        2) Leviton 2320
        3) Pass & Seymour L620R
        4) Cooper CWL620R

MM. REC-SIM-L630R: NEMA L6-30R Locking Type Simplex Receptacle:

1. 250-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.

    a. Manufacturers:

        1) Hubbell HBL2620
        2) Leviton 2620
        3) Pass & Seymour L630R
        4) Cooper CWL630R

NN. REC-SIM-L720R: NEMA L7-20R Locking Type Simplex Receptacle:

1. 277-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.

    a. Manufacturers:

        1) Hubbell HBL2330
        2) Leviton 2330
        3) Pass & Seymour L720R
        4) Cooper CWL720R.

OO. REC-SIM-L730R: NEMA L7-30R Locking Type Simplex Receptacle:

1. 277-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.

    a. Manufacturers:

        1) Hubbell HBL2630
        2) Leviton 2630
        3) Pass & Seymour L730R
        4) Cooper CWL730R

PP. REC-SIM-L1420R: NEMA L14-20R Locking Type Simplex Receptacle:

1. 125/250-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL 2410
2) Pass & Seymour L1420
3) Cooper CWL1420R

QQ. REC-SIM-L1430R: NEMA L14-30R Locking Type Simplex Receptacle:

1. 125/250-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL 2710
2) Leviton 2710
3) Pass & Seymour L1430R
4) Cooper CWL1430R

RR. REC-SIM-L1520R: NEMA L15-20R Locking Type Simplex Receptacle:

1. 250-volt, 20 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL2420
2) Leviton 2420
3) Pass & Seymour L1520R
4) Cooper CWL1520R

SS. REC-SIM-L1530R: NEMA L15-30R Locking Type Simplex Receptacle:

1. 250-volt, 30 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL2720
2) Leviton 2720
3) Pass & Seymour L1530R
4) Cooper CWL1530R

TT. REC-SIM-L1620R: NEMA L16-20R Locking Type Simplex Receptacle:

1. 480-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL2431
2) Pass & Seymour L1620R
3) Cooper CWL1620R

UU. REC-SIM-L1630R: NEMA L16-30R Locking Type Simplex Receptacle:

1. 480-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face.

a. Manufacturers:

1) Hubbell HBL2730
2) Leviton 2730
3) Pass & Seymour L1630R
4) Cooper CWL1630R

VV. REC-SIM-L2120R: NEMA L21-20R Locking Type Simplex Receptacle:

1. 120/208Y 3 phase 20-amp 5 wire grounding type.

a. Manufacturers:

1) Hubbell HBL2510
2) Cooper CWL2120R
3) Pass & Seymour L2120R

WW. REC-SIM-L2130R: NEMA L21-30R Locking Type Simplex Receptacle:

1. 120/208Y 3 phase 30-amp 5 wire grounding type.

a. Manufacturers:

1) Hubbell HBL2810
2) Cooper CWL2130R
3) Pass & Seymour L2130R

XX. REC-SIM-XP: NEMA 5-20R Explosion Proof Simplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type, Class 1, Division 1, Group C rated. Factory sealed, dead end.

a. Manufacturers:

1) Appleton CPE1-2375
2) Crouse-Hinds CPS152201
3) Killark KRS-215-220

YY. REC-TAMP: NEMA 5-20R Tamper Resistant Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.

a. Manufacturers:

1) Hubbell BR20TR
2) Leviton TBR20
3) Pass & Seymour TR5362
4) Cooper TRBR20

2. Decorative Grade: Provide decorative style duplex tamper resistant receptacles in public spaces where walls are finished.

    a. Manufacturers:

        1) Hubbell DR20TR
        2) Leviton TDR20
        3) Pass & Seymour TR2635

3. Hospital Grade: 125-volt, 20 amp, 3-wire grounding type hospital grade with impact resistant thermoplastic face.

    a. Manufacturers:

        1) Hubbell HBL8300SG
        2) Leviton 8300-SG
        3) Pass & Seymour TR63-H
        4) Cooper TR8300

ZZ. REC-TAMP-O: NEMA 5-20R Occupancy Controlled Tamper Resistant Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.

    a. Occupancy Control: Top half of duplex shall be split circuit wired and controlled by remote relay. Occupancy controlled receptacle shall have permanent NEMA approved and Electrical Code compliant marking on face of device.
    b. Manufacturers:

        1) Hubbell BR20 C1/2 TR
        2) Leviton TBR20 S1/2
        3) Pass & Seymour TR5362 H/D
        4) Cooper TRBR20

2. Decorative Grade: Provide decorative style duplex tamper resistant receptacles in public spaces where walls are finished.

    a. Occupancy Control: Top half of duplex shall be split circuit wired and controlled by remote relay. Occupancy controlled receptacle shall have permanent NEMA approved and Electrical Code compliant marking on face of device.
    b. Manufacturers:

        1) Hubbell DR20 C1/2 TR
        2) Leviton TDR20 S1/2
        3) Pass & Seymour TR2635 H/D

AAA. REC-TAMP-GFI: NEMA 5-20R GFI Tamper Resistant Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type tamper-resistant with test and reset buttons in impact resistant thermoplastic face, listed.

    a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
    b. Manufacturers:

1) Hubbell GFTR20
2) Cooper TRSGF20
3) Pass & Seymour 2097TR
4) Leviton GFTR2

2. Hospital Grade: 125-volt, 20 amp, 3-wire grounding type hospital grade tamper-resistant, weather resistant WR listed, with test and reset buttons in impact resistant thermoplastic face, listed.

a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
b. Manufacturers:

1) Hubbell GFRTW20
2) Cooper TRSGFH20
3) Pass & Seymour 2097HGTR
4) Leviton GFTR2-HG

BBB. REC-TAMP-GFI-O: NEMA 5-20R Occupancy Controlled GFI Tamper Resistant Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type tamper-resistant with test and reset buttons in impact resistant thermoplastic face, listed.

a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
b. Occupancy Control: Top and bottom of duplex controlled by remote relay. Occupancy controlled receptacle shall have permanent NEMA approved and Electrical Code compliant marking on face of device.
c. Manufacturers:

1) HubbellGFTR20
2) Cooper TRSGF20
3) Pass & Seymour 2097TR
4) Leviton GFTR2

CCC. REC-TAMP-GFI-O-QUAD: NEMA 5-20R Double Duplex Occupancy Controlled GFI Tamper Resistant Receptacle:

1. Consists of one duplex occupancy controlled tamper resistant GFI receptacle and one duplex tamper resistant GFI receptacle, double gang box, plaster ring and faceplate.

a. Manufacturers:

1) Refer to Tamper Resistant Receptacle above.

DDD. REC-TAMP-QUAD: NEMA 5-20R Double Duplex Tamper Resistant Receptacle:

1. Consists of two duplex tamper resistant receptacles, double gang box, plaster ring and faceplate.

a. Manufacturers:

1) Refer to Tamper Resistant Receptacle above.

EEE. REC-QUAD-O: NEMA 5-20R Plug Load Controlled Duplex Receptacle:

1. Consists of two occupancy controlled duplex receptacles, double gang box, plaster ring and faceplate.

    a. Manufacturers:

        1) Refer to Occupancy Controlled Duplex Receptacle above.

FFF. REC-QUAD-IL: NEMA 5-20R Double Illuminated Face Duplex Receptacle:

1. Consists of two illuminated face duplex receptacles, double gang box, plaster ring and faceplate.

    a. Manufacturers:

        1) Refer to Duplex Illuminated Face Receptacle above.

GGG. REC-QUAD: NEMA 5-20R Double Duplex Receptacle:

1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.

    a. Manufacturers:

        1) Refer to Duplex Receptacle above.

HHH. REC-QUAD-GFI: NEMA 5-20R Double Duplex GFI Receptacle:

1. Consists of two duplex GFI receptacles, double gang box, plaster ring and faceplate.

    a. Manufacturers:

        1) Refer to Duplex GFI Receptacle above.

III. REC-QUAD-USB: NEMA 5-20R Double Duplex USB Receptacle:

1. Consists of two duplex USB receptacles, double gang box, plaster ring and faceplate.

    a. Manufacturers:

        1) Refer to USB Receptacle above.

JJJ. REC-QUAD-WP: NEMA 5-20R Weatherproof Ground Fault Quad Receptacle:

1. Consists of two duplex, GFCI receptacles. Double gang box. Provide extra-duty NEMA 3R rated while-in-use cast aluminum outlet box hood.

    a. Manufacturers:

        1) Receptacle: Refer to GFCI Receptacle above.
        2) Cover:

            a) Intermatic WP1030MXD
            b) Pass & Seymour WIUCAST2
            c) Thomas & Betts Red Dot 2CKU

KKK. REC-XR#: 600-volt, 60 amp, 3-pole, 4-wire Locking Type Simplex Receptacle for X-ray Isolated Power Equipment:

1. Black nylon or polycarbonate face. Cast aluminum surface mounted box, 45-degree angle adapter, weather protective lift cover on receptacle.

a. Manufacturers:

1) Hubbell HBL26410-RECP/HBL26401-BOX/HBL26404-ADAPTER
2) Pass & Seymour 26420/26401/26404
3) Cooper 26420/26401/26404

LLL. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.

MMM. Side wired devices shall have four binding screws that are undercut for positive wire retention.

NNN. Ground fault circuit interrupter (GFCI) receptacles shall be listed and comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.

OOO. Isolated ground receptacles shall have the equipment ground contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from the mounting strap.

PPP. Integral surge suppression receptacles with integral surge suppression shall comply with the following:

1. Category A3 listed.
2. Line to ground, line to neutral, and neutral to ground modes.
3. Metal-oxide varistors with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 210 joules per mode.
4. Status indication: Light visible in the face of the device and audible alarm to indicate device is no longer active or in service.
5. Distinctive symbol on device face to denote SPD-type device.
6. Device shall be blue with blue coverplate.
7. NEMA 5-20R duplex receptacle, 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap.

a. Manufacturers:

1) Hubbell HBL5362SA
2) Leviton
3) Pass & Seymour
4) Cooper

QQQ. Hazardous (Classified) location receptacles shall comply with NEMA FB 11.

2.05 COUNTERTOP AND FURNITURE RECEPTACLE ASSEMBLIES

A. REC-#: Pop-up Style Receptacle Assembly Listed for Countertop Applications.

1. 125-volt, 15/20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Two (2) NEMA 5-15R/5-20R, with both simplex devices on same face or opposite face of assembly, gasketed countertop enclosure, UL 948 section 146 spill test. Architect to select finish from standard factory options. Device(s) installation, orientation, and finish shall be coordinated with Architect/Engineer prior to installation.
2. Product Specific Coordination:

    a. The Contractor shall provide provisions as required to maintain the product listing. Refer to the manufacturer's instructions for a complete list of product specific installation requirements.
    b. Hubbell: Provide GFCI circuit breaker for overcurrent protection device serving branch circuit.
    c. Lew Electric: Provide a REC-DUP-GFI in the cabinet cavity below the countertop for the device to plug into. Coordinate installation of the duplex device with the space available in the below countertop cabinet.
    d. Branch Circuit: Provide a 15A/1P circuit breaker for 15 amp rated devices served by a dedicated branch circuit.

3. Manufacturers:

    a. Hubbell RCT200
    b. Lew Electric PUR20

B. REC-#: Pop-up Style Receptacle Assembly Listed for Furniture Installation.

1. 125-volt, 15/20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Two (2) NEMA 5-15R/5-20R, with both simplex devices on same face of assembly. Two (2) Type A USB charging rated at 5VDC 3.0A minimum. Mounted in 5"x5"x5" maximum pop-up enclosure. Architect to select finish from standard factory options.
2. Device(s) installation, orientation, and finish shall be coordinated with Architect/Engineer prior to installation.
3. Product Specific Coordination:

    a. The Contractor shall provide provisions as required to maintain the product listing. Refer to the manufacturer's instructions for a complete list of product specific installation requirements.
    b. Hubbell: Provide a REC-DUP-GFI in the cabinet cavity below the countertop for the device to plug into. Coordinate installation of the duplex device with the space available in the below countertop cabinet.
    c. Lew Electric: Provide gfi circuit breaker for overcurrent protection device serving branch circuit.
    d. Wiremold: Provide GFCI circuit breaker for overcurrent protection device serving branch circuit.
    e. Branch Circuit: Provide a 15A/1P circuit breaker for 15 amp rated devices served by a dedicated branch circuit.

4. Manufacturers:

    a. Hubbell WSBUSB2X2
    b. Wiremold DQFPUST
    c. Lew Electric PUFP-CT-2USB

C. REC-#: Modular Furniture Power System Listed for Furniture Installation.

1. 125-volt, 15/20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Three (3) NEMA 5-15R/5-20R, with both simplex devices on same face of assembly. One (1) combination Type A/Type C USB charging rated at 5VDC 3.0A minimum. Integral circuit breaker. First unit includes 10ft plug-and-cord. Daisy-chained units including a 3ft cord between devices. Refer to plans for quantity of devices required. UL 962A Spill/Splash rated. Color selection by architect based on standard factory options.
2. Mounting: on surface hardwareor recessed in surface hardware
3. Device(s) installation, orientation, and finish shall be coordinated with Architect/Engineer prior to installation.
4. Product Specific Coordination:

    a. The Contractor shall provide provisions as required to maintain the product listing. Refer to the manufacturer's instructions for a complete list of product specific installation requirements.
    b. Branch Circuit: Provide a 15A/1P circuit breaker for 15 amp rated devices served by a dedicated branch circuit.

5. Manufacturers:

    a. Legrand Modpower Series

2.06 FLOOR BOXES

A. Cover Color and Style: Verify with Architect from standard manufacturer options.

B. Refer to Technology drawings for voice/data, Audio/Video outlet, and coordination requirements.

C. Floor Boxes Housing Material Based on Cast-in-Place Floor Type:

1. Slab on Grade: Cast Iron or listed for slab on grade with special kit, coating ,or equivalent; corrosion resistant.
2. Elevated Slab: Cast Iron,
3. Raised Access Floor, Cast-in-Place, or Access Floor Panels: Stamped steel.
4. Wood Floor, not Cast-in-Place: Stamped steel and rated for wood floor application.

D. FB-#: Concealed Center Compartment:

1. Floor Box, flush-mounted hinged cover, square/rectangular center service area with closed while-in-use cover and cable egress doors in cover, provide complete with appropriate outlet cover plates and hardware. For use with 4-inch minimum concrete pour floors, fully adjustable, UL 514 scrub water listed.

2. Gang / Outlet Descriptions:

    a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4-inch conduit.
    b. Voice/Data outlet with 3/4-inch conduit. Refer to Technology drawings for additional information.
    c. Audio/Visual outlet with 3/4-inch conduit. Refer to Technology drawings for additional information.
    d. Spare with 3/4-inch conduit.

3. Manufacturers:

a. Hubbell CFB Series
b. Legrand Wiremold RFB Series
c. ABB Steel City 664/665/667 Series

4. Installation: Group route raceway conduits under slab on grade or in ceiling space below to nearest wall or as shown on plans. Extend conduit to a location above the finished accessible ceiling. Provide provisions to core drill elevated floors and route conduits to ceiling space of associated floor box. Provide hub reducers when applicable.

E. FB-#: Concealed Center Compartment (Fire Rated):

1. Floor Box, Fire Rated-1 hour, square/rectangular flush-mounted hinged cover, center service area with closed while-in-use cover and cable egress doors in cover, provide complete with appropriate outlet coverplates and hardware. For use with 2-inch minimum 5-1/2-inch maximum concrete pour floors, fully adjustable, UL 514 scrub water listed. Provide boxes located in elevated floors with fire rated installation kit.

2. Gang / Outlet Descriptions:

a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 1-1/4-inch conduit.
b. Voice/Data outlet with1-1/4-inch conduit. Refer to Technology drawings for additional information.
c. Audio/Visual outlet with 1-1/4-inch conduit. Refer to Technology drawings for additional information.
d. Spare with 3/4-inch conduit.

3. Manufacturers:

a. Hubbell CFB Series
b. Legrand Wiremold Evolution Series

4. Installation: Group route raceway conduits under slab on grade or in ceiling space below to nearest wall or as shown on plans. Extend conduit to a location above the finished accessible ceiling. Provide provisions to core drill elevated floors and route conduits to ceiling space of associated floor box, UL 514 scrub water listed. Provide hub reducers when applicable.

F. FB-#: Concealed Center Compartment (Access Floor):

1. Floor Box, access floor type, square/rectangular flush-mounted hinged cover, center service area with closed while-in-use cover and sable egress doors in cover, provide complete with appropriate outlet cover plates and hardware, UL 514 scrub water listed. For use in access floors systems 3/4" to 2" thick.

2. Gang / Outlet Descriptions:

a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4-inch conduit.
b. Voice/Data outlet with 3/4 -inch conduit. Refer to Technology drawings for additional information.
c. Audio/Visual outlet with 3/4 -inch conduit. Refer to Technology drawings for additional information.
d. Spare with 3/4- inch conduit.

3. Manufacturers:

    a. Hubbell AFB Series
    b. Legrand Wiremold Evolution Series
    c. ABB Steel City AFM Series

4. Installation: Group route raceway conduits under finished access floor to nearest wall or as shown on plans. Extend conduit to a location above the finished accessible ceiling. Provide hub reducers when applicable.

G. FB-#: Round Flush with Finished Floor:

1. Floor Box, round, round flush-mounted hinged cover with flange, provide complete with appropriate outlet cover plates and hardware, for use with X-inch minimum concrete pour floors, fully adjustable.

2. Gang / Outlet Descriptions:

    a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4-inch conduit.
    b. Voice/Data outlet with 3/4-inch conduit.
    c. Audio/Visual outlet with 3/4-inch conduit.
    d. Power furniture/equipment feed with flexible whip and 3/4-inch conduit.
    e. Voice/Data furniture/equipment feed with flexible whip and 3/4-inch conduit.
    f. Audio/Visual furniture/equipment feed with flexible whip and 3/4-inch conduit.
    g. Spare with 3/4- inch conduit.
    h. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

    a. Cast:

        1) Hubbell 2503 Series
        2) Legrand Wiremold 880 Series
        3) ABB Steel City 600 Series

    b. Stamped Steel:

        1) Hubbell B2527 Series
        2) Legrand Wiremold 880 Series
        3) ABB Steel City 68 Series

    c. Non-Metallic PVC:

        1) Hubbell PFB1 Series
        2) Legrand Wiremold 880 Series
        3) ABB Steel City 68 HP Series

4. Installation: Group route raceway conduits under slab on grade or in elevated slab to nearest wall. Route conduits to nearest wall or as shown on drawings. Extend conduit to a location above the finished accessible ceiling. Provide hub reducers when applicable.

