Hufft

PROJECT MANUAL
DESIGN DEVELOPMENT – ***DRAFT SPEC NOT FOR CONSTRUCTION***
September 11, 2026

University Of Arkansas – Dillard Hall

122 Harmon Avenue
Fayetteville, AR 72712

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PROJECT INFORMATION & CONTACTS

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University of Arkansas – Dillard Hall		September 10, 2026
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DIVISION 00 - PROCUREMENT & CONTRACTING REQUIREMENTS

SECTION 00 22 00 – SUPPLEMENTARY INSTRUCTIONS

PART 1 - AIA DOCUMENT A701-2018 "INSTRUCTIONS TO BIDDERS" is included as a part of these documents by this reference. Copies are available from The American Institute of Architects, 1735 New York Avenue N. W., Washington, D. C. 20006, or the local AIA office.

THE FOLLOWING PARAGRAPHS modify, delete from, and/or add to the above referenced Instructions to Bidders, as if originally written therein. Where any Article of the Instructions is modified, or where any Paragraph, Subparagraph or clause thereof is modified or deleted by the following Supplementary Instructions, the unaltered provisions will remain in effect.

1.01 ADD the following paragraph to Article 1 - Definitions:

A. "1.10 STIPULATED SUM amounts must include ALL COSTS for materials, labor, equipment, testing and any and all items of expense, fees, taxes, overhead and profit for the Contractor's full and complete performance of the Work as set forth in the Contract Documents."

1.02 ADD Paragraph 2.1.7 to read as follows:

A. "2.1.7 the Bidder agrees that any deviations from or exceptions to the Specifications, Drawings, Terms and Conditions and/or any other Bid Document will be clearly defined and set forth in the Bidder's Proposal. If no exceptions are shown in the proposal, none will be considered at the time of Contract Award."

1.03 REPLACE Paragraph 3.3.2.2 to read as follows:

A. "3.3.2.2 Substitution of “named” or “Basis-of-Design” products must be approved by the Architect in writing (via email), in compliance with requirements of Section 01 25 00 – Substitution Procedures. Substitutions proposed by a Bidder that have not been approved in advance by the Architect are not to be included in the Base Bid amount but must be appropriately itemized on the Bid Form or attached thereto as a “Contractor’s Voluntary Alternate” with the corresponding add or deduct amount included. Substitution requests are not required for products indicated by performance requirements or criteria, or when indicated as “or equal”, however products not meeting the intent of the Construction Documents may be rejected by the Architect."

1.04 ADD Paragraph 3.3.6 as follows:

A. "3.3.6 Substitution requests will be received by the Architect only from General Contractor Bidders (manufacturers and sub-contractor requests must be forwarded through a General Contractor Bidder) and only when submitted on a “CSI Substitution Request Form” that has been fully executed by the GC bidder making the request. Note that Consideration of substitutions by the Architect is not guaranteed, as it is subject to the Owner’s option whether to compensate the Architect for the Additional Services required for its review. The burden of proof of the merit of a proposed substitute is upon the proposer. The Architect’s decision of approval or disapproval of a proposed substitution will be final. Substitution requests will not be considered by the Architect within 5 days (120 hours) of bid/proposal receipt time."

1.05 ADD Paragraph: "4.1.9 as follows:

A. “4.1.9 Bids will remain in effect for the number of days indicated on the Invitation to Bid."

1.06 DELETE Paragraph 4.2 in its entirety – as no bid security will be required.

1.07 ADD Paragraph: "5.1.1 as follows:

A. “Properly identified Bids received on time will be opened privately by the Owner or Architect as agent for the Owner. No information regarding bid abstracts or tabulations will be made available to any Bidders."

1.08 DELETE subparagraph 7.1.2 and ADD the following:

A. "7.1.2 Costs for Performance and Labor and Material Payment Bonds is to be indicated as an alternate cost on the Bid Form and is not to be included within the Base Bid amount. The Owner reserves the right to require such bonds to be furnished upon execution of the Contract (or subsequent to contract execution as a change order) in the amount specified on the Bid Form.

1.09 ADD the following Paragraph 8.1 – Form of Agreement:

A. “8.1 Form of Agreement: The Agreement form may be either AIA Document A101, or on an equivalent non-standard form with similar language acceptable to the Owner. If approval by both parties cannot be reached on the format of the non-standard form, then AIA Document A101 will be used.”

END OF SECTION 00 22 00

SECTION 00 31 32 – GEOTECHNICAL DATA

GEOTECHNICAL REPORT: The Owner has retained a "Soils Engineer" to prepare a Geotechnical Report for the work of this Project. The Geotechnical Report is available for review by the Contractor.
LIMITATIONS OF GEOTECHNICAL REPORT & TEST BORING LOG: Data contained in the Geotechnical Report, which includes a test boring log, IS NOT INTENDED as a representation or warranty of accuracy or continuity. Neither the Owner nor the Architect will be responsible for any interpretations or conclusions drawn there from by the Contractor.
AVAILABILITY OF REPORT: The Geotechnical Report is made available solely for the convenience and use by the Contractor.
ADDITIONAL BORINGS or other exploratory operations may be made by the Contractor at no cost to the Owner.