H. FB-#: Square or Rectangular (Standard):

1. Floor Box, square or rectangular, square/rectangular flush-mounted hinged cover with flange, provide complete with appropriate outlet cover plates and hardware, for use with X-inch minimum concrete pour floors, fully adjustable.

2. Gang / Outlet Descriptions:

   a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4-inch conduit.
   b. Voice/Data outlet with 3/4-inch conduit.
   c. Audio/Visual outlet with 3/4-inch conduit.
   d. Power furniture/equipment feed with flexible whip and 3/4-inch conduit.
   e. Voice/Data furniture/equipment feed with flexible whip and 3/4-inch conduit.
   f. Audio/Visual furniture/equipment feed with flexible whip and 3/4-inch conduit.
   g. Spare with 3/4- inch conduit.
   h. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

   a. Cast:

      1) Hubbell B### Series
      2) Legrand Wiremold 880 Series
      3) ABB Steel City 640 / 840 Series

   b. Stamped Steel:

      1) Hubbell 242# Series
      2) Legrand Wiremold 880 Series
      3) ABB Steel City 740 Series

   c. Non-Metallic PVC:

      1) Hubbell
      2) Legrand Wiremold 880 Series
      3) ABB Steel City 640 Series

4. Installation: Group route raceway conduits under slab on grade or in elevated slab to nearest wall. Route conduits to nearest wall or as shown on drawings. Extend conduit to a location above the finished accessible ceiling. Provide hub reducers when applicable.

I. FB-#: Square or Rectangular (Shallow):

1. Floor Box, square or rectangular, square/rectangular flush-mounted hinged cover with flange, provide complete with appropriate outlet cover plates and hardware, for use with X-inch minimum concrete pour floors, fully adjustable.

2. Gang / Outlet Descriptions:

   a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4-inch conduit.
   b. Voice/Data outlet with 3/4-inch conduit.
   c. Audio/Visual outlet with 3/4-inch conduit.
   d. Power furniture/equipment feed with flexible whip and 3/4-inch conduit.
   e. Voice/Data furniture/equipment feed with flexible whip and 3/4-inch conduit.

f. Audio/Visual furniture/equipment feed with flexible whip and 3/4-inch conduit.
g. Spare with 3/4- inch conduit.
h. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

a. Cast:

1) Hubbell B### Series
2) Legrand Wiremold 880 Series
3) ABB Steel City 640 / 840 Series

b. Stamped Steel:

1) Hubbell B243# Series
2) Legrand Wiremold 880 Series
3) ABB Steel City 740 Series

4. Installation: Group route raceway conduits under slab on grade or in elevated slab to nearest wall. Route conduits to nearest wall or as shown on drawings. Extend conduit to a location above the finished accessible ceiling. Provide hub reducers when applicable.

J. FB-#: Floor Box with Service Fitting:

1. Floor Box, with service fitting style box, cast aluminum, 1" chase nipple, provide complete with appropriate outlet cover plates and hardware. Provide with flush mounted floor box when installed in floors. Provide with recessed backbox when installed in equipment/furniture.
2. Floor Box (when applicable), square, flush-mounted hinged cover with flange, provide complete with appropriate outlet cover plates and hardware, for use with X-inch minimum concrete pour floors, fully adjustable.

3. Gang / Outlet Descriptions:

a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4 -inch conduit.
b. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4 -inch conduit.

4. Manufacturers:

a. Hubbell
b. ABB Steel City

5. Installation: Group route raceway conduits under slab on grade, in elevated slab to nearest wall, or in furniture/equipment. Route conduits to nearest wall or as shown on drawings. Extend conduit to a location above the finished accessible ceiling. Provide hub reducers when applicable.

K. FB-#: Floor Box Activation for Underfloor Duct System:

1. Floor box activations for underfloor duct systems, provide complete with appropriate outlet cover plates and hardware.

2. Gang / Outlet Descriptions:

a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle.
b. Voice/Data outlet.
c. Audio/Visual outlet.
d. Power furniture/equipment feed with flexible whip and 3/4-inch conduit.
e. Voice/Data furniture/equipment feed with flexible whip.
f. Audio/Visual furniture/equipment feed with flexible whip.
g. Spare.
h. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

a. Match underfloor duct system manufacturer, refer to Specification Section 260538 - Underfloor Ducts.

2.07 PEDESTAL STYLE BOX

A. REC-PED: Cast aluminum pedestal style box with 1" hub. One (1) REC-DUP. Install back to back in box. Provide stainless steel cover plates.

1. Manufacturers:

a. Hubbell SA6686, HBL5362, (2) Covers
b. ABB Thomas & Betts

B. REC-PED-QUAD: Cast aluminum pedestal style box with 1" hub. Two (2) REC-DUP. Install back to back in box. Provide stainless steel cover plates.

1. Manufacturers:

a. Hubbell SA6688, (2) HBL5362, (2) Covers
b. ABB Thomas & Betts

2.08 POKE-THROUGH FITTINGS

A. Cover Color and Style: Verify with Architect from manufacturer standard options.

B. Refer to Technology drawings for voice/data, Audio/Video outlet, and coordination requirements.

C. UL listed as fire-rated poke-through device for 1, 2, 4-hour rated floors: include fire stops and smoke barriers in through-floor component. UL514A listed for scrub locations.

D. Terminate in 4-inch square by 2-1/2-inch deep junction box.

E. Suitable for installation with a floor thickness of 2-1/4 to 7 inches.

F. PT-#: 3" Fire Rated Poke-Through:

1. Semi-flush mounted, hinged covers, for use with 3-inch core holes, provide complete with appropriate outlet coverplates and hardware. UL 514 scrub rated listed.

2. Gang / Outlet Descriptions, route conduit in ceiling space of lower level. Provide provisions to core drill floor to route power circuits to panel on same floor as poke through. Route low voltage raceways to scheduled technology room:

    a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle.
    b. Voice/Data outlet.
    c. Audio/Visual outlet.
    d. Power furniture/equipment feed with flexible whip.
    e. Voice/Data furniture/equipment feed with flexible whip.
    f. Audio/Visual furniture/equipment feed with flexible whip.
    g. Conduit Raceway (in ceiling space below floor):

        1) Power: 3/4-inch conduit.
        2) Voice/Data: 3/4-inch conduit.
        3) Audio/Visual: 3/4-inch conduit.

    h. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

    a. Hubbell PT2X2
    b. Wiremold
    c. Thomas & Betts

G. PT-#: 4" Fire Rated Poke-Through:

1. Semi-flush mounted, hinged covers, for use with 4-inch core holes, provide complete with appropriate outlet coverplates and hardware. UL 514 scrub rated listed.

2. Gang / Outlet Descriptions, route conduit in ceiling space of lower level. Provide provisions to core drill floor to route power circuits to panel on same floor as poke through. Route low voltage raceways to scheduled technology room:

    a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle.
    b. Voice/Data outlet.
    c. Audio/Visual outlet.
    d. Power furniture/equipment feed with flexible whip.
    e. Voice/Data furniture/equipment feed with flexible whip.
    f. Audio/Visual furniture/equipment feed with flexible whip.
    g. Spare.
    h. Conduit Raceway (in ceiling space below floor):

        1) Power: 3/4-inch conduit.
        2) Voice/Data: 3/4-inch conduit.
        3) Audio/Visual: 3/4-inch conduit.

    i. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

    a. Hubbell SystemOne Series

b. Legrand Wiremold 4RF/RC Series
c. ABB Steel City FPT4 Series

H. PT-#: Concealed Center Service Fire-Rated Poke-Through:

1. Semi-flush mounted, concealed service center with pass through cable covers, for use with 4-inch core holes, provide complete with appropriate outlet cover plates and hardware. UL 514 scrub rated listed. 1-hour fire rated.

2. Gang / Outlet Descriptions, route conduit in ceiling space of lower level. Provide provisions to core drill floor to route power circuits to panel on same floor as poke through. Route low voltage raceways to scheduled technology room:

a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle.
b. Voice/Data outlet.
c. Audio/Visual outlet.
d. Spare.
e. Conduit Raceway (in ceiling space below floor):

1) Power: 3/4 -inch conduit.
2) Voice/Data: 3/4-inch conduit.
3) Audio/Visual: 3/4-inch conduit.

f. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

a. Hubbell SystemOne Series
b. Legrand Wiremold Evolution Series

2.09 PENDANT CORD/CONNECTOR DEVICES

A. Description: Matching, locking type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, heavy-duty grade or refer to Details as shown on drawings.

1. Body: Nylon with screw-open cable gripping jaws and provisions for attaching external cable grip.

B. External Cable Grip: Woven wire mesh type made of high strength galvanized steel wire stand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.010 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded copper conductors, with Type SOW-A jacket; with green insulated grounding conductor and equipment rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection, FS/UL listed.

2.011 CORD REELS

A. CR-#: 50' 3#12 AWG type 'SOW-A' cord with adjustable ball stop. 120 volt, NEMA 5-20R, simplex receptacle connector, rated 16 amps continuous.

1. Manufacturers:

a. Daniel Woodhead 92433
b. 9521 w/ Hubbell 5369CY
c. Appleton RL153L
d. Hubbell HBL HBL45123C20

B. CR-#: 50' 3#16 AWG type 'SJOW-A' cord with adjustable ball stop. Hand lamp with simplex 120-volt NEMA 5-15R receptacles, rated 6.5 amps.

1. Manufacturers:

a. Daniel Woodhead 954
b. 106US
c. Appleton
d. Hubbell HBL50163IN

C. CR-#: 25' 3#16 AWG type 'SJOW-A' cord with adjustable ball stop. Two 120-volt NEMA 5-15R receptacles mounted in cast outlet box, rated 10 amps.

1. Manufacturers:

a. Daniel Woodhead 925
b. Appleton RL2510
c. Hubbell HBLC25163C

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.

B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.

C. Ground Fault Protection: Provide ground fault protection for all branch circuit breakers serving 120/208 receptacles and electrical outlets rated 50 amps or less single-phase and 100 amps or less three-phase in the following locations, as shown on drawings, or required by adopted code:

1. Bathrooms, locker rooms, shower rooms, and laundry areas.
2. Kitchens' all 120-volt through 250-volt receptacles.
3. Buffet, serving, food and beverage preparation areas; all 120-volt through 250-volt receptacles.
4. Rooftops.

5. Interior/Exterior locations subject to damp/wet conditions.
6. When located within 6 feet of sinks, bathtubs, and shower stalls.
7. Plug-and-cord receptacles when the utilization appliance is located within 6 feet of a sink edge.
8. Aquariums and bait wells.
9. Garages, accessory buildings, service bays.
10. Accessory dwelling buildings.
11. Exterior dwelling outlets (disconnects, equipment connections, etc.) when required by code. Dwelling outlets located in basements and crawl spaces when required by code.
12. Boathouses.
13. Specific Appliances: Auto vacuum machines, water drink/bottle fill coolers, water pressure spraying machines, tire inflation machines, vending machines, sump pumps, dishwashers, electric ranges, ovens, clothes dryers, microwave ovens.
14. Horticultural luminaire branch circuits.
15. Future Provisions: Provide a conduit raceway and backbox for the future addition of countertop pop-receptacle when receptacles are not installed in kitchen islands and peninsulas.

D. Arc-Fault Protection: Provide arc-fault protection for all branch circuit breakers serving the following spaces, or required by adopted code.

1. Dwelling unit living and occupied areas including but not limited to kitchens, family, dining, living, parlors, libraries, dens, bedrooms, sunrooms, recreation, closets, hallways, laundry, and similar spaces.
2. Dormitory bedrooms, living rooms, hallways, closets, bathrooms, and similar rooms.
3. Guest rooms and guest suites.
4. Sleeping rooms for nursing homes, limited care, and similar non-dwelling living quarters dedicated to sleeping.

E. Tamper Resistant Protection: Provide tamper resistant protection for all 15 / 20-amp 120/208 straight blade wiring devices in the following locations, as shown on the drawings, or required by adopted code.

1. Dwelling units and accessory dwelling unit structures.
2. Boathouses.
3. Dormitories.
4. Guest rooms, guest suites, and common public areas.
5. Childcare, preschool, elementary, middle, high school, educational facilities.
6. Medical Business Office: Offices, corridors, waiting rooms, common areas.
7. Public Buildings: Corridors, waiting rooms, common areas.
8. Public Spaces involving: Transportation waiting, gymnasiums, fitness centers, auditoriums, public use venue common areas.
9. Nursing homes, assisted living, psychiatric spaces, substance abuse, foster care facilities.
10. Agricultural buildings common areas accessible to the public.
11. Park and recreational areas.

F. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This may include X-ray or similar non-destructive means.

G. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.

H. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

J. Install devices and wall plates flush and level.

K. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 260553 - Electrical Identification.

L. Test receptacles and modular wiring connectors for proper polarity, ground continuity and compliance with requirements.

M. Healthcare devices shall be tested in accordance with NFPA 99 6.3.3 for grounding, voltage, and impedance measurements.

N. Floor Box Installation:

1. Set boxes level and flush with finish flooring material.
2. Use cast iron floor boxes for installations in slab on grade. Trim shall match floor covering to be used.
3. Provide a minimum horizontal offset of 24 inches between boxes.
4. Provide saw-cutting and patching of existing concrete floors as necessary for floor box installations within existing floors.

END OF SECTION

SECTION 262813 - FUSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fuses

B. Spare Fuse Cabinet

1.02 REFERENCES

A. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Types

B. UL 198E - Class R Fuses

C. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)

D. NEMA FU 1 - Low Voltage Cartridge Fuses

E. NFPA 70 - National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit product data under provisions of Section 260500.

1.04 EXTRA MATERIALS

A. Provide two fuse pullers.

B. Provide three of each size and type of fuse installed.

1.05 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40F or more than 100F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS - FUSES

A. Bussman, Division of Eaton

B. Edison Fuse, Division of Cooper Industries

C. Mersen

D. Littelfuse Inc

2.02 FUSES

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.

D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.

E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.

F. Control transformer fuses: Class CC (time delay).

G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.

2.03 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch- thick 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- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install fuses where indicated on the drawings and specifications.

B. Install fuses in accordance with manufacturer's instruction.

C. Install fuses in packaged equipment as required by equipment manufacturer.

D. Install fuse with label oriented such that manufacturer, type, and size are easily read.

E. Install spare fuse cabinet in the Main Electrical Room.

END OF SECTION

SECTION 262816 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fusible switches

B. Non-fusible switches

C. Molded case circuit switches

D. Molded case switches

E. Motor disconnect switch

F. Mechanically interlocked disconnect

G. Elevator Service Disconnect Switch

H. Mobile Diagnostics Service Disconnect

I. Enclosures

1.02 RELATED SECTIONS AND WORK

A. Refer to the Disconnect and Starter Schedule for rating and configuration.

1.03 REFERENCES

A. NEMA KS 1 - Enclosed Switches

1.04 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Product Data: For each type of enclosed switch, circuit breakers, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.

C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.05 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.01 FUSIBLE AND NON-FUSIBLE SWITCHES

A. Acceptable Manufacturers:

1. Square D 3110 Series
2. Eaton DH Series
3. ABB TH Series
4. Siemens HNF / HF Series

B. FDS-#; Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.

C. DS-#; Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool. Handle lockable in OFF position.

D. Enclosures: Type as indicated on the disconnect schedule.

E. Accessories: Provide the following accessories. Refer to Disconnect Schedule for additional requirements for each application.

1. Lockable
2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

2.02 MOLDED CASE CIRCUIT BREAKERS AND SWITCHES

A. Acceptable Manufacturers:

1. Square D
2. Eaton
3. ABB
4. Siemens

B. CB-#; Molded Case Circuit Breaker: NEMA AB 1, 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 settings.
3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time adjustments.

d. Ground-fault pickup level, time delay, and I2t responses.

4. Current Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.

C. CB-#; Molded Case Switches: Molded case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

D. Accessories: Provide the following accessories. Refer to Disconnect Schedule for additional requirements for each application.

1. Lockable
2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

2.03 MOTOR DISCONNECT SWITCH

A. Acceptable Manufacturers:

1. Square D 3110 Series
2. Eaton r5 Series
3. ABB ML Series
4. Siemens LBR Series

B. MD-#; Rotary Switch Assemblies: Rated for making and breaking loads, rotary type enclosed switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool. Handle lockable in OFF position.

C. Enclosures: Type as indicated on the Disconnect Schedule.

D. Ground lug connection provided in enclosure.

E. Accessories: Provide the following accessories. Refer to Disconnect Schedule for additional requirements for each application.

1. Lockable
2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

F. Listed UL 508 suitable for motor control.

2.04 MECHANICALLY INTERLOCKED DISCONNECT

A. Acceptable Manufacturers:

1. Disconnect

a. Square D 3110 Series
b. Eaton DH Series
c. ABB TH Series
d. Siemens HF Series

2. Receptacle

a. Crouse-Hinds Arktite
b. Appleton Powertite

B. DSS-#; Switch and Plug Assemblies: Rated for making and breaking loads, enclosed switch with externally operable interlock to prevent disconnecting receptacle with switch in ON position or inserting receptacle in ON position without a tool. Padlock lockable provision to meet OSHA lockout/tagout regulations.

C. Enclosures: Type as indicated on the Disconnect Schedule.

D. Ground lug connection provided in enclosure.

E. Accessories: Provide the following accessories. Refer to Disconnect Schedule for additional requirements for each application.

1. Lockable
2. Matching male pin and sleeve plug, two auxiliary/pilot contacts.
3. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

F. Listed UL 2682 suitable for motor disconnect.

2.05 ELEVATOR SERVICE DISCONNECT SWITCH

A. Acceptable Manufacturers:

1. Eaton Bussmann PS Series
2. Mersen ES Series
3. Littlefuse LPS Series

B. Elevator Service Fused Disconnect Switch: Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool, with lockable handle, ratings per drawing schedule, 120 volt shut trip, two field convertible mechanically interlocked form C auxiliary contacts, shunt trip voltage monitor relay, integral control transformer, Pilot Light "on", neutral bar/lug, NEMA 1 enclosure, minimum 100K SCCR, UL Listed.

C. Provide with fire alarm interface relays for:

1. Elevator Recall
2. Elevator Alternative Floor Recall
3. Elevator Shut Down Sequence

D. Accessories: Provide the following accessories. Refer to Disconnect Schedule for additional requirements for each application.

1. Lockable
2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

2.06 MOBILE DIAGNOSTICS SERVICE DISCONNECT

A. Acceptable Manufacturers:

1. Square D 3110 Series
2. Eaton DH Series
3. ABB TH Series
4. Siemens HF Series

B. MDSD-#; Mobile Diagnostics Service Disconnect: Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool.

C. Accessories: Provide the following accessories. Refer to Disconnect Schedule for additional requirements for each application.

1. Lockable
2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install disconnect switches where indicated on the drawings.

B. Install fuses in fusible disconnect switches.

C. Field coordinate installation with other contractors and equipment to maintain code required working space requirements.

D. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

3.02 ELEVATOR SERVICE DISCONNECT SWITCH

A. Coordinate installation with elevator requirements and contractor.

B. Coordinate installation with fire alarm contractor.

3.03 MOBILE DIAGNOSTICS SERVICE DISCONNECT

A. Coordinate installation with mobile medical equipment requirements and vendor.

3.04 ADJUSTING

A. Set field-adjustable circuit breaker trip ranges.

END OF SECTION

SECTION 262821 - CONTACTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. General-purpose contactors

B. Lighting contactors

C. Enclosures

1.02 RELATED SECTIONS AND WORK

A. Refer to Lighting Contactor Schedule.

1.03 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems

B. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies

C. UL 508 - Industrial Control Equipment

1.04 SUBMITTALS

A. Submit shop drawings under provisions of Section 260500.

B. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, and poles.

C. Submit manufacturer's instructions under provisions of Section 260500.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Electric 8903 Series

B. Eaton Corporation C30CN / CN35 Series

C. ABB

D. Siemens LC / CLM / CM Series

2.02 C-#; GENERAL-PURPOSE CONTACTORS

A. Contactors: NEMA ICS 2 and UL 508; electrically held,-wire control.

B. Coil Operating Voltage: 120 volts, 60 Hertz.

C. Size: NEMA ICS 2; size as indicated on the drawings.

D. Contacts: 30 amp, 600 volts, 60 Hertz.

E. Poles: 2 Field convertible NO and NC configurations.

F. Enclosure: ANSI/NEMA ICS 6; Type 1.

G. Provide solderless pressure wire terminals.

H. Provide Hand-Off-Auto selector switch.

2.03 LC-#; LIGHTING CONTACTORS

A. Contactors: NEMA ICS 2 and UL 508; electrically held,-wire control.

B. Coil Operating Voltage: 120 or 277 volts, 60 Hertz.

C. Contacts: 30 amp, 600 volts, 60 Hertz.

D. Poles: 2 Field convertible NO and NC configurations.

E. Enclosure: ANSI/NEMA ICS 6; Type 1.

F. Provide solderless pressure wire terminals.

G. Provide Hand-Off-Auto selector switch.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction boxes: and equipment enclosures.

E. 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.

END OF SECTION

SECTION 264300 - SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes materials and installation requirements for factory and field wired low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at designated service entrance equipment, distribution panels, electronic equipment, elevators, and receptacle devices.

1.02 QUALITY ASSURANCE

A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be "Listed by Underwriters Laboratories" to UL 1449.

B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment. The qualified manufacturer must have been engaged in the design and manufacturer of such products for a minimum of five years.

1.03 REFERENCES

A. ANSI/IEEE C62.33 - IEEE Guide on Testing of MOV components

B. ANSI/IEEE C62.35 - IEEE Guide on Testing of SAD components

C. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits

D. ANSI/IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits

E. ANSI/UL 1449 Latest Edition - UL Standard for Safety for Surge Protective Devices

F. CBEMA - Computer Business Equipment Manufacturers Association

G. IEC 664 - International Engineering Consortium, Standard for Clamping Voltage

H. NFPA 70 - National Electrical Code (NEC)

I. UL 67 - Listed for Internal Panelboard Transient Voltage Surge Suppressors

J. UL 96A - Devices listed as approved for secondary surge arrestors (VZCA)

K. UL 248-1 - Fusing

L. UL 1283 - Electromagnetic Interference Filters, Fifth Edition

1.04 SUBMITTALS

A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under "Testing, Warranty and Life Expectancy" as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.

B. Fuse information: Provide fuse information if required for operation. Include size, manufacturer, time-current chart responses to UL 1449 testing requirements, maximum surge protection capability per mode and phase as limited by the fuse, and verification of repetitive surge protection device operation without system degeneration greater than 10%.

1.05 SPARE PARTS

A. Surge Protection Modules: Furnish 1 replacement module for each type installed.

B. Fuses: Furnish to the Owner 3 spare fuses of each type and rating installed.

1.06 TESTING, WARRANTY AND LIFE EXPECTANCY

A. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.

1. Single pulse surge current capacity: Single pulse surge current tested in a mode at rated surge currents.
2. Single pulse surge current capacity test: An initial UL 1449 defined 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage (VPR).
3. A single 8 x 20µs waveform pulse of maximum rated surge current per mode shall then be applied. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.

B. Minimum Repetitive Surge Current Capacity:

1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
2. Minimum Repetitive Surge Current Capacity Test:

    a. An initial UL 1449 surge defined as 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage.
    b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50µs 10kV or 20kV open circuit voltage waveform and an 8 x 20µs 10,000A short circuit current waveform, shall then be applied at one-minute intervals.
    c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.

3. Survival is achieved if the suppression voltage (VPR) does not vary by more than 10%.

4. Proof of such testing shall be the test log generated by the surge generator.

C. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination wave surge.

D. Warranty: Ten (10) years. Includes workmanship, installation and programming.

E. No scheduled parts replacement or preventative maintenance shall be required.

PART 2 - PRODUCTS

2.01 DESCRIPTION

A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems.

B. Short Circuit Current Rating: Provide factory label for SCCR rating. The short circuit current rating shall be the larger of the listed value on the drawings or as required by the equipment protected.

C. Type Definitions - Permitted Installation Locations:

1. Type 1. Supply-side or Load-side of service disconnect. Load-side of service disconnects when listed for application and approved.
2. Type 2. Load-side of service disconnect or separately derived system.
3. Type 3. Load-side of branch circuits.
4. Type 4. Integral to Original Equipment Manufacturer OEM equipment, factory installed.

2.02 RATINGS

A. **SPD-**Insert #**;** Service Entrance Suppressors:

1. For 277/480 120/208-volt, 3 phase, 4 wire, type 2 unit.

    a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
    b. Nominal Discharge Current: 20 kA.
    c. Mounting: Refer to the drawings.
    d. Voltage Protection Rating: Refer to requirements below.
    e. Components: Minimum component size of 20mm thermally protected metal oxide varistors (MOV).
    f. Disconnect: Surge-rated disconnect with 200,000 SCCR.

2. Manufacturers:

    a. Square D Surgelogic EM# Series
    b. Siemens TPS4 or BSPD Series
    c. Eaton SPD Series
    d. ABB Current Technology Current Guard Plus
    e. ASCO Power Technologies 5## Series
    f. LEA International LSS Series

B. **SPD-**Insert #**;** Service Entrance Suppressors - Hybrid:

1. For 277/480-volt, 3 phase, 4 wire, type 2 unit.

    a. Surge current capacity: 120,000/240,000 amps per protection mode/phase
    b. Nominal Discharge Current (I_N): 20 kA.
    c. Mounting: Refer to the drawings.
    d. Voltage Protection Rating: Refer to requirements below.
    e. Components: Minimum component size of modular 20mm thermally protected metal oxide varistors (MOV). Modular hybrid combination of 20mm MOV may be combined with silicon avalanche diodes (SAD) or selenium cells.

2. Manufacturers:

    a. ABB Current Technology SL3 Series
    b. ASCO Power Technologies 570 Series
    c. LEA International DS Series

C. Receptacles:

1. For 120-volt, 1 phase, 3 wire, type 3 unit.

    a. Surge current capacity (I_N): 12,000 amps per protection mode.
    b. Components: 20mm MOV
    c. Maximum Continuous Operating Voltage: 150 Volts

2. Refer to Specification Section 262726 for additional receptacle construction information.

D. Voltage Protection Rating:

1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).

    a. 277/480 Volt, 3 phase, 4 wire.1200 Volt L-N, L-G, N-G and 1800 Volt L-L
    b. 480 Volt, 3 phase, 3 wire. 2000 Volt L-G, L-L
    c. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L
    d. 240 Volt, 3 phase, 3 wire. 1200 Volt L-G, L-L
    e. 120/240 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L

E. EMI/RFI Noise Rejection or Filtering:

1. Each unit shall include a UL1283 first order, high-frequency filter for noise filtering between 10 KHz and 100 MHz.

F. Indication:

1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.
2. Each unit shall include a visual indicator that indicates the unit is functioning properly and providing protection.
3. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.
4. Provide each service entrance type unit(s) with a transient counter.

5. Each unit shall contain form "C" contacts for remote indication of an alarm status.

G. Fuses:

1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.
2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.

B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

3.02 INSTALLATION

A. Mounting Location:

1. The unit shall be installed as close as practical to the panel secondary lugs in accordance with applicable national/Local Electrical Codes and the manufacturer's recommended installation instructions. Connect the unit to the transformer or switchboard or panel using a conduit nipple. Flush mount the unit in the front of the switchboard. Mount unit directly across from the breaker or disconnect serving it.
2. Integral surge protection devices mount between the main and branch circuit breakers.
3. If internal surge protection device is specified, device shall be installed in a barrier compartment isolated from other components.

B. Connections:

1. Conductors from the protected bus to the unit shall not be any longer than necessary avoiding unnecessary bends. The conductor leads shall be twisted together and as short as possible. Connection shall be with mechanical lugs for each phase, neutral, and ground if applicable. Contractor shall provide wire and circuit breakers sized per the approved manufacturer's requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer's requirements, but no greater than 5'-0".
2. The surge protection unit shall be isolatable from the electrical distribution system via 3 pole circuit breaker mounted in the switchboard/panelboard or be equipped with a factory supplied integral fused switch or circuit breaker. Single phase 120-volt units shall be hardwired without a disconnecting means.
3. Neutral and ground shall not be bonded together at secondary panelboard locations.

C. Additional Locations: Critical Load Protection - Fixed Equipment (120 Vac):

1. Install Type 3 hard-wired surge protection device between each of the following equipment items and its power supply conductors.

a. Fire alarm master panel
b. Phone switch
c. Intercom master

d. Building management system master
e. Security system master
f. Telephone switch
g. TV head
h. Elevator control panel

D. General:

1. Check unit for proper operation of protection and indication under start-up.
2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.
3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).
4. Install fuses in all fuse holders and fused disconnects internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.
6. Manufacturer service phone number shall be posted on the front of the surge protection device.

END OF SECTION

SECTION 265119 - LED LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires and accessories

B. Exterior luminaires and accessories

C. Submerged luminaires

D. Light-emitting diode (LED) luminaire systems

E. LED emergency lighting units

F. Emergency exit signs

G. Emergency inverter for LED light engines (individual luminaires - integral)

H. Lighting poles

1.02 RELATED SECTIONS

A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

1. 26 09 33 Lighting Control Systems

    a. Automatic load control relay (ALCR) (individual luminaire - integral) (ALCR3)

2. 26 52 15 Emergency Lighting Inverter
3. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.03 REFERENCES

A. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products

B. ANSI C82.16 - Light-Emitting Diode Drivers - Method of Measurement

C. ANSI C82.77 - Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment

D. NFPA 70E - National Electrical Safety Code

E. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays or System

F. UL 8750 - Light Emitting Diode (LED) Equipment for use in Lighting Products

G. LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products

H. LM-80 - Measuring Luminous Flux and Color Maintenance of LED

I. FS W-L-305 - Light Set, General Illumination (Emergency or Auxiliary)

J. UL 924 - Standard for Emergency Lighting and Power Equipment

K. UL676 Standard for Underwater Luminaires and Submersible Junction Box

L. Project site classification as defined in IESNA RP-33[**LZ0**][**LZ1**][**LZ2**][**LZ3**][**LZ**].

1.04 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Basic Requirements of Submittal:

1. Submit product data sheets for luminaires, LED light engines, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with luminaires listed in ascending order, and with each luminaire's, LED light engine, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
2. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
3. Include outline drawings, support points, weights, and accessory information for each luminaire.
4. Submit manufacturer origin of LED chipset and driver.

C. LED Lighting - Performance Testing Submittal (when requested by Architect/Engineer):

1. IESNA LM-79: Include photometric report for the latest generation system being furnished. Provide name of independent testing laboratory, report number, date of test, luminaire series/model number, input wattage, and light source specifications.
2. IESNA LM-80: Measuring Lumen Maintenance of LED Light Sources.

D. LED Lighting - Control Compatibility Submittal:

1. Submit lighting control capability data for each LED luminaire. The submittal shall clearly identify device data proposed by the Contractor and approved by the luminaire manufacturer for dimming, switching, addressable, wireless, and similar control characteristics.

E. Submit Design Lights Consortium (DLC) information for each luminaire type.

F. Submit utility rebate forms where offered at project location. Submit completed rebate forms within 30 days of Substantial Completion.

1.05 EXTRA STOCK

A. Provide extra stock under provisions of Section 260500.

B. LED Light Engines or Modules: 10 percent of quantity installed, minimum one (1) of each size and type of field replaceable light engine or module. Provide field replacement installation instructions.

C. Lenses: Three (3) percent of quantity installed, minimum one (1) of each size and type.

D. LED Drivers: 10 percent of quantity installed, minimum one (1) of each size and type.

E. Exit Signs: Provide 2 **a**dditional exit sign luminaires complete with labor, conduit, and wire. Additional exit luminaires shall be located per the Architect/Engineer or provided as attic stock when a location is not defined prior to Owner occupancy. When multiple exit signs are scheduled, the quantity listed above shall represent each type listed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site. Store and protect under provisions of Section 260500.

B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.

C. Handle site lighting poles carefully to prevent breakage and damage to finish.

1.07 MOCKUP

A. Provide and install luminaires with power and control connections in mockup rooms as identified in Division 1. Approved luminaires in mockup may be reused as part of complete work if in original condition.

1.08 WARRANTY

A. The warranty period begins at the date of Substantial Completion.

B. LED Light Engines and Drivers:

1. LED Drivers and Dimming Drivers: Five (5) years
2. Light Emitting Diode (LED) Light Engines: Five (5) years

C. Emergency Lighting Units and Exit Signs:

1. Emergency Lighting Units: Three (3) year, non-prorated
2. Exit Signs: Three (3) year, non-prorated
3. Emergency Unit and Exit Sign Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for ten (10) years under normal conditions.

D. Emergency Drivers:

1. Emergency LED Driver: Three (3) years

E. Emergency Inverter for LED Light Engines:

1. Emergency Inverter and Battery: Sealed nickel cadmium five (5) year, non-prorated.

F. Automatic Load Control Relay (ALCR): Five (5) year

G. Pole Finish: Three (3) year warranty of pole color and finish

1.09 REGULATORY REQUIREMENTS

A. Conform to NFPA 101 for installation requirements.

PART 2 - PRODUCTS

2.01 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Lensed Troffers: Provide hinged frames with latches and 0.125-inch thick virgin acrylic lenses. Prismatic lenses shall have depth of no less than 0.080", KSH12 or equal. Other lenses as scheduled.

B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.

C. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction.

D. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified. Verify suspension length prior to submittal.

E. Painted reflector surfaces shall have a minimum reflectance of 90%.

F. All painted components shall be painted after fabrication.

G. Where indicated on drawings, provide wire guards for luminaires to protect against damage and vandalism. Wire guards shall be constructed of durable coated steel wire.

2.02 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Listed for wet or damp location as scheduled. Provide ingress protection (IP) rating when scheduled.

B. Provide low temperature LED drivers, with reliable starting to -20F.

C. Provide high temperature ambient LED drivers, with reliable operating temp to 65C. The luminaire LED driver shall auto dim or turn off if the manufacturer’s maximum operating temp is exceeded.

D. In-grade luminaires shall have lamp/optic separation to prevent surface temperature from exceeding 115F. Compartment separation of wire entry and control gear/lamp chamber.

E. Exterior LED luminaires shall contain separate, easily accessible and replaceable Category C surge protection device.

F. Where indicated on drawings, provide wire guards for luminaires to protect against damage and vandalism. Wire guards shall be constructed of durable coated steel wire.

2.03 SUBMERGED LUMINAIRES - GENERAL

A. Fountain and pool luminaires shall be listed for the specific submersible location (e.g., fountain, swimming pool, or spa) to meet depth specified. Manufacturer to test all luminaire enclosures to minimum 10 psi (0.70kg/cm2) internal pressure while totally submerged in water. No visible air bubbles allowed. Manufacturer to verify luminaire functionality at specified operating depth.

2.04 GERMICIDAL IRRADIATION LUMINAIRES

A. Germicidal irradiation luminaires shall be listed. Refer to luminaire schedule for additional information.

B. Lighting Controls shall prohibit Germicidal irradiation operation during human occupancy unless the luminaire is specifically listed for use during occupancy.

2.05 HORTICULTURAL LUMINAIRES

A. Horticultural luminaires shall be labeled for the application, safety cable connection to support structure, cord and plug electrical connection.

B. Branch Circuit Protection:

1. Provide GFCI branch circuit protection for luminaires operating at 120-volts or less.
2. Provide special SPGFCI circuit protection for luminaires operating in excess of 150-volts.

2.06 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

A. Light emitting diodes used in interior applications shall have a minimum color rendering index (CRI) of 70. The R9 color rendering value shall be a minimum of 50. Light emitting diodes used in exterior applications shall have a minimum color rendering index (CRI) of 70. Color temperature of the luminaires shall be as noted on the luminaire schedule. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.

B. Refer to the luminaire schedule for color temperature and minimum color rendering index CRI requirements. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.

C. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.