END OF SECTION 00 31 32

SECTION 00 72 00 – GENERAL CONDITIONS

GENERAL CONDITIONS: AIA Document A201 - 2017 Edition: "General Conditions of the Contract for Construction" is included as a part of the Contract Documents herein by reference. A copy is attached to this Project Manual and *DRAFT* copies are available from the American Institute of Architects (1-800-242-3837). www.aiacontracts.org
Participation in the Work of this Project is considered acknowledgement of the participants understanding of, and agreement with, all requirements of the Contract for Construction.
Maintain one (1) original, printed edition of the General Conditions at the Project Site during construction.

END OF SECTION 00 72 00

SECTION 00 73 00 – SUPPLEMENTARY CONDITIONS

PART 1 - THE FOLLOWING "SUPPLEMENTARY CONDITIONS" modify the above referenced "General Conditions" as if originally written therein. Where a portion of the General Conditions is modified or deleted by these Supplementary Conditions, the unaltered portions of the General Conditions will remain in full effect. The General Conditions may also be modified elsewhere in the Contract Documents by provisions located in other Sections of the Specifications.

1.01 ADD to paragraph 1.1.8 the following:

A. “The Initial Decision Maker” will be the Architect.”

1.02 ADD to paragraph 1.2, CORRELATION AND INTENT . . . the following:

A. 1.2.4 Although the Construction Documents have been prepared with due care and diligence, perfection is not guaranteed. Design and construction is complex, consequently every possible field condition cannot be anticipated or indicated. The Drawings may be diagrammatic, and all components required for complete installation may not be fully indicated.

B. 1.2.5 Unless otherwise indicated within the Construction Documents, all notes written in the imperative mood refer to action(s) to be performed by the Contractor - the words 'the Contractor shall' are always implied.”

C. 1.2.6 Figured dimensions and marked data will take precedence over scaled measurements, and details will take precedence over smaller scale general drawings of which they are intended to amplify. Details or conditions indicated for a portion of the Work but not carried out fully for other portions will apply throughout to similar portions of the Work, except as specifically noted.

D. 1.2.7 In case of conflict in or between requirements of the Contract Documents (including General and Supplementary Conditions, Division-01 General Requirements, Drawings and Specifications) or with manufacturer's product requirements, the Contractor will be deemed to have agreed to provide the greater quantity and better quality of materials and Work.

1.03 ADD to Paragraph 1.8 Building Information Models Use and Reliance, the following:

A. 1.8.1 Electronic media data (EMD) of the Contract Documents are the Architect’s ‘Instruments of Service’, who retains all common law, statutory law and other rights, including their copyright. No representation is made regarding the accuracy or completeness of EMD.

B. 1.8.2 If EMD files are transferred from the Architect to the Contractor, the Contractor will not use them for any purpose other than preparation of shop drawings, coordination drawings, or for Record Drawings of this Project. The Contractor agrees not to transfer the EMD to any entity not involved in the construction Work without the prior written consent of the Architect.

C. 1.8.3 The Contractor further agrees to waive all claims against the Owner and the Architect, resulting in any way from any use of the use of EMD. Use of EMD does not reduce or minimize in any way the Contractor’s responsibility to take field measurements, check dimensions, and to coordinate with other construction Work at the Project Site.

1.04 ADD to Paragraph 3.2.1, the following:

A. Execution of the Contract by the Contractor is a representation that the Contractor has carefully examined and understands the intent of the Contract Documents. No claims will be approved for additional time or costs resulting from the Contractor's lack of familiarization of the requirements of the Construction Contract.

1.05 ADD to Paragraph 3.5 the following:

A. 3.5.3 Equipment, material, or services provided by the Contractor that fail to receive approval by AHJ representatives are immediately rejected and constitute Contract default. The Contractor must correct such failure as expeditiously as possible in a manner acceptable to the AHJ and to the Owner within thirty (30) days of notice from the AHJ. If the Contractor does not correct such rejected Work within that time period, the Owner may make the required corrections, and deduct all costs incurred plus a ten percent (10%) administrative fee or $500 (whichever is greater) from the Contract Sum.

1.06 ADD to Paragraph 3.10 the following:

A. 3.10.4 If the Contractor fails to adhere to the Construction Schedule, the Contractor will furnish additional labor and/or services or work sufficient overtime as may be necessary to make construction progress conform to the Construction Schedule, at no additional cost to the Owner. Failure to adhere to the schedule, or failure to take steps to regain the schedule, will constitute Contract default.