D. Rated life shall be minimum of 50,000 hours at L70.

E. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.

F. Dynamic Tunable LED (DLED): Variable correlated color temperature LED systems shall offer a range of temperature control from 2700K through 6000K. Color rendering index shall be a minimum of 80. Dimming control from 100% to 1%. Shall offer compatibility with any LED dimming driver/controller including 0-10V, DALI, DMX, etc.

G. Warm Dim LED (WLED): Variable warm dimming LED systems shall offer a range of temperature control from 2700K through 1800K. Color rendering index shall be a minimum of 80. Dimming control from 100% to 1%. Shall offer compatibility with any LED dimming driver/controller including 0-10V, DALI, DMX, etc.

H. Luminaire delivered lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.

I. LED luminaires shall be designed for ease of component replacement including modular replaceable boards or Zhaga sockets. Luminaires that are factory sealed and do not have field replaceable parts shall provide a 10-year warranty.

J. LED light engine shall have a maximum LLD of 0.85 at 50,000 hours at 25C ambient.

K. LED Driver:

1. Solid state driver with integral heat sink. Driver shall have over-heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 10%. Driver shall have a voltage fluctuation tolerance of +/- 10%.
2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type. Dimming shall control light output in a continuous curve from 100% to 10% unless noted otherwise.
3. Driver shall have a minimum of 50,000 hours rated life.
4. Driver shall be tested to ANSI C82-16 for input current inrush, total harmonic distortion (THD), and power factor. Driver start time shall be less than 0.5 seconds to 98% of initial light output. Flicker should be less than 30% throughout the operating range.
5. Driver shall be field replaceable without removal of the luminaire.
6. Class A sound rating; inaudible in a 27 dBA ambient.
7. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

2.07 LED EMERGENCY LIGHTING UNITS

A. Self-Powered Emergency Lighting Units: One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. 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.

B. Battery: Maintenance free lead calcium type, with 90 minute capacity to supply the connected lamp load.

C. Charger: Dual-rate solid state current limiting charger, capable of maintaining the battery in a full-charge state during normal conditions, and capable of recharging discharged battery to full charged within 168 hours. Low voltage disconnect to prevent deep discharge of battery.

D. LED Lamp Wattage: As scheduled on luminaire schedule.

E. Remote Lamps: Match LED lamps on unit.

F. Indicators: Provide lamps to indicate AC ON and RECHARGING.

G. Provide test switch to transfer unit from normal supply to battery supply.

H. Electrical Connection: Knockout for conduit connection.

I. Unit Voltage: Refer to luminaire schedule volts, AC.

J. Self-Diagnostics and Testing:

1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.
2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five-minute discharge/diagnostic test at any time.

2.08 EMERGENCY EXIT SIGNS

A. Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings.

B. Self-Powered Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings. One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, test switch, AC ON pilot light, automatic charger, and electronic circuitry. Power failure 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.

C. Directional Indicators: The directional indicator for exit signage shall be of a chevron type meeting all requirements of NFPA 101.

D. Self-Diagnostics and Testing:

1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.
2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five minute discharge/diagnostic test at any time.

2.09 EMERGENCY INVERTER FOR LED LIGHT ENGINES (INDIVIDUAL LUMINAIRES - INTEGRAL)

A. Unit: Self-contained, with automatic transfer to battery supply on loss of normal power, UL 924 listed for factory or field installation, indoor and damp locations, 32F to 122F operating temperature. Compatible with switched, dimmed, and unswitched lighting controls. Compatible with LED light engines. The inverter output shall be sinusoidal with solid-state low voltage disconnect circuit.

B. Battery: Sealed, high temperature, maintenance free, nickel cadmium battery with capacity to provide 90 minutes of emergency operation at full lumen and wattage output, with 24-hour recharge time. Refer to Luminaire Schedule for lumen and wattage requirements.

C. Features: Integral battery charger with LED charging indicator light, test switch, electronic circuitry for use with LED drivers. Test and monitor switch shall be integral to luminaire or mounted flush in finished ceiling per Luminaire Schedule.

D. Factory and Field Installation: Listed for installation inside and adjacent to luminaire. Refer to Luminaire Schedule for individual luminaire requirements. Remote-mounted units shall be located above finished ceiling, adjacent to luminaire, and accessible from below through luminaire opening.

E. Self-Test Diagnostics and Testing: Provide with listed automatic monthly self-test diagnostics.

F. Manufacturers:

1. Myers LVU Series

2.010 LIGHTING POLES

A. Manufacturers:

1. Manufacturer of luminaire (metallic pole)
2. Valmont Poles (metallic pole)
3. U.S. Pole Company (metallic pole)
4. KW Industries (metallic pole)
5. Ameron Pole Products Division (concrete pole)
6. Stresscrete (concrete pole)
7. Traditional Concrete (concrete pole)
8. TimberWood (wooden pole)
9. Lithonia (wooden pole)
10. Valmont NV (wooden pole)

B. Metal Poles: Square Round straight tapered steel aluminum **lighting pole with** anchor base.

1. Painted steel poles shall have electrostatic applied polyester powder coated paint finish thermally cured with UV protection. Interior of pole shall be coated with same coating for a minimum of 12" from base plate.
2. Galvanized steel hot dipped finish to standard AASHTO M 111.
3. Anodized aluminum finish to MIL-A-8625 Type II, minimum 0.8 mil thickness. Provide anodized color sample to Architect/Engineer prior to ordering.

C. Prestressed Concrete Poles: Square Round straight tapered lighting pole with anchor base.

D. Fiberglass Direct Embedded Pole: Fiberglass reinforced composite shaft constructed by filament winding "E" type fiberglass with thermosetting polyester resin. The resin shall be pigmented, UV inhibiting with a polyurethane top coating. Pole shall have a handhole 18" above grade and a wiring access opening 24" below grade.

E. Laminated Wood Poles: Raceway type lighting pole; pressure treat with alkaline copper quaternary (ACQ) preservative. Wood species and finish selection by Architect/Engineer.

F. Wind Load: 100 MPH velocity, with 1.14 percent three-second gust factor with luminaires and brackets mounted.

G. Hand Hole: 2 x 4 inches with removable weatherproof cover installed at manufacturer's standard location. Provide matching gasketed cover plate.

H. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole. Grout between anchor plate and concrete base with non-shrink grout after pole is plumbed.

I. Vibration Damper: Canister or snake type second mode vibration damper internal to the metal pole as recommended by pole manufacturer. Provide additional pole top damper for first mode vibration on single-head metal poles where recommended by manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. The architectural ceiling framing system may be used in lieu of independent support with prior written approval by the ceiling system manufacturer and Authority Having Jurisdiction (AHJ). Luminaires and wiring installed in fire-rated ceiling assemblies shall be independently supported for all applications.

1. Install recessed flanged luminaires to permit removal from below. Use manufacturer-supplied plaster frames and swing gate supports. Provide independent support as follows:

   a. Luminaires less than 56 lbs: Provide a minimum of two (2) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires.
   b. Luminaires 56 lbs or greater: Provide a minimum of four (4) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires. Support luminaire independent of the ceiling system.
   c. Luminaires larger than eight square feet (8 ft2): Support luminaire independent of the ceiling system.

B. Do not fasten luminaire supports to piping, ductwork, mechanical equipment, or conduit, unless otherwise noted. Support wires shall be tightly wrapped (minimum of three turns within 3 inches of the connection) and sharply bend to prevent vertical movement.

C. Support suspended or pendant mounted luminaires independent of ceiling grid with adjustable stainless steel aircraft cables or per luminaire schedule mounting requirements. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.

D. Support wire used to independently support luminaires, raceways, and wiring systems shall be distinguishable from ceiling support systems by color (field paint), tagging or equivalent means.

E. Provide seismic bracing of luminaires per IBC Chapter 16. Design pendant luminaires on a component seismic coefficient (Cc) of 0.67. Design vertical supports with a factor of safety of 4.0. Contractor shall verify the Seismic Hazard Exposure Group and Performance Criteria Factor.

F. Install lamps in lamp holders of luminaires.

G. Adjust aimable luminaires to obtain lighting levels on objects and areas as directed to obtain desired lighting levels.

H. Recessed luminaires and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.

I. Industrial Pendant Luminaires: Use power hook hangers rated 500 pounds minimum or provide safety chain between driver and structure. Provide safety chain between reflector and driver.

J. Luminaire Pole Bases: Sized and constructed as indicated on the drawings. Project anchor bolts 2 inches minimum above base. Install poles plumb with double nuts for adjustment. Grout around pole anchor base.

K. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

3.02 CONSTRUCTION USE OF PROJECT LUMINAIRES

A. The Contractor shall provide temporary construction lighting per the requirements of Division 1.

B. The project luminaires shown on the construction documents shall not be used for temporary construction purposes without providing a plan for Owner approval that addresses energy and luminaire operating hours.

3.03 AUTOMATIC LOAD CONTROL RELAYS

A. Factory or field installation per manufacturer requirements.

B. Remote Test Switch: Provide connection to remote test switch.

C. Fire Alarm Override: Provide connection to addressable fire alarm relay.

3.04 EMERGENCY LIGHTING UNITS AND EXIT SIGNS

A. Install units plumb and level.

B. Aim directional lamp heads as directed.

C. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.05 RELAMPING

A. Replace failed LED light engine modules or arrays at completion of work.

3.06 ADJUSTING AND CLEANING

A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.

B. Touch up luminaire and pole finish at completion of work.

3.07 OWNER TRAINING

A. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion, with the Owner's Representative.

B. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.08 LUMINAIRE SCHEDULE

A. As shown on the drawings.

END OF SECTION

WACHTER TECHNOLOGY DESIGN SERVICES

DIVISION 27 AUDIOVISUAL SYSTEMS SPECIFICATION PACKAGE

Communications Infrastructure | Audio-Video | Room Scheduling | Sound Masking

PROJECT BASIS

Item	Requirement
Equipment Rooms	Rooms 175 and 275
AV Rack	Panduit R4P36 with PE2VD12 vertical manager and Middle Atlantic accessories
AV Systems	Digital signage, office displays, huddle rooms, large huddle rooms, large conference rooms
Room Scheduling	Crestron TSS-1080-B, wall and glass mounting
Sound Masking	Biamp Cambridge Qt X controllers with active emitters
Network/Pathways	Shared Division 27 cabling, equipment-room, ladder-tray, sleeve, and Owner IT infrastructure

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SECTION 27 05 26 - Grounding and Bonding for Communications Systems
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SECTION 27 41 16 - Audio-Video Systems
SECTION 27 41 33 - Room Scheduling Systems
SECTION 27 51 19 - Sound Masking Systems

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide common requirements for the Division 27 infrastructure and AV systems.

B. Provide complete coordination, installation, testing, training, and closeout.

1.2 RELATED SECTIONS

A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS

A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE

A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS

A. Provide new commercial-grade materials suitable for the environment.

B. Provide plenum-rated materials where required.

C. Provide manufacturer accessories for complete, listed, serviceable assemblies.

2.2 DOCUMENTATION

A. Provide consistent room, rack, cable, device, IP, and test documentation.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate power, grounding, pathways, boxes, network, ceilings, walls, furniture, security devices, and room finishes.

3.2 CLOSEOUT

A. Provide as-builts, schedules, test reports, configuration files, warranties, and training records.

END OF SECTION 27 05 00

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Provide grounding and bonding for communications and AV racks, tray, metallic pathways, and enclosures.

1.2 RELATED SECTIONS
A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS
A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE
A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 BONDING MATERIALS
A. Provide copper bonding conductors, listed lugs, bonding jumpers, rack bonding kits, and telecommunications grounding busbars.

2.2 IDENTIFICATION
A. Provide machine-printed grounding labels.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Bond racks, tray, managers, and metallic pathways; remove paint at bonding points as required.

3.2 TESTING
A. Verify continuity and correct deficiencies.

END OF SECTION 27 05 26

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Provide pathways for structured cabling and AV cabling, including conduit, J-hooks, pull boxes, sleeves, and tray transitions.

1.2 RELATED SECTIONS
A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS
A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE
A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 CONDUIT AND SUPPORTS
A. Provide EMT, insulated bushings, pull tape, J-hooks, pull boxes, supports, and fittings.

2.2 CAPACITY
A. Pathways shall include growth allowance and maintain cable bend radius.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Route parallel or perpendicular to building lines, maintain access, and coordinate with other systems.

3.2 PROTECTION
A. Do not attach cabling to ceiling grid, sprinklers, ductwork, or unrelated systems.

3.3 PROJECT-SPECIFIC REQUIREMENTS
A. Maintain minimum 25 percent spare pathway capacity.

END OF SECTION 27 05 28

SECTION 27 05 43 - THROUGH-FLOOR AND HORIZONTAL SLEEVES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Provide sleeves serving Rooms 175 and 275 and AV distribution pathways.

1.2 RELATED SECTIONS
A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS
A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE
A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 SLEEVES
A. Provide minimum six 4-inch through-floor sleeves and six 4-inch horizontal sleeves at applicable room/pathway conditions.

B. Provide insulated bushings, pull tape, labels, caps, and re-enterable firestopping.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Align sleeves with ladder tray and keep accessible.

3.2 CAPACITY
A. Document use and maintain spare capacity.

3.3 PROJECT-SPECIFIC REQUIREMENTS
A. Maintain minimum 50 percent spare sleeve capacity.

END OF SECTION 27 05 43

SECTION 27 05 53 - IDENTIFICATION AND ADMINISTRATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide identification for cables, pathways, racks, rooms, patch panels, AV devices, scheduling panels, and sound-masking components.

B. Use [TYPE PREFIX]-[4 DIGIT NUMBER]-[SEQUENCE SUFFIX] with the same complete ID at both cable ends.

1.2 RELATED SECTIONS

A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS

A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE

A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 LABELS

A. Provide durable machine-printed labels; handwritten final labels are not acceptable.

2.2 NUMBERING

A. Reserve 0001-1999 for AV systems; use approved subsystem prefixes and suffix X for installed spares.

PART 3 - EXECUTION

3.1 APPLICATION

A. Label cables, equipment, rack positions, patch points, faceplates, and accessible transition points.

3.2 DOCUMENTATION

A. Match labels to schedules, drawings, rack elevations, and test reports.

END OF SECTION 27 05 53

SECTION 27 10 00 - STRUCTURED CABLING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Provide shared structured cabling used by network-connected AV, room scheduling, and sound masking equipment.

1.2 RELATED SECTIONS
A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS
A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE
A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 COPPER
A. Provide Category-rated cable, jacks, patch panels, and patch cords suitable for the connected devices and PoE requirements.

2.2 FIBER
A. Provide OS2 backbone and rack-mounted fiber termination hardware where required for AV network connectivity.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install continuous home runs in approved pathways and terminate in designated passive racks.

3.2 TESTING
A. Certify copper links and test fiber strands; correlate results to cable IDs.

END OF SECTION 27 10 00

SECTION 27 11 00 - TELECOMMUNICATIONS ROOMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide complete infrastructure for Rooms 175 and 275.

B. Provide four racks per room: RK-1 active network, RK-2 passive telecommunications, RK-3 AV, and RK-4 future.

1.2 RELATED SECTIONS

A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS

A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE

A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 ROOM CONFIGURATION

A. Provide Panduit R4P36 racks and Panduit PE2VD12 vertical cable managers.

2.2 POWER

A. Coordinate L6-20R receptacles above ladder tray and centralized UPS-backed circuits where applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Maintain front/rear service access, airflow, grounding, overhead routing, and future capacity.

3.2 CLOSEOUT

A. Provide room layouts, rack elevations, power schedules, and pathway/sleeve schedules.

3.3 PROJECT-SPECIFIC REQUIREMENTS

A. Maintain minimum 30 percent spare space in RK-1 through RK-3; maintain RK-4 unloaded unless approved.

END OF SECTION 27 11 00

SECTION 27 11 16 - COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide AV equipment racks and accessories in Rooms 175 and 275.

1.2 RELATED SECTIONS

A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS

A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE

A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 RACKS AND MANAGERS

A. Provide Panduit R4P36 four-post 45RU rack and Panduit PE2VD12 vertical cable manager.

2.2 RACK ACCESSORIES

A. Provide Middle Atlantic LACE-44-OWP lacing strips, LBP-LTF lacer panels, U2V vented shelves, PDX-920R rack surge protectors, PDT-1620C-NS vertical power strips, and rack screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install plumb, level, securely anchored, bonded, and labeled.

3.2 CLOSEOUT

A. Provide final rack elevations and equipment inventory.

END OF SECTION 27 11 16

SECTION 27 11 23 - COMMUNICATIONS CABLE MANAGEMENT AND CABLE TRAY

PART 1 - GENERAL

1.1 SUMMARY

A. Provide overhead ladder tray and cable management supporting AV and communications systems.

1.2 RELATED SECTIONS

A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS

A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE

A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 CABLE TRAY

A. Provide 1-1/4 inch x 18 inch tray, supports, waterfalls, radius drops, splice kits, and bonding jumpers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Align tray above rack rows and with sleeve/pathway entrances; keep unrelated systems out.

3.2 CAPACITY

A. Maintain spare tray capacity and document final fill.

3.3 PROJECT-SPECIFIC REQUIREMENTS

A. Maintain minimum 25 percent spare ladder-tray capacity.

END OF SECTION 27 11 23

SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY
A. Provide OS2 single-mode backbone from the existing MDF to Rooms 175 and 275 for network and AV infrastructure.

1.2 RELATED SECTIONS
A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS
A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE
A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 FIBER
A. Provide OS2 cable, LC duplex connectivity, enclosures, panels, splice trays, slack storage, labels, and patch cords.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Terminate in RK-2 passive racks and provide service loops.

3.2 TESTING
A. Provide insertion-loss and OTDR testing by cable and strand.

END OF SECTION 27 13 23

SECTION 27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY
A. Provide copper horizontal cabling for network-connected AV devices, scheduling panels, processors, cameras, touch panels, loudspeakers, and controllers.

1.2 RELATED SECTIONS
A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS
A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE
A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 CABLING
A. Provide category-rated cable, connectors, patch panels, faceplates, and patch cords compatible with bandwidth and PoE requirements.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install continuous home runs, maintain separation and support, and label both ends.

3.2 TESTING
A. Certify 100 percent of installed permanent links and provide electronic reports.

END OF SECTION 27 15 13

SECTION 27 21 00 - DATA COMMUNICATIONS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Coordinate network switches, ports, PoE, VLANs, uplinks, IP addressing, and AV network segmentation with Owner IT.

1.2 RELATED SECTIONS
A. Division 26 - Electrical.

B. Section 27 41 16 - Audio-Video Systems.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where infrastructure is shared.

1.3 SUBMITTALS
A. Product data for materials and equipment furnished under this Section.

B. Shop drawings, device schedules, coordination details, and installation diagrams.

C. Testing procedures, test records, as-built drawings, warranties, and operation and maintenance documentation.

1.4 QUALITY ASSURANCE
A. Installer shall be experienced with systems of similar type, scale, and complexity.

B. Coordinate work with Division 26, Owner IT, architectural, mechanical, fire-protection, security, and affected trades before rough-in.

PART 2 - PRODUCTS

2.1 NETWORK EQUIPMENT
A. Coordinate Cisco Catalyst 9300X-PXG and 9300-48P building network infrastructure with D-Link AV switches and AVPro Edge MXnet switching.

2.2 POWER
A. Coordinate centralized UPS-backed power and rack receptacles where applicable.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install and dress network equipment in designated racks with service access and airflow.

3.2 TESTING
A. Verify power, uplinks, PoE, VLAN, patching, and device connectivity with Owner IT.

END OF SECTION 27 21 00

SECTION 27 41 16 - AUDIO-VIDEO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide complete digital signage, office display, huddle room, large huddle room, and large conference room AV systems.

B. Provide displays, mounts, in-wall boxes, power kits, signal extension, collaboration compute, cameras, microphones, DSP, amplification, loudspeakers, touch panels, interconnects, racks, programming, testing, commissioning, training, and closeout.

C. Provide equipment in accordance with the project equipment list and approved shop drawings.

1.2 RELATED SECTIONS

A. Division 26 - Electrical: power, raceways, boxes, grounding, and branch circuits.

B. Division 27 - Communications: structured cabling, network cabling, equipment-room coordination, and pathways.

C. Section 27 41 33 - Room Scheduling Systems.

D. Section 27 51 19 - Sound Masking Systems.

E. Division 28 - Electronic Safety and Security where AV systems share network infrastructure.

1.3 SYSTEM DESCRIPTION

A. Digital signage shall use AVPro Edge MXnet, SpinetiX players, Samsung displays, Chief mounting, AVPro Edge receivers, and Extron interconnects.

B. Huddle rooms shall use Samsung QM55C displays, Chief infrastructure, Crestron UC-SB1-CAM, Crestron AirMedia, AVPro Edge receivers, and associated cabling.

C. Large huddle rooms shall use Crestron collaboration compute and control, Shure P300 processing, Crestron amplification, Samsung QM65C display, Crestron 1 Beyond camera, video/USB extension, and D-Link switch.

D. Large conference rooms shall use Crestron collaboration compute, DM NAX processing, Samsung QM75C displays, Crestron 1 Beyond cameras, Shure MXA920 microphones, Crestron SAROS loudspeakers, video/USB extension, touch control, and D-Link switch.

E. Equipment racks shall be located in Rooms 175 and 275.

1.4 ROOM TYPES

A. Digital signage areas include Reception 166, Break Room 169, NSP 185 and 285, South Work Lounges 174.1 and 274.1, RTO 193, South Corridors 174 and 274, Work Lounge 232, and Executive Lounge 240.

B. Huddle rooms include 180, 177, 189, 190, 191, 192, 281, 287, 280, 277, 289, and 292.

C. Large huddle rooms include 176, 183, 276, and 283. Large conference rooms include 196 and 245.

1.5 SUBMITTALS

A. Provide product data, device plans, wall elevations, rack elevations, signal flow, control diagrams, cable schedules, room schedules, signage risers, collaboration diagrams, and network requirements.

B. Provide as-builts, final equipment list, rack elevations, cable and device schedules, IP schedule where permitted, configuration files, warranty, commissioning, and training records.

1.6 QUALITY ASSURANCE

A. AV contractor shall be experienced with commercial AV systems of similar complexity and shall coordinate all rough-in requirements before installation.

B. Coordinate IP devices, addressing, VLANs, QoS, switch ports, and PoE budgets with Owner IT.

PART 2 - PRODUCTS

2.1 DIGITAL SIGNAGE

A. Provide AVPro Edge AC-MXNET-1G-E encoder, AC-MXNET-CBOX-HA control box, AC-MXNET-SW24E switch, Chief U1V shelf, and SpinetiX HMP400 player.

B. Provide Samsung QM75C/QM55C displays, Chief mounts and in-wall boxes, proximity power kits, AVPro Edge AC-EX70-UHD-R2 receivers, and Extron HDMI cabling as scheduled.

2.2 OFFICE DISPLAY SYSTEMS

A. Provide Samsung QM55C displays, Chief LSTU mounts, PAC526 boxes, PAC526P2-KIT power kits, MuxLab 500505 splitters, AVPro Edge receivers, Extron HDMI, and DisplayPort adapters.

2.3 HUDDLE ROOMS

A. Provide Samsung QM55C, Chief LTM1U/PAC526/PAC526P4-KIT, Crestron UC-SB1-CAM, Crestron AM3-111 KIT, AVPro Edge receiver, and Extron HDMI.

2.4 LARGE HUDDLE ROOMS

A. Provide Crestron CCC-120-T, CCCA-CMK-110/120, AMP-X75, AM3-111 KIT, TS-1080-UC-B, HD-TXC-4KZ-101, HD-RXC-4KZ-101, and IV-CAM-P12-B.

B. Provide Shure P300-IMX/CRT1, D-Link DGS-1210-10P, Samsung QM65C, Chief infrastructure, SCT USB extension, C2G USB, AVPro Edge receiver, and Extron HDMI.

2.5 LARGE CONFERENCE ROOMS

A. Provide Crestron CCC-120-T, CCCA-CMK-110/120, DM-NAX-AP-100, AM3-111 KIT, TS-1080-UC-B, HD-TXC/RXC-4KZ-101, IV-CAM-I12D-B for Room 245, and IV-CAM-P12-B as scheduled.

B. Provide D-Link DGS-1210-10P, Samsung QM75C, Chief infrastructure, SCT/C2G USB, AVPro Edge receiver, Extron HDMI, Crestron SAROS DM-NAX-IC4A-W and IC4P-W loudspeakers, templates, tie-down kits, and Shure MXA920 microphones.

2.6 MOUNTS, CABLING, AND RACK ACCESSORIES

A. Provide Chief mounts, boxes, power kits, anchors, backing, HDMI, USB, DisplayPort, HDBaseT, network cabling, patch cords, labels, and cable management.

B. Provide Panduit and Middle Atlantic rack equipment defined in Section 27 11 16.

PART 3 - EXECUTION

3.1 EXAMINATION AND COORDINATION

A. Verify dimensions, wall/ceiling construction, furniture, power, data, pathways, fields of view, microphone/loudspeaker locations, and rack conditions.

B. Coordinate displays with blocking and boxes, ceiling devices with lighting/HVAC/sprinklers, and room-entry devices with signage and security.

3.2 INSTALLATION

A. Install equipment plumb, level, secure, serviceable, concealed where practical, and labeled at both cable ends.

B. Install complete signage, office display, huddle, large huddle, conference, rack, control, audio, camera, and signal-extension systems.

3.3 CONFIGURATION, TESTING, AND COMMISSIONING

A. Configure routing, displays, control, DSP, microphones, loudspeakers, cameras, USB extension, AirMedia, collaboration compute, and network settings.

B. Test content playback, local presentation, conferencing, audio pickup/playback, camera operation, USB extension, control, source routing, network connectivity, and rack power.

C. Commission audio levels, microphone sensitivity, loudspeaker levels, camera views, displays, routing, and controls; correct and retest deficiencies.

3.4 TRAINING AND CLOSEOUT

A. Train Owner on system operation, basic troubleshooting, and support escalation.

B. Provide complete closeout records reflecting final installed conditions.

END OF SECTION 27 41 16

SECTION 27 41 33 - ROOM SCHEDULING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide room scheduling systems for Rooms 117, 176, 180, 183, 189, 190, 191, 192, 196, 277, 280, 281, 287, 289, 292, 245, 276, and 283.

B. Provide scheduling panels, wall/glass mounting, network/PoE, configuration, testing, training, and closeout.

1.2 RELATED SECTIONS

A. Division 26 - Electrical.

B. Division 27 - Communications.

C. Section 27 41 16 - Audio-Video Systems.

D. Division 28 - Coordinate room-entry placement with security devices.

1.3 SUBMITTALS

A. Provide product data, location plans, wall/glass mounting details, network/PoE requirements, configuration documentation, and closeout inventory.

PART 2 - PRODUCTS

2.1 PANELS

A. Basis of Design: Crestron TSS-1080-B 10.1-inch Room Scheduling Touch Screen.

B. Provide manufacturer wall and glass mounting accessories suitable for each condition.

C. Provide network cabling and PoE.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install at room entrances; coordinate with signage, door hardware, readers, switches, glass sidelights, and wall elevations.

B. Conceal cabling and provide a clean finished installation.

3.2 CONFIGURATION AND TESTING

A. Configure room name, assignment, scheduling service, and Owner IT connection.

B. Verify PoE, network, room identity, booking, status display, and calendar synchronization.

3.3 CLOSEOUT

A. Provide final inventory, room assignments, configuration, warranty, and training records.

END OF SECTION 27 41 33

SECTION 27 51 19 - SOUND MASKING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide complete sound masking for open office areas using Biamp Cambridge Qt X controllers and active emitters.

B. Provide rack kits, rough-in brackets, cabling, software/configuration, tools, commissioning, and closeout.

1.2 RELATED SECTIONS

A. Division 26 - Electrical.

B. Division 27 - Communications.

C. Section 27 41 16 - Audio-Video Systems.

1.3 SUBMITTALS

A. Provide product data, emitter layout, controller locations, zone plan, cabling plan, rack elevations, commissioning procedure, configuration report, and closeout.

PART 2 - PRODUCTS

2.1 CONTROLLERS

A. Basis of Design: Biamp Cambridge Qt X 600 controller with six Qt outputs.

B. Provide Qt X RMT-KT rack mount kits, power, network, and control accessories.

2.2 ACTIVE EMITTERS

A. Provide Biamp Cambridge active emitters compatible with Qt X and the installed ceiling condition.

B. Provide compatible emitter cabling, DRB-1 KIT rough-in brackets where required, mounts, safety accessories, and installation tools.

C. Do not mix incompatible device types on an output run.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install emitters in open office areas; coordinate with lighting, HVAC, sprinklers, ceilings, finishes, and access panels.

B. Install controllers in designated racks and dress cabling neatly.

3.2 CONFIGURATION AND COMMISSIONING

A. Configure outputs, zones, and levels for uniform coverage.

B. Verify every controller and emitter, balance system after finishes/furniture are in place, and document final settings.

3.3 CLOSEOUT

A. Provide final emitter layout, controller locations, zones, cable schedule, settings, commissioning report, warranty, and training records.

END OF SECTION 27 51 19

SECTION APPENDIX A - RELATED DIVISION COORDINATION MATRIX

Reference	Coordination Responsibility
Division 26 - Electrical	Power, receptacles, branch circuits, raceways, boxes, grounding, in-wall power kits.
Division 27 - Communications	Cabling, PoE, pathways, sleeves, racks, ladder tray, identification, network coordination.
Division 28 - Security	Coordinate shared network, pathways, room-entry devices, ceilings, and equipment-room interfaces.

END OF SECTION APPENDIX A

WACHTER TECHNOLOGY DESIGN SERVICES

TELECOMMUNICATIONS SPECIFICATION PACKAGE

Lowell office remodel Server Rooms 175 and 275 | Structured Cabling | Fiber Backbone | Active Network

PACKAGE BASIS

Item	Project Requirement
Telecommunications Rooms	Server Room 175 and Server Room 275
Rack Allocation	RK-1 Active Network, RK-2 Passive Telecommunications, RK-3 Audio Visual, RK-4 Future Expansion
Rack Basis of Design	Panduit R4P36 unloaded 45RU four-post racks with Panduit PE2VD12 vertical cable managers
Copper Cabling	CAT6 for general network devices and CAT6A for Cisco Meraki MR46 wireless access points
Fiber Backbone	OS2 single-mode fiber from existing MDF to Server Rooms 175 and 275 with LC duplex connectivity
Active Network	Cisco Catalyst 9300X-PXG and Cisco Catalyst 9300-48P
Power	L6-20R receptacles and centralized UPS-backed circuits where applicable

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SECTION 27 05 53 – IDENTIFICATION AND ADMINISTRATION FOR COMMUNICATIONS SYSTEMS

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3.5 WIRELESS ACCESS POINT IDENTIFICATION

3.6 DOCUMENTATION REQUIREMENTS

SECTION 27 11 00 - TELECOMMUNICATIONS ROOMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide complete telecommunications room infrastructure for Server Room 175 and Server Room 275.

B. Each telecommunications room shall support structured cabling, wireless access point cabling, optical fiber backbone cabling, active network equipment, passive patching infrastructure, AV infrastructure, and future expansion.

C. Work includes equipment racks, vertical cable management, ladder tray coordination, grounding and bonding coordination, power coordination, rack identification, room layout coordination, sleeve coordination, and future capacity planning.

D. Telecommunications rooms shall be configured to support current project requirements without limiting reasonable future technology expansion.

1.2 RELATED SECTIONS

A. Section 27 05 26 - Grounding and Bonding for Communications Systems.

B. Section 27 05 28 - Pathways for Communications Systems.

C. Section 27 05 43 - Through-Floor and Horizontal Sleeves for Communications Systems.

D. Section 27 05 53 - Identification and Administration for Communications Systems.

E. Section 27 11 16 - Communications Cabinets, Racks, Frames, and Enclosures.

F. Section 27 11 23 - Communications Cable Management and Ladder Tray.

G. Section 27 13 23 - Communications Optical Fiber Backbone Cabling.

H. Section 27 15 13 - Communications Copper Horizontal Cabling.

I. Section 27 21 00 - Data Communications Equipment.

J. Section 27 21 33 - Wireless Access Points.

K. Division 26 - Electrical power, grounding electrode system, branch circuits, and centralized UPS connections.

1.3 ROOM LOCATIONS

A. Telecommunications rooms included in this Section are:

1. Server Room 175.
2. Server Room 275.

B. Each room shall be arranged with a consistent rack strategy to support operations, maintenance, documentation, and future expansion.

C. Room layouts shall coordinate with architectural room dimensions, door swings, egress, clearance requirements, pathway entry points, through-floor sleeves, horizontal sleeves, ladder tray, power, grounding, and HVAC requirements.

1.4 SUBMITTALS

A. Product Data: Submit product data for racks, vertical cable managers, ladder tray interfaces, bonding accessories, rack labeling, rack hardware, and related telecommunications room infrastructure.

B. Telecommunications Room Layouts: Submit scaled room layouts for Server Room 175 and Server Room 275 showing rack rows, rack IDs, vertical cable managers, ladder tray, sleeve locations, pathway exits, power receptacle locations, grounding points, and required clearances.

C. Rack Elevations: Submit front and rear rack elevations identifying rack function and major equipment zones.

D. Power Coordination: Submit electrical coordination drawings showing NEMA L6-20R receptacles above ladder tray and centralized UPS-fed circuiting where applicable.

E. Sleeve Coordination: Submit sleeve schedules identifying through-floor and horizontal sleeve locations, sizes, destinations, assigned use, and spare capacity.

F. Closeout Documentation: Submit final room layouts, rack elevations, rack IDs, power coordination records, sleeve schedules, grounding records, and as-built pathway relationships.

1.5 QUALITY ASSURANCE

A. Telecommunications rooms shall be planned and installed by personnel experienced with enterprise telecommunications rooms and structured cabling infrastructure.

B. Rack layouts and pathway interfaces shall be coordinated before equipment installation.

C. Installed work shall be neat, serviceable, labeled, accessible, and suitable for maintenance by Owner IT and future service providers.

D. Server Room 175 and Server Room 275 shall follow the same rack naming and functional allocation convention unless otherwise approved by the Owner.

1.6 COORDINATION

A. Coordinate telecommunications room requirements with architectural, electrical, mechanical, fire protection, security, AV, and Owner IT requirements.

B. Coordinate HVAC requirements for active network equipment in RK-1 and AV-related equipment in RK-3.

C. Coordinate centralized UPS power distribution with Division 26 Electrical. No local floor-standing UPS shall be installed in Server Room 175 or Server Room 275 unless specifically approved by the Owner.

D. Coordinate wall penetrations, floor penetrations, sleeves, and pathway routing before rough-in.

E. Coordinate ladder tray elevations with rack height, L6-20R receptacle locations, tie-down requirements, and cable entry routing.

PART 2 - PRODUCTS

2.1 ROOM CONFIGURATION

A. Each telecommunications room shall include four rack positions.

B. Each rack position shall be assigned a specific function as indicated below:

Rack ID	Function	Primary Use	Turnover Requirement
RK-1	Active Network Equipment	Cisco Catalyst switching, fiber uplinks, network electronics, active equipment	Minimum 30 percent spare rack space
RK-2	Passive Telecommunications Infrastructure	CAT6/CAT6A patch panels, OS2 fiber enclosures, passive patching	Minimum 30 percent spare rack space
RK-3	Audio Visual Infrastructure	AV network equipment, AV processors, sound masking controllers, AV patching	Minimum 30 percent spare rack space
RK-4	Future Expansion	Reserved for future project or Owner technology systems	Remain unloaded unless approved by Owner

2.2 SERVER ROOM 175 RACK ASSIGNMENTS

Rack Identifier	Rack Function	Basis of Design Rack	Basis of Design Cable Manager
175-RK-1	Active Network Equipment	Panduit R4P36 unloaded 45RU four-post rack	Panduit PE2VD12 vertical cable manager
175-RK-2	Passive Telecommunications Infrastructure	Panduit R4P36 unloaded 45RU four-post rack	Panduit PE2VD12 vertical cable manager
175-RK-3	Audio Visual Infrastructure	Panduit R4P36 unloaded 45RU four-post rack	Panduit PE2VD12 vertical cable manager
175-RK-4	Future Expansion	Panduit R4P36 unloaded 45RU four-post rack	Panduit PE2VD12 vertical cable manager

2.3 SERVER ROOM 275 RACK ASSIGNMENTS

Rack Identifier	Rack Function	Basis of Design Rack	Basis of Design Cable Manager
275-RK-1	Active Network Equipment	Panduit R4P36 unloaded 45RU four-post rack	Panduit PE2VD12 vertical cable manager
275-RK-2	Passive Telecommunications Infrastructure	Panduit R4P36 unloaded 45RU four-post rack	Panduit PE2VD12 vertical cable manager
275-RK-3	Audio Visual Infrastructure	Panduit R4P36 unloaded 45RU four-post rack	Panduit PE2VD12 vertical cable manager
275-RK-4	Future Expansion	Panduit R4P36 unloaded 45RU four-post rack	Panduit PE2VD12 vertical cable manager

2.4 EQUIPMENT RACKS

A. Basis of Design: Panduit R4P36 unloaded 45RU four-post rack.

B. Provide four racks in Server Room 175 and four racks in Server Room 275.

C. Racks shall be suitable for installation of active network equipment, patch panels, fiber enclosures, AV equipment, cable management accessories, and future Owner equipment.

D. Racks shall be installed unloaded unless otherwise shown in approved rack elevations.

E. Rack layout shall preserve access to front and rear equipment rails and shall support clean cable routing from overhead ladder tray.

2.5 VERTICAL CABLE MANAGEMENT

A. Basis of Design: Panduit PE2VD12 45RU vertical cable manager.

B. Provide vertical cable managers at row ends and between adjacent racks.

C. Typical rack row arrangement shall be:

VCM / RK-1 / VCM / RK-2 / VCM / RK-3 / VCM / RK-4 / VCM

D. Cable managers shall support front and rear patching and shall be sized for installed cabling plus future growth.

2.6 ACTIVE NETWORK RACK REQUIREMENTS

A. RK-1 shall be dedicated to active network equipment.

B. Active network equipment shall include Cisco Catalyst 9300X-PXG switches with dual 1000W power supplies and Cisco Catalyst 9300-48P switches with 748W power supply where indicated by Owner IT requirements.

C. RK-1 shall provide organized power cord routing, fiber patching, copper patching, and switch service access.

D. No passive bulk patching unrelated to active network equipment shall be installed in RK-1 unless approved by Owner IT.

2.7 PASSIVE TELECOMMUNICATIONS RACK REQUIREMENTS

A. RK-2 shall be dedicated to passive telecommunications infrastructure.

B. Typical components include CAT6 patch panels, CAT6A patch panels, OS2 fiber enclosures, fiber adapter panels, fiber slack storage, and passive cross-connect fields.

C. No active network switches shall be installed in RK-2 unless specifically approved by Owner IT.

D. Patch panels shall be arranged to support clean patch cord routing to RK-1 and future equipment.

2.8 AUDIO VISUAL RACK REQUIREMENTS

A. RK-3 shall be dedicated to AV infrastructure and AV-related technology equipment.

B. Typical equipment may include AV processors, AV network equipment, audio DSP equipment, sound masking controllers, room system interfaces, AV patching, and related rack-mounted components.

C. Coordinate RK-3 heat load, power requirements, and network requirements with AV system design and Owner IT.

D. Provide minimum 30 percent spare rack capacity in RK-3 at turnover.

2.9 FUTURE EXPANSION RACK REQUIREMENTS

A. RK-4 shall be reserved for future expansion.

B. RK-4 shall remain unloaded at project turnover unless Owner authorizes project equipment to be installed in the rack.

C. Maintain clear access, ladder tray routing, grounding, and power provisions for future use.

D. Do not use RK-4 for storage, temporary construction materials, or contractor-installed equipment without written approval.

2.10 POWER COORDINATION

A. Provide telecommunications power coordination for racks and on the walls in Server Room 175 and Server Room 275.

B. Provide NEMA L6-20R twist-lock receptacles above telecommunications racks, affixed to the sides of the ladder tray overhead.

1. Provide minimum two L6-20R receptacles per rack unless electrical drawings indicate a greater quantity.
2. Total minimum per room shall be eight L6-20R receptacles.
3. Receptacles serving active network equipment shall be connected to centralized UPS-backed circuits where applicable.
4. Centralized UPS is installed in another room. Do not provide local floor-standing UPS units in Server Room 175 or Server Room 275 unless specifically directed by Owner.

C. Provide NEMA, 5-20R duplex receptacles for security equipment and as convenience outlets as specified.

1. (1) receptacle mounted above the security panel.
2. (2) Convenience receptacles per wall.

2.11 LADDER TRAY COORDINATION

A. Coordinate telecommunications rooms with 1-1/4 inch by 18 inch telecommunications ladder tray installed above rack rows.

B. Ladder tray shall align with rack rows, sleeves, pathway exits, vertical cable drops, and power receptacle locations.

C. Maintain minimum 25 percent spare ladder tray capacity at project turnover.

2.12 SLEEVE COORDINATION

A. Coordinate through-floor and horizontal sleeves serving Server Room 175 and Server Room 275.

B. Sleeves shall align with ladder tray and shall be accessible for cable installation and future work.

C. Minimum sleeve requirements shall be defined in Section 27 05 43.

D. Maintain minimum 50 percent spare sleeve capacity at turnover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that rooms are clean, dry, secure, and suitable for installation of telecommunications equipment.

B. Verify room dimensions, door swings, wall construction, sleeve locations, pathway entries, power rough-in, grounding provisions, and HVAC conditions before rack installation.

C. Do not install racks where required clearances, service access, or pathway routing cannot be maintained.

D. Notify the Design Professional and Owner of conflicts before proceeding.

3.2 INSTALLATION - GENERAL

A. Install racks plumb, level, aligned, and securely anchored.

B. Install rack rows in the approved order and orientation.

C. Install vertical cable managers between racks and at row ends.

D. Coordinate overhead ladder tray drops with rack positions and cable manager openings.

E. Bond racks, ladder tray, cable managers, and metallic pathways to telecommunications grounding system.

F. Do not install unrelated equipment, storage, tools, or materials in telecommunications rooms after room turnover.

3.3 RACK LABELING

A. Label each rack on front and rear.

B. Rack labels shall use the room and rack identifier format shown below:

1. 175-RK-1, 175-RK-2, 175-RK-3, 175-RK-4.
2. 275-RK-1, 275-RK-2, 275-RK-3, 275-RK-4.

C. Rack function labels shall identify Active Network, Passive Telecommunications, Audio Visual, and Future Expansion.

D. Rack labels shall match rack elevations, cable schedules, patch panel schedules, and as-built documentation.

3.4 RACK SPACE MANAGEMENT

A. Maintain minimum 30 percent spare rack space in RK-1, RK-2, and RK-3 unless approved by Owner.

B. Maintain RK-4 as fully available future expansion rack unless Owner approves other use.

C. Install equipment to maintain serviceability, airflow, cable routing, and patching access.

D. Do not block access to vertical cable managers, grounding points, fiber slack storage, receptacles, or ladder tray drops.

3.5 POWER INSTALLATION COORDINATION

A. Coordinate final L6-20R and 5-20R receptacle placement before rack and equipment installation is finalized..

B. Power receptacles shall be accessible for maintenance and shall not interfere with ladder tray cable routing.

C. Coordinate circuit labeling with rack IDs and centralized UPS source information where applicable.

D. Power cords shall be dressed separately from data patch cords where practical.

3.6 PATHWAY AND SLEEVE COORDINATION

A. Coordinate all pathway entries into server rooms with ladder tray and rack row arrangement.

B. Route sleeves and pathways to avoid blocking rack service clearances.

C. Provide protective bushings and firestopping at sleeves as required by Section 27 05 43.

D. Document sleeve assignments and remaining spare capacity at closeout.

3.7 CLEANING AND PROTECTION

A. Protect installed racks, cable managers, patch panels, fiber enclosures, and room infrastructure from construction dust and damage.

B. Remove packing materials, wire scraps, debris, and unused materials from telecommunications rooms.

C. Leave rooms clean and ready for Owner IT operations.

3.8 CLOSEOUT

A. Provide final room layouts for Server Room 175 and Server Room 275.

B. Provide final rack elevations showing rack IDs, rack functions, installed equipment, and spare rack space.

C. Provide final power coordination schedule identifying L6-20R receptacles, rack assignments, and centralized UPS source where applicable.

D. Provide final sleeve schedule identifying sleeve use and spare capacity.

E. Provide photographs of final rack lineups, ladder tray, sleeves, and room labeling if required by Owner.

END OF SECTION 27 11 00

SECTION 27 11 23 – COMMUNICATIONS CABLE MANAGEMENT AND CABLE TRAY

PART 1 – GENERAL

1. Summary

This article establishes project requirements for summary serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

2. Related Sections

This article establishes project requirements for related sections serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

3. System Description

This article establishes project requirements for system description serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

4. Submittals

This article establishes project requirements for submittals serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

5. Quality Assurance

This article establishes project requirements for quality assurance serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

6. Coordination Requirements

This article establishes project requirements for coordination requirements serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

PART 2 – PRODUCTS

1. Telecommunications Cable Tray

This article establishes project requirements for telecommunications cable tray serving as pathways for both horizontal and backbone cabling. Sized appropriately for a 25% initial fill ratio per applicable standards.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

2. Waterfalls and Radius Drops

This article establishes project requirements for waterfalls and radius drops.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

3. Splice Kits and Bonding Jumpers

This article establishes project requirements for splice kits and bonding jumpers serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

4. Through-Floor Sleeves

This article establishes project requirements for through-floor sleeves serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

5. Horizontal Sleeves

This article establishes project requirements for horizontal sleeves serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

6. Sleeve Labeling

This article establishes project requirements for sleeve labeling serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

7. Firestopping Components

This article establishes project requirements for firestopping components serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

8. Capacity Requirements

This article establishes project requirements for capacity requirements serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

PART 3 – EXECUTION

1. Installation Requirements

This article establishes project requirements for installation requirements serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

2. Support Spacing and Alignment

This article establishes project requirements for support spacing and alignment serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

3. Rack Coordination

This article establishes project requirements for rack coordination serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

4. Grounding and Bonding

This article establishes project requirements for grounding and bonding serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

5. Sleeve Installation

This article establishes project requirements for sleeve installation serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

6. Future Capacity Requirements

This article establishes project requirements for future capacity requirements serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

7. Field Quality Control

This article establishes project requirements for field quality control serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

8. Closeout Documentation

This article establishes project requirements for closeout documentation serving Server Rooms 175 and 275. Requirements shall support Panduit R4P36 rack rows, PE2VD12 vertical cable managers, OS2 backbone fiber, CAT6/CAT6A cabling, and future expansion capacity.

Provide all accessories, hardware, labeling, coordination, and documentation required for a complete and maintainable installation.

DESIGN CRITERIA

Provide 1-1/4 inch x 18 inch telecommunications ladder tray above rack rows.

Provide minimum six (6) 4-inch through-floor sleeves and six (6) 4-inch horizontal sleeves per room.

Maintain 25 percent spare ladder tray capacity at turnover.

Maintain 50 percent spare sleeve capacity at turnover.

Align tray and sleeves to support active network rack, passive telecom rack, AV rack, and future expansion rack.

SECTION 27 13 23 – COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 – GENERAL

Summary

Requirements for summary shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Related Sections

Requirements for related sections shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Backbone Topology

Requirements for backbone topology shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Submittals

Requirements for submittals shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Quality Assurance

Requirements for quality assurance shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Closeout Documentation

Requirements for closeout documentation shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

PART 2 – PRODUCTS

OS2 Single-Mode Fiber

Requirements for os2 single-mode fiber shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Fiber Enclosures

Requirements for fiber enclosures shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

LC Duplex Adapters

Requirements for lc duplex adapters shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Splice Trays

Requirements for splice trays shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Fiber Patch Cords

Requirements for fiber patch cords shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Fiber Labeling Requirements

Requirements for fiber labeling requirements shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

PART 3 – EXECUTION

Backbone Routing

Requirements for backbone routing shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

MDF Connections

Requirements for mdf connections shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

RK-2 Termination Requirements

Requirements for rk-2 termination requirements shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Service Loops

Requirements for service loops shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

OTDR Testing

Requirements for otdr testing shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Insertion Loss Testing

Requirements for insertion loss testing shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

Fiber Documentation

Requirements for fiber documentation shall support OS2 backbone fiber connectivity between the existing MDF and Server Rooms 175 and 275. Install and document all components in accordance with Section 27 05 53 administration standards.

PROJECT DESIGN CRITERIA

Backbone topology: Existing MDF to Server Room 175 and Server Room 275.

Fiber type: OS2 single-mode fiber.

Terminations: LC duplex connectivity.

Fiber enclosures located in RK-2 Passive Telecommunications Rack.

Fiber identification to use FBR prefix numbering per Section 27 05 53.

Provide OTDR and insertion loss test results for all installed backbone fibers.

SECTION 27 15 13 – COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 – GENERAL

1. Summary

This article establishes requirements for summary within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

2. Related Sections

This article establishes requirements for related sections within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

3. System Description

This article establishes requirements for system description within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

4. Submittals

This article establishes requirements for submittals within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

5. Quality Assurance

This article establishes requirements for quality assurance within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

6. Closeout Requirements

This article establishes requirements for closeout requirements within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

PART 2 – PRODUCTS

1. CAT6 Horizontal Cabling

This article establishes requirements for cat6 horizontal cabling within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

2. CAT6A Wireless Access Point Cabling

This article establishes requirements for cat6a wireless access point cabling within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

3. Patch Panels

This article establishes requirements for patch panels within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

4. Modular Jacks and Faceplates

This article establishes requirements for modular jacks and faceplates within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

5. Patch Cords

This article establishes requirements for patch cords within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

6. Labeling and Administration

This article establishes requirements for labeling and administration within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

PART 3 – EXECUTION

1. Cable Routing

This article establishes requirements for cable routing within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

2. Workstation Cabling

This article establishes requirements for workstation cabling within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

3. Meraki MR46 Cabling

This article establishes requirements for meraki mr46 cabling within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

4. Patch Panel Terminations

This article establishes requirements for patch panel terminations within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

5. Testing and Certification

This article establishes requirements for testing and certification within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

6. Documentation and Closeout

This article establishes requirements for documentation and closeout within the telecommunications infrastructure serving Server Rooms 175 and 275.

All work shall comply with the project cable administration methodology established in Section 27 05 53.

PROJECT DESIGN CRITERIA

Provide CAT6 cabling for workstation outlets, printers, and general network-connected devices.

Provide CAT6A cabling for all Cisco Meraki MR46 wireless access points.

Provide two (2) CAT6A cables to each wireless access point location.

Terminate horizontal cabling on patch panels located in RK-2 Passive Telecommunications Rack.

Use cable identification format established in Section 27 05 53.

Certify 100 percent of installed copper cabling and provide electronic test reports.

Coordinate patch panel assignments with Cisco Catalyst 9300X-PXG and Cisco Catalyst 9300-48P switching infrastructure.

SECTION 27 21 00 - DATA COMMUNICATIONS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Provide data communications equipment coordination, rack placement, power coordination, testing, documentation, and closeout requirements for active network equipment serving the telecommunications infrastructure.

B. Active network equipment shall be located in the designated Active Network Equipment rack, RK-1, within Server Room 175 and Server Room 275 unless otherwise directed by Owner IT.

C. This Section includes requirements for Cisco Catalyst switching equipment, redundant switch power supplies, centralized UPS coordination, L6-20R receptacle coordination, fiber uplink coordination, copper patching coordination, wireless access point connectivity, testing, commissioning, and final documentation.

D. Network configuration, licensing, security policy, VLAN assignment, IP addressing, and switch programming shall be coordinated with Owner IT. Configuration responsibility shall be confirmed during submittal review.

1.2 RELATED SECTIONS

A. Section 27 05 26 - Grounding and Bonding for Communications Systems.

B. Section 27 05 53 - Identification and Administration for Communications Systems.

C. Section 27 11 00 - Telecommunications Rooms.

D. Section 27 11 16 - Communications Cabinets, Racks, Frames, and Enclosures.

E. Section 27 11 23 - Communications Cable Management and Ladder Tray.

F. Section 27 13 23 - Communications Optical Fiber Backbone Cabling.

G. Section 27 15 13 - Communications Copper Horizontal Cabling.

H. Section 27 21 33 - Wireless Access Points.

I. Division 26 - Electrical power, branch circuits, grounding, receptacles, and centralized UPS distribution.

1.3 SYSTEM DESCRIPTION

A. The active network system shall support wired data connectivity, wireless access point connectivity, backbone fiber uplinks, AV network devices, and future network expansion.

B. The active network rack for each server room shall be designated as follows:

1. 175-RK-1 - Active Network Equipment Rack in Server Room 175.
2. 275-RK-1 - Active Network Equipment Rack in Server Room 275.

C. Active network equipment shall connect to passive copper patch panels and optical fiber enclosures located in RK-2 unless otherwise approved by Owner IT.

D. Power serving active network equipment shall be coordinated with centralized building UPS infrastructure located outside Server Rooms 175 and 275.

1.4 SUBMITTALS

A. Product Data: Submit product data for network switches, power supplies, optics, stack modules, rack mount kits, power cords, patch cords, and related accessories furnished under this Section.

B. Rack Elevations: Submit rack elevations showing active network equipment installed within RK-1, planned spare rack space, patching zones, fiber uplink zones, and power cord routing.

C. Power Coordination Submittal: Submit schedule identifying switch power requirements, power supply quantities, plug type, receptacle assignment, rack served, UPS source, panelboard, and circuit number where known.

D. Network Coordination Schedule: Submit coordination schedule identifying switch name, rack, RU position, uplink location, fiber patch panel, copper patching relationship, WAP patching relationship, and Owner IT configuration notes.

E. Testing Plan: Submit test procedure for power verification, fiber uplink verification, copper patching verification, WAP connectivity verification, and closeout documentation.

F. Closeout Documentation: Submit final rack elevations, switch schedules, power schedules, circuit schedules, UPS source records, patching schedules, fiber uplink documentation, WAP port mapping, and as-built records.

1.5 QUALITY ASSURANCE

A. Installation shall be performed by personnel experienced with enterprise network equipment installation, rack dressing, fiber patching, copper patching, and telecommunications room coordination.

B. Active network equipment installation shall maintain adequate airflow, service access, patching access, power cord serviceability, and future expansion capacity.

C. Final labeling and documentation shall comply with Section 27 05 53.

D. Coordinate all network-related requirements with Owner IT before energizing, patching, or commissioning active network equipment.

1.6 COORDINATION

A. Coordinate final switch models, port counts, optics, licensing, software, and configuration requirements with Owner IT.

B. Coordinate centralized UPS-backed circuits with Division 26 Electrical and Owner facilities personnel.

C. Coordinate fiber uplink patching with Section 27 13 23.

D. Coordinate copper patching with Section 27 15 13.

E. Coordinate wireless access point port requirements with Section 27 21 33.

F. Coordinate AV network equipment and AV switch needs with the AV system design and RK-3 allocation requirements where applicable.

PART 2 - PRODUCTS

2.1 ACTIVE NETWORK EQUIPMENT

A. Basis of Design, high-capacity switch: Cisco Catalyst 9300X-PXG or Owner-approved equivalent.

B. Cisco Catalyst 9300X-PXG switches shall be provided with dual 1000W power supplies for redundant operation where required by Owner IT.

C. Basis of Design, access switch: Cisco Catalyst 9300-48P or Owner-approved equivalent.

D. Cisco Catalyst 9300-48P switches shall be provided with 748W power supply minimum unless Owner IT requires a higher-capacity power supply.

E. Provide network switch accessories required for a complete installation, including rack mount kits, power cords, blanking panels where needed, optics, stacking provisions where applicable, and labeling accessories.

2.2 NETWORK EQUIPMENT SCHEDULE

Equipment Type	Basis of Design	Power Supply Requirement	Typical Location
High-Capacity Switch	Cisco Catalyst 9300X-PXG	Dual 1000W power supplies	175-RK-1 and 275-RK-1
Access Switch	Cisco Catalyst 9300-48P	748W power supply minimum	175-RK-1 and 275-RK-1
Fiber Uplink Hardware	Owner IT approved optics and patch cords	As required by switch and UPS-backed circuiting	175-RK-1 and 275-RK-1
Stacking / Expansion Accessories	Owner IT approved stacking hardware	As required by system design	175-RK-1 and 275-RK-1

2.3 POWER DISTRIBUTION REQUIREMENTS

A. Active network equipment shall be powered from NEMA L6-20R twist-lock receptacles located above the telecommunications ladder tray.

B. Provide receptacle coordination for each rack as indicated in Section 27 11 00. Minimum quantity shall be two L6-20R receptacles per rack unless electrical drawings indicate a greater quantity.

C. For RK-1 active network racks, receptacles shall be connected to centralized UPS-backed circuits where applicable.

D. Power serving Cisco Catalyst switches shall be coordinated so that redundant power supplies are connected in accordance with Owner IT and electrical design requirements.

E. Where redundant power supplies are provided, coordinate separate receptacles and circuit assignments where available to improve resilience.

F. Power cords shall be routed neatly and shall not obstruct airflow, fiber patching, copper patching, cable managers, switch service access, or rack equipment removal.

2.4 CENTRALIZED UPS REQUIREMENTS

A. The telecommunications system shall utilize a centralized building UPS located outside Server Rooms 175 and 275.

B. No local floor-standing UPS systems shall be provided in Server Room 175 or Server Room 275 unless specifically authorized by Owner.

C. Provide active equipment power from UPS-backed branch circuits where available and where required by Owner IT.

D. Coordinate final UPS runtime, maintenance bypass, panelboard source, branch circuit assignment, and receptacle labeling with Division 26 Electrical and Owner facilities personnel.

2.5 POWER IDENTIFICATION

A. Each receptacle serving data communications equipment shall be permanently labeled.

B. Labels shall identify panelboard, circuit number, UPS source where applicable, room, rack served, and receptacle identifier.

C. Example label format: UPS-PNL1-CKT17 / 175-RK-1.

D. Power identification shall be included in closeout documentation.

2.6 FIBER UPLINK COMPONENTS

A. Provide fiber optics, fiber patch cords, and related uplink accessories as coordinated with Owner IT and Section 27 13 23.

B. Fiber patch cords shall be compatible with the installed OS2 single-mode backbone, fiber enclosures, and switch optics.

C. Fiber patch cords shall be dressed in cable managers to maintain bend radius and serviceability.

2.7 COPPER PATCHING COMPONENTS

A. Provide copper patch cords as required to connect active network equipment to patch panels located in RK-2.

B. Patch cords shall be of appropriate category rating for connected permanent link, including CAT6 and CAT6A as applicable.

C. Patch cord lengths shall be selected to avoid excessive slack while maintaining service loops and future traceability.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that RK-1 racks, vertical cable managers, overhead ladder tray, grounding, power receptacles, and pathway infrastructure are installed before active network equipment installation.

B. Verify that centralized UPS-backed receptacles are installed, labeled, and ready for use where required.

C. Verify that rack space, airflow, and cable routing are suitable for the planned network equipment.

D. Do not install active network equipment until environmental conditions are suitable for electronics installation.

3.2 INSTALLATION

A. Install active network equipment in 175-RK-1 and 275-RK-1 unless otherwise directed by Owner IT.

B. Install switches plumb, level, and securely mounted using manufacturer rack mount hardware.

C. Maintain minimum 30 percent spare rack capacity in active network racks after installation unless approved by Owner.

D. Route fiber patch cords and copper patch cords through vertical cable managers and horizontal management as required.

E. Route power cords separately from data patching where practical.

F. Do not block switch ventilation, fan modules, power supply removal, stacking modules, or fiber uplink ports.

3.3 POWER VERIFICATION

A. Before energizing active network equipment, verify receptacle type, voltage, grounding, circuit labeling, rack assignment, and UPS source where applicable.

B. Verify each NEMA L6-20R receptacle serving active equipment is installed in the correct room and rack location.

C. Verify branch circuits serving redundant power supplies are assigned in accordance with Owner IT and electrical design requirements.

D. Document voltage readings, receptacle identifiers, panelboard, circuit number, UPS source, and rack served.

E. Correct missing labels, incorrect circuiting, or power deficiencies before connecting active equipment.

3.4 CENTRALIZED UPS VERIFICATION

A. Verify with Division 26 and Owner facilities personnel that UPS-backed circuits are active and properly identified.

B. Verify that active network equipment intended to be UPS-supported is connected to UPS-backed receptacles.

C. Where the centralized UPS has monitoring or alarm contacts related to telecommunications power, coordinate connection and documentation with Owner IT and facilities personnel.

D. Document UPS source information in the closeout power schedule.

3.5 FIBER UPLINK VERIFICATION

A. Verify OS2 fiber backbone terminations are complete and tested before switch uplink activation.

B. Verify fiber patching between RK-2 passive fiber enclosures and RK-1 active network equipment.

C. Verify polarity, strand assignments, fiber labels, and uplink documentation.

D. Coordinate optical transceiver installation and validation with Owner IT.

3.6 COPPER PATCHING VERIFICATION

A. Verify that CAT6 and CAT6A permanent links have passed certification testing before patching to active equipment.

B. Verify patch panel labels match cable schedules and Section 27 05 53 requirements.

C. Verify switch port assignments match Owner IT patching records.

D. Document patch panel port, switch name, switch port, room, device, and cable ID where known.

3.7 WIRELESS ACCESS POINT CONNECTIVITY VERIFICATION

A. Verify that each Cisco Meraki MR46 wireless access point location has two certified CAT6A cables.

B. Verify both WAP cables are patched to appropriate switch ports as directed by Owner IT.

C. Verify link status and PoE delivery for each WAP-connected cable where active equipment and APs are available for testing.

D. Document WAP device ID, cable IDs, patch panel ports, switch name, and switch port assignments.

3.8 SWITCH POWER-UP AND BASIC FUNCTIONAL TESTING

A. Verify each switch powers on from designated receptacle location.

B. Verify each installed power supply is recognized by the switch where configuration access is provided by Owner IT.

C. Verify fan operation and no visible hardware alarms after initial power-up where access is provided by Owner IT.

D. Verify switch stack status where stacking is utilized and where configuration access is provided by Owner IT.

E. Report hardware alarms, power supply alarms, fan alarms, or link failures to Owner IT and Design Professional.

3.9 TESTING AND ACCEPTANCE

A. Testing shall include electrical verification, UPS source verification, fiber uplink verification, copper patching verification, WAP connectivity verification, and documentation review.

B. Electrical verification shall document receptacle voltage, grounding, circuit identifier, UPS source, rack served, and equipment connected.

C. Fiber verification shall document fiber enclosure, fiber cable ID, strand or port assignment, switch uplink, optic type where known, and link status where active equipment is available.

D. Copper verification shall document patch panel port, cable ID, switch port, device type, and certification status.

E. WAP verification shall document both CAT6A cables assigned to each Meraki MR46 access point.

F. Deficiencies shall be corrected and retested before acceptance.

3.10 CLOSEOUT DOCUMENTATION

A. Provide final rack elevations for 175-RK-1 and 275-RK-1.

B. Provide switch equipment schedule identifying switch model, rack, RU location, power supplies, uplinks, and associated patching notes.

C. Provide power schedule identifying receptacle ID, panelboard, circuit number, UPS source, rack served, and connected equipment.

D. Provide fiber uplink schedule identifying fiber enclosure, fiber cable ID, strand or adapter port, switch, and uplink port where known.

E. Provide copper patching schedule identifying patch panel, cable ID, switch port, device served, and testing status.

F. Provide WAP connectivity schedule identifying WAP device ID, cable IDs, patch panel ports, and switch ports where known.

G. Provide final documentation in a format suitable for Owner IT operations and future maintenance.

END OF SECTION 27 21 00

WACHTER TECHNOLOGY DESIGN SERVICES

Division 28 - Electronic Safety and Security Specification Package

Lowell Office Remodel | Video Surveillance (Axis) | Access Control (LenelS2) | Server Rooms 175 and 275

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SECTION 28 05 00 - Common Work Results for Electronic Safety and Security

PART 1 - GENERAL

1.1 SUMMARY

A. Provide common requirements applicable to all Division 28 electronic safety and security systems, including video surveillance and access control.

B. Work includes labor, materials, equipment, tools, testing, coordination, and incidentals required for complete and functional security systems.

C. Security head-end equipment shall be located in the existing server rooms. Access control head-end shall be located in Server Room 175 and cameras on two floors shall connect to network infrastructure in Server Room 175 and Server Room 275.

D. Coordinate Division 28 work with Division 27 Communications, Division 26 Electrical, door hardware, architectural, mechanical, and Owner IT requirements.

1.2 RELATED SECTIONS

A. Section 28 05 13 - Conductors and Cables for Electronic Safety and Security.

B. Section 28 05 26 - Grounding and Bonding for Electronic Safety and Security.

C. Section 28 05 28 - Pathways for Electronic Safety and Security.

D. Section 28 05 53 - Identification for Electronic Safety and Security.

E. Section 28 06 00 - Schedules for Electronic Safety and Security.

F. Section 28 13 00 - Access Control.

G. Section 28 23 00 - Video Surveillance.

H. Division 27 - Communications, for shared pathways, cabling, telecommunications rooms, and network connectivity.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NFPA 731 - Standard for the Installation of Premises Security Systems.

C. UL 294 - Access Control System Units.

D. UL 2802 - Performance Testing of Camera Image Quality.

E. ANSI/TIA-568, 569, 606, and 607 standards.

F. Requirements of the Authority Having Jurisdiction.

1.4 SUBMITTALS

A. Product data for all security system components furnished under Division 28.

B. Shop drawings including riser diagrams, device locations, mounting details, and head-end layouts.

C. Coordination drawings for shared pathways, telecommunications rooms, and network infrastructure.

D. Point-to-point wiring diagrams and sequence of operations.

E. Test plans and closeout documentation.

1.5 QUALITY ASSURANCE

A. Security integrator shall be trained and authorized for the specified LenelS2 access control and Axis surveillance systems.

B. Installers shall be experienced with enterprise security systems of comparable size and complexity.

C. Materials shall be new, commercial grade, and listed or labeled by recognized testing agencies where applicable.

1.6 COORDINATION

A. Coordinate device locations with door hardware, frames, ceilings, millwork, lighting, and architectural elevations.

B. Coordinate IP addressing, VLANs, switch ports, PoE, cybersecurity, and time synchronization with Owner IT.

C. Coordinate demarcation of door hardware wiring with the door hardware vendor.

D. Coordinate head-end equipment placement, power, and cooling with Server Rooms 175 and 275.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide commercial-grade equipment listed for the intended use and environment.

B. Provide power supplies, batteries, lock power, PoE devices, surge protection, and enclosures required for complete operation.

C. Use products from a single manufacturer family where required for warranty and system compatibility.

2.2 POWER SUPPLIES

A. Provide UL-listed security power supplies with battery backup where required by system operation.

B. Power supplies shall be sized for connected loads plus spare capacity.

C. Provide fire alarm interface relays where required by code and door release sequence.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install systems in accordance with manufacturer requirements, approved shop drawings, applicable codes, and Authority Having Jurisdiction requirements.

B. Label all enclosures, devices, cables, power supplies, and panels in accordance with Section 28 05 53.

C. Conceal wiring where possible and protect exposed wiring in raceway.

3.2 TESTING

A. Provide point-to-point testing, functional testing, and integrated system testing.

B. Correct deficiencies and retest before acceptance.

3.3 CLOSEOUT

A. Submit as-built drawings, device schedules, programming records where allowed, user manuals, warranties, and training documentation.

B. Provide Owner training on all installed security systems.

END OF SECTION 28 05 00

SECTION 28 05 13 - Conductors and Cables for Electronic Safety and Security

PART 1 - GENERAL

1.1 SUMMARY

A. Provide conductors and cables for video surveillance and access control systems including camera cabling, card access cabling, power cabling, and grounding conductors.

B. Cabling shall home run to network infrastructure and security head-end in Server Room 175 and Server Room 275 as indicated.

C. All cabling shall be labeled and documented in accordance with Section 28 05 53 and the project cable administration standard.

1.2 RELATED SECTIONS

A. Section 28 05 00 - Common Work Results for Electronic Safety and Security.

B. Section 28 05 28 - Pathways for Electronic Safety and Security.

C. Section 28 13 00 - Access Control.

D. Section 28 23 00 - Video Surveillance.

E. Section 27 15 13 - Communications Copper Horizontal Cabling.

1.3 SUBMITTALS

A. Product data for all cable types, connectors, and terminations.

B. Cable schedule identifying cable ID, type, origin, destination, device, and pathway.

C. Test reports for network and low-voltage cabling.

PART 2 - PRODUCTS

2.1 CAMERA CABLING

A. Provide Category cabling to each IP camera suitable for PoE operation as coordinated with Owner IT and Section 27 15 13.

B. Provide plenum-rated cable where installed in environmental air plenums.

C. Provide PoE surge protection on exterior camera circuits using the surge devices specified in Section 28 23 00.

2.2 ACCESS CONTROL CABLING

A. Provide access control cable (Belden 658AMJ / 558AMJ or approved equal) home run from each door location to the access control head-end.

B. Provide reader cable, door contact cable, request-to-exit cable, lock power cable, and intercom cable as required by device manufacturer.

C. Provide composite access cable where approved to reduce pathway congestion.

2.3 GROUNDING CONDUCTORS

A. Provide 14 AWG green grounding conductors and ground clamps for surge protector grounding.

B. Provide bonding conductors as required by Section 28 05 26.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cabling as continuous home runs without splices unless specifically approved.

B. Maintain bend radius, pulling tension, cable fill, and separation from power conductors.

C. Route cabling in approved pathways and support systems in accordance with Section 28 05 28.

D. Label each cable at both ends per Section 28 05 53.

3.2 TESTING

A. Test and certify network cabling serving IP cameras and IP-based devices.

B. Verify continuity and correct termination of access control cabling.

C. Correct and retest failed cabling before acceptance.

3.3 DOCUMENTATION

A. Provide final cable schedule matching installed labels and device assignments.

END OF SECTION 28 05 13

SECTION 28 05 26 - Grounding and Bonding for Electronic Safety and Security

PART 1 - GENERAL

1.1 SUMMARY

A. Provide grounding and bonding for security equipment, racks, enclosures, exterior cameras, surge protection devices, and metallic pathways.

B. Coordinate security grounding with the telecommunications grounding system and Division 26 Electrical.

1.2 RELATED SECTIONS

A. Section 28 05 00 - Common Work Results for Electronic Safety and Security.

B. Section 28 23 00 - Video Surveillance.

C. Section 27 05 26 - Grounding and Bonding for Communications Systems.

1.3 SUBMITTALS

A. Grounding and bonding diagram for security equipment and exterior camera surge protection.

B. Product data for grounding conductors, clamps, lugs, and bonding hardware.

PART 2 - PRODUCTS

2.1 GROUNDING MATERIALS

A. Provide 14 AWG green grounding wire and ground clamps for Ditek surge protector grounding.

B. Provide copper bonding conductors, listed lugs, and bonding jumpers sized per code and manufacturer requirements.

C. Provide antioxidant compound at bonding connections where required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ground all exterior camera surge protection devices using 14 AWG green wire and ground clamps.

B. Bond security equipment racks, enclosures, and metallic pathways to the grounding system.

C. Remove paint, oxidation, and coatings at bonding points for reliable electrical continuity.

D. Label grounding conductors and connections.

3.2 TESTING

A. Verify continuity of bonded systems before acceptance.

B. Correct loose, incomplete, or inaccessible bonding connections prior to turnover.

END OF SECTION 28 05 26

SECTION 28 05 28 - Pathways for Electronic Safety and Security

PART 1 - GENERAL

1.1 SUMMARY

A. Provide pathways for security cabling including conduit, back boxes, J-hooks, cable supports, sleeves, and wire duct.

B. Pathways shall support camera cabling, access control cabling, intercom cabling, and future expansion.

C. Coordinate shared pathways with Division 27 Communications.

1.2 RELATED SECTIONS

A. Section 28 05 00 - Common Work Results for Electronic Safety and Security.

B. Section 28 05 13 - Conductors and Cables for Electronic Safety and Security.

C. Section 27 05 28 - Pathways for Communications Systems.

1.3 SUBMITTALS

A. Product data for conduit, back boxes, wire duct, cable supports, and sleeves.

B. Pathway coordination drawings.

PART 2 - PRODUCTS

2.1 CONDUIT AND BOXES

A. Provide conduit back boxes for exterior dome cameras (Axis T94S01P) and card reader locations.

B. Provide 4 in. square boxes, octagon boxes, 1/2 in. conduit, chase nipples, threaded couplings, and misc. mounting hardware for swivel fixture hanger camera mounts.

C. Provide recessed junction boxes at card reader locations, sized appropriately (single or double gang).

2.2 CABLE SUPPORTS AND WIRE DUCT

A. Provide J-hooks or approved cable supports for security cabling where cable tray is not provided.

B. Provide Panduit 6 in. wire duct for head-end cable routing between access control panels.

C. Provide pull string in empty conduits and spare sleeves.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install conduit ends with insulated bushings and protect cable jackets from abrasion.

B. Route pathways to maintain access, maintain cable fill limits, and avoid conflict with building systems.

C. Do not attach cabling directly to ceiling grid, sprinkler piping, ductwork, or unrelated systems.

D. Coordinate firestopping at rated penetrations.

3.2 CAPACITY

A. Provide minimum 25 percent spare pathway capacity unless otherwise indicated.

B. Provide additional pathway where security system growth would exceed available capacity.

END OF SECTION 28 05 28

SECTION 28 05 53 - Identification for Electronic Safety and Security

PART 1 - GENERAL

1.1 SUMMARY

A. Provide identification and labeling for all security cabling, devices, cameras, readers, panels, enclosures, and head-end equipment.

B. Identification shall be consistent across drawings, schedules, labels, test reports, and as-built documentation.

C. Cable identification shall follow the project cable administration standard using a type prefix, four-digit number, and sequence suffix, with the same complete ID applied at both ends of each cable.

1.2 RELATED SECTIONS

A. Section 28 05 00 - Common Work Results for Electronic Safety and Security.

B. Section 28 06 00 - Schedules for Electronic Safety and Security.

C. Section 27 05 53 - Identification and Administration for Communications Systems.

PART 2 - PRODUCTS

2.1 LABELS

A. Provide machine-printed, durable labels suitable for cabling, devices, panels, and enclosures.

B. Handwritten labels are not acceptable for final installation.

PART 3 - EXECUTION

3.1 CABLE AND DEVICE IDENTIFICATION

A. Apply the project cable ID format to all security cabling. Physical security cabling shall use the reserved numbering block established in the project administration standard.

B. Label cameras using a camera device identifier, and label access control doors using a door/reader identifier.

C. Label the same cable identically at both ends.

3.2 IDENTIFICATION EXAMPLES

A. Example camera cable: CAM-2001-A.

B. Example access control cable: ACS-2101-A.

C. Example spare cable: CAM-2050-X.

Item	Prefix	Example	Notes
Camera cable	CAM	CAM-2001-A	IP camera home run
Access control cable	ACS	ACS-2101-A	Card reader / door cabling
Spare cable	(type)	CAM-2050-X	Fully installed spare

3.3 DOCUMENTATION

A. Provide a labeling schedule identifying cable ID, device ID, door ID, camera ID, panel, and location.

B. Review identification for duplicates, incorrect number blocks, incorrect prefixes, and missing suffixes before construction and before closeout.

END OF SECTION 28 05 53

SECTION 28 06 00 - Schedules for Electronic Safety and Security

PART 1 - GENERAL

1.1 SUMMARY

A. Provide security system schedules including camera schedule, door/access control schedule, device schedule, and equipment schedule.

B. Schedules shall coordinate with drawings, the parts lists, and Sections 28 13 00 and 28 23 00.

1.2 RELATED SECTIONS

A. Section 28 05 53 - Identification for Electronic Safety and Security.

B. Section 28 13 00 - Access Control.

C. Section 28 23 00 - Video Surveillance.

PART 2 - PRODUCTS

2.1 CAMERA SCHEDULE

A. Provide a camera schedule identifying camera ID, model, type, quantity, floor, server room connection, mount type, and location.

Model	Type	Qty	Notes
Axis M3077-PLVE	360 degree	20	(17) pendant / (3) ceiling
Axis M4216-LV	Interior fixed dome	9	(6) conduit back box / (3) included mount
Axis P3277-LVE	Exterior fixed dome	3	Conduit back box
Axis P9117-PV	Ceiling corner	1	Elevator car
Axis Q6020-E	Exterior panoramic	1	Combined with Q6088-E
Axis Q6088-E	Exterior PTZ	1	Combined with Q6020-E

2.2 ACCESS CONTROL DOOR SCHEDULE

A. Provide a door schedule identifying door ID, reader, lock type, REX, door contact, power supply, panel, and sequence of operation.

Door	Area	Reader	Notes
X-166A	Main Entrance Reception	HID Signo 40	Video intercom, ADA interior/exterior buttons, motorized operator
166B	Reception to Central Corridor South	HID Signo 40	Card reader
167A	IT Area	HID Signo 40	Card reader
167.2A	IT Secure Space	HID Signo 40	Card reader
165.1A	HR Storage	HID Signo 40	Card reader
197.1A	Electrical Room	HID Signo 40	Card reader
197.3A	Mechanical Room	HID Signo 40	Card reader
175A	Server Room (head-end)	HID Signo 40	Card reader
195A	Storage Room	HID Signo 40	Card reader
232.1A	Electrical Room	HID Signo 40	Card reader
237A	Storage Room	HID Signo 40	Card reader
275A	Server Room	HID Signo 40	Card reader

X-172A	East Stairs Exit	HID Signo 40	Card reader
X-184A	South Stairs Exit	HID Signo 40	Card reader

PART 3 - EXECUTION

3.1 SCHEDULE MAINTENANCE

A. Update schedules through submittal, construction, and closeout to reflect final installed conditions.

B. Coordinate schedules with identification requirements in Section 28 05 53.

END OF SECTION 28 06 00

SECTION 28 13 00 - ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a complete electronic access control system based on LenelS2, including network node enclosures, application and I/O blades, power supplies, card readers, request-to-exit devices, door contacts, electric strikes coordination, video intercom, ADA door operator controls, programmable logic, reception release controls, cabling, programming, testing, commissioning, and training.

B. All access control equipment shall connect back to the existing system for programming and control. Access control head-end shall be located in Server Room 175.

C. Fourteen (14) doors total shall be secured and accessed via card reader as scheduled. The main entrance shall receive a video intercom and be ADA compliant with interior and exterior handicap access buttons.

D. Door hardware will be supplied and installed by the door vendor. Wachter will wire door access control hardware at the agreed demarcation point with the door hardware vendor.

1.2 RELATED SECTIONS

A. Section 28 05 00 - Common Work Results for Electronic Safety and Security.

B. Section 28 05 13 - Conductors and Cables for Electronic Safety and Security.

C. Section 28 05 26 - Grounding and Bonding for Electronic Safety and Security.

D. Section 28 05 28 - Pathways for Electronic Safety and Security.

E. Section 28 05 53 - Identification for Electronic Safety and Security.

F. Section 28 06 00 - Schedules for Electronic Safety and Security.

G. Section 28 23 00 - Video Surveillance.

1.3 SYSTEM DESCRIPTION

A. Basis of Design: LenelS2 NetBox network node platform integrated with the Owner existing access control system.

B. The system shall centrally manage access-controlled openings and locally process access decisions at field controllers.

C. The system shall monitor door status, request-to-exit, forced door, held door, tamper, and power conditions where hardware is provided.

D. Coordinate integration with the video surveillance system for event-based monitoring where required.

1.4 SUBMITTALS

A. Access-controlled opening schedule with door ID, reader, lock, REX, contact, power supply, and sequence of operation.

B. Product data for all head-end, field, and door interface devices.

C. Riser diagrams and point-to-point wiring diagrams.

D. Head-end enclosure layout and power calculations.

E. Test and commissioning procedures.

1.5 QUALITY ASSURANCE

A. Security integrator shall be trained and authorized for LenelS2 installation, configuration, and support.

B. Access control equipment shall comply with UL 294 where applicable.

C. Coordinate access control hardware with the door hardware vendor before procurement.

1.6 COORDINATION

A. Coordinate demarcation point for door hardware wiring with the door hardware vendor.

B. Coordinate IP addressing, VLANs, and network connectivity with Owner IT.

C. Coordinate head-end placement, power, and cooling with Server Room 175.

PART 2 - PRODUCTS

2.1 HEAD-END EQUIPMENT (BASIS OF DESIGN)

Item	Description	Qty	Notes
LenelS2 NetBox	7 Slot Enclosure network node	2	Access control head-end
LenelS2 S2-ACM	Access Control Application Blade	8	Reader/door control
LenelS2 S2-INP	Supervised Input Blade	1	Monitored inputs
LenelS2 S2-OUTP	Relay Output Blade	1	Relay outputs
Altronix MAXFIT7F8APS	24VDC 10A Power Supply with Batteries	2	Head-end power

2.2 DOOR DEVICES (BASIS OF DESIGN)

Item	Description	Qty	Notes
HID Signo 40	Card Reader	16	At secured doors
Bosch DS-160	Request-to-Exit Motion Detector	14	One per secured door
GRI	Flush Mount Door Contact	17	Door position monitoring
Electric Strike	24VDC Fail Secure - Flush Mount	13	By door supplier contractor
Electric Strike	24VDC Fail Secure - Top of Glass	2	By door supplier contractor
Electric Panic Hardware	For glass doors	2	By door supplier contractor
Transfer Hinge	For main entry doors	2	By door supplier contractor
Motorized Door Opener	For main entry doors	1	By door supplier contractor

2.3 MAIN ENTRANCE AND ADA DEVICES

Item	Description	Qty	Notes
2N IP Video Intercom	Main entrance intercom	1	IP style
SDC 484A2U	ADA button to operate motorized opener	1	Interior
SDC 482A4U	ADA button to operate motorized opener	1	Exterior
SDC 480-SSB	Backbox for ADA button (4 inch)	1	Interior
SDC 480-2SB	Backbox for ADA button (single gang)	1	Exterior
BEA Br3-X	Programmable Logic Module	1	Delays, timing, sequencing for main entry door
Alarm Controls RP-27	Single gang plate, 2 N/O momentary buttons	1	Remote unlock from reception desk

2.4 CABLING AND HEAD-END ROUTING

A. Provide Belden 658AMJ / 558AMJ card access cable home run from door locations to the head-end.

B. Provide Panduit 6 in. wire duct for head-end cable routing between panels.

C. Cabling and identification shall comply with Sections 28 05 13 and 28 05 53.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install head-end NetBox enclosures, blades, and power supplies in Server Room 175.

B. Install card readers, REX devices, door contacts, intercom, ADA buttons, and logic module at scheduled locations.

C. Wire door access control hardware to the agreed demarcation point with the door hardware vendor.

D. Conceal wiring where possible and protect exposed wiring in raceway.

3.2 SEQUENCE OF OPERATION

A. Program door access levels, schedules, alarms, inputs, outputs, and operator permissions as directed by Owner.

B. Configure the main entry door using the BEA Br3-X logic module to coordinate reader access, motorized operator, ADA buttons, strike/panic hardware, and timing.

C. Provide reception desk remote unlock via the Alarm Controls RP-27 plate.

3.3 TESTING

A. Test each controlled opening for credential access, denied access, REX operation, door position status, forced/held alarms, lock operation, and power failure response.

B. Test video intercom operation and ADA operator sequence at the main entrance.

C. Correct deficiencies and retest before acceptance.

3.4 TRAINING AND CLOSEOUT

A. Provide administrator and operator training.

B. Provide as-built drawings, panel and door schedules, programming report, warranties, and O&M manuals.

END OF SECTION 28 13 00

SECTION 28 23 00 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a complete IP video surveillance system including cameras, mounts, surge protection, cabling coordination, connection to the existing video management and storage platform, storage expansion, testing, commissioning, and closeout documentation.

B. All cameras shall connect back to the existing software platform and storage solution. Storage capacity shall be added to maintain retention based on the calculated load of the new cameras.

C. Video surveillance headend equipment shall be located in the existing server rooms. Cameras shall home run to network infrastructure in Server Room 175 and Server Room 275 as indicated by the security floor plans and telecommunications design.

D. Provide surge suppression on all exterior cameras.

1.2 RELATED SECTIONS

A. Section 28 05 00 - Common Work Results for Electronic Safety and Security.

B. Section 28 05 13 - Conductors and Cables for Electronic Safety and Security.

C. Section 28 05 26 - Grounding and Bonding for Electronic Safety and Security.

D. Section 28 05 28 - Pathways for Electronic Safety and Security.

E. Section 28 05 53 - Identification for Electronic Safety and Security.

F. Section 28 13 00 - Access Control.

G. Section 27 15 13 - Communications Copper Horizontal Cabling.

H. Section 27 11 00 - Telecommunications Rooms (Server Rooms 175 and 275).

1.3 SYSTEM DESCRIPTION

A. Basis of Design cameras shall be Axis Communications IP cameras as scheduled.

B. The system shall provide coverage of building entries/exits, hallways, open public areas, IT office areas, server rooms, stairwells, elevator, central corridor, and break room as indicated on the security floor plans.

C. Cameras on two floors shall connect to network infrastructure located in Server Room 175 (first floor) and Server Room 275 (second floor) and integrate with the existing enterprise VMS and storage.

D. Provide pendant mounts, conduit back boxes, wall mounts, corner mount brackets, and swivel fixture hangers as required to clear obstructions and achieve required fields of view.

1.4 SUBMITTALS

A. Product data for all cameras, mounts, back boxes, PoE surge protectors, grounding hardware, and accessories.

B. Camera schedule identifying camera ID, model, type, location, floor, mount type, server room connection, and field of view.

C. Camera coverage plans and mounting details.

D. Storage and retention calculations demonstrating added storage capacity for new cameras.

E. Network coordination showing PoE requirements, switch ports, VLAN, and IP addressing coordinated with Owner IT.

F. Test plan and closeout documentation.

1.5 QUALITY ASSURANCE

A. Installer shall be an Axis-experienced security integrator familiar with the Owner existing VMS platform.

B. System shall comply with applicable network, cybersecurity, electrical, grounding, and local code requirements.

C. Identification and cable labeling shall comply with the project cable administration standard.

PART 2 - PRODUCTS

2.1 CAMERA SCHEDULE (BASIS OF DESIGN)

Model	Type	Qty	Notes
Axis M3077-PLVE	Camera - 360 degree	20	(17) pendant mount / (3) ceiling mount
Axis M4216-LV	Varifocal Fixed Dome - Interior	9	(6) with conduit back box / (3) with included mount
Axis P3277-LVE	Varifocal Fixed Dome - Exterior	3	With conduit back box
Axis P9117-PV	Ceiling Corner Mount	1	For elevator car
Axis Q6020-E	Exterior Panoramic	1	Combined with Q6088-E as one unit
Axis Q6088-E	Exterior PTZ	1	Combined with Q6020-E as one unit

2.2 MOUNTS AND ACCESSORIES

Item	Type	Qty	Notes
Axis T94S01P	Conduit Back Box	9	For P3277-LVE and M4216-LV
Axis T91G61	Wall Mount	1	For Q6088
Axis T91A64	Corner Mount Bracket	1	For Q6088
Garvin SC-50	Swivel Fixture Hanger 1/2"	17	With 4 in. square box, octagon box, 1/2 in. conduit, chase nipple, threaded coupling, and misc. mounting hardware

2.3 SURGE PROTECTION AND GROUNDING

Item	Type	Qty	Notes
Ditek DTK-MRJPOE	PoE Surge Protector	4	For exterior cameras
14 AWG Green Wire	Grounding Conductor	As required	For Ditek surge protector grounding
Ground Clamps	Grounding Hardware	As required	For Ditek surge protector grounding

2.4 CAMERA CABLING

A. Provide Category cabling to each camera in accordance with Section 27 15 13 and the project cable administration standard.

B. Home run camera cabling to network infrastructure in Server Room 175 or Server Room 275 based on floor and security floor plan.

C. Provide PoE surge protection on all exterior camera circuits.

2.5 VMS AND STORAGE

A. Connect all cameras to the existing Owner video management software platform.

B. Provide added storage capacity to maintain the Owner required retention period based on the calculated load of the new cameras.

C. Coordinate licensing, camera enrollment, and configuration with Owner IT and security administrator.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cameras at locations shown on security floor plans and aim to achieve required fields of view.

B. Install pendant mounts, conduit back boxes, wall mounts, corner brackets, and swivel hangers as required to clear obstructions.

C. Install exterior cameras with PoE surge protection and proper grounding using 14 AWG green wire and ground clamps.

D. Coordinate camera cabling, PoE, and switch capacity with Server Rooms 175 and 275 and Owner IT.

3.2 EXTERIOR CAMERA REQUIREMENTS

A. Provide fixed dome cameras at each building entry/exit door.

B. Provide a combined Panoramic / 360 PTZ camera unit at the south-east corner of the building.

C. Provide surge suppression on all exterior cameras.

3.3 INTERIOR CAMERA REQUIREMENTS

A. Provide 360 degree ceiling mounted cameras for hallways, open public areas, IT office area, and server rooms.

B. Provide fixed dome cameras in stairwells, elevator, central corridor, and break room.

C. Provide pendant mounts as needed to clear obstacles.

3.4 CONFIGURATION AND STORAGE

A. Configure camera names, IP addresses, recording parameters, event settings, time synchronization, and retention.

B. Add storage capacity to the existing platform and verify retention meets Owner requirements.

C. Apply firmware and cybersecurity settings approved by Owner IT.

3.5 TESTING AND ACCEPTANCE

A. Verify image quality during day and low-light conditions where applicable.

B. Verify recording, playback, export, time/date accuracy, and event triggers.

C. Verify PoE surge protection and grounding on all exterior cameras.

D. Correct deficiencies and retest before acceptance.

3.6 CLOSEOUT

A. Provide camera schedule, IP list where permitted, coverage plans, storage/retention documentation, test results, warranties, and O&M manuals.

B. Provide as-built drawings and updated device schedules.

END OF SECTION 28 23 00