1.07 ADD to Paragraph 3.12.10 the following:

A. 3.12.10.3 The Contractor will require that any entity engaged to provide Professional Design Services maintain Professional Liability Insurance with minimum limits of $1,000,000 per claim and annual aggregate. Insurance coverage must be maintained not less than one (1) year after Substantial Completion. Provide the Architect with a Certificate of Insurance evidencing coverage prior to performance of such services.

1.08 ADD to Article 4 – Architect”, the following:

A. 4.1.3 “ARCHITECT'S LIMITED-SCOPE CONSTRUCTION ADMINISTRATION SERVICES: The Architect's services during construction may be "limited" to a specific hourly maximum, or only on an "as-need" basis upon the Owner's request. As the services of the Architect are intended solely for the benefit of the Owner, the Contractor may not rely upon the performance of Architect's services. When the Architect is not involved in such instances, REVISE Article 4 from Paragraph 4.2, through Paragraph 4.6 inclusive, by substituting the word "Owner", wherever the word "Architect" is used.

1.09 ADD to Paragraph 4.2 the following:

A. 4.2.15 "The Architect's review does not constitute approval of safety provisions or procedures, and approval of any construction means, methods, techniques, sequences or procedures, unless specifically agreed to in writing and signed by the Architect, with specific reference to the submittal.

1.10 ADD to Paragraph 6.1 the following:

A. 6.1.5. The Contractor is not responsible for the control or management of the Owner's separate contractors, and the Owner releases this Contractor from any liabilities related to Work performed by separate contractors. Separate contractors will be required to comply with all safety requirements instituted by this Contractor (as applicable), and will not be allowed to interfere with this Contractor's construction operations.

1.11 ADD the following to Paragraph 8.3 – Delays and Extensions of Time:

A. "8.3.4 The Owner may direct Contractor to work overtime, and to accelerate the Work, and if so instructed, Contractor agrees to work overtime and accelerate the Work. If such direction is not due to causes within the Contractor's control, the Owner agrees to pay for overtime and accelerated Work, but only for related overtime charges which will consist of the premium or extra hourly wage incurred by the Contractor only. No insurance, taxes, overhead or profit will be paid by Owner based on any premium wage paid. Written authorization for payment of overtime charges must be received by the Contractor from the Owner in writing prior to performing the Work.

B. 8.3.5 Normal inclement weather and associated site conditions will not be considered as a valid cause for delay of the Work, as it is anticipated that the Contractor will estimate sufficiently for work stoppages due to reasonably anticipated inclement weather within the Construction Schedule.

C. 8.3.6 Notwithstanding the foregoing, if Contractor is delayed in the performance or progress of the Work by Abnormal Weather Conditions (as defined herein) then the Contractor will be entitled to an extension of the completion date for the impacted portion of the Work provided the Contractor makes claim not more than seven (7) days after the cause of the delay begins. "Abnormal Weather Conditions" are hereby defined as temperature and precipitation that are abnormal for the location of the Work as determined by the National Climatic Data Center, Asheville, North Carolina, based on the previous ten (10) year mean for the Work location. Abnormal Weather Conditions and causes beyond the control of the Contractor which delay the work, including but not limited to catastrophic weather events, fire or vandalism, theft, actions or stoppages by public officials, will extend the completion date by equal periods of time as the delay impacts the critical path of the Construction Schedule, provided the Contractor makes claim not more than seven (7) days after the cause of the delay begins and provides proof of impact on the critical path Work, which is not concurrent with a Contractor-caused delay.

D. 8.3.7 To qualify as an adverse weather day, weather conditions or related site conditions must prevent Work on critical path activities for 50 percent or more of the Contractor's scheduled work day.

1.12 ADD the following to Paragraph 9.3 – Applications for Payment:

A. ADD to Subparagraph 9.3.1, the following:

(1) 9.3.1.3 Unless otherwise indicated in the Owner – Contractor Agreement Form, the Owner will retain ten percent (10%) retainage of the amount of each progress payment application until Substantial Completion is obtained.

(2) 9.3.1.4 Upon Substantial Completion, and with the concurrence of the Architect and the Contractor's surety (if any), retainage may be reduced to an amount equal to 200% of the value of the Work remaining to be completed, including defective work not yet remedied (whether covered by a warranty or not) and Work yet to be performed or completed, plus an amount sufficient to protect the Owner for liquidated damages or other charges, liens or offsets due the Owner.

B. ADD to Subparagraph 9.7 Failure of Payment, the following:

(1) 9.7.1 If the Contractor has received payment for labor or materials and if a lien is subsequently filed by any Subcontractor claiming an interest in that labor or materials, and if same has not been released or insured over by the Owner's title company or bonded over by the Contractor within ten (10) days following the recording or filing of such Lien, the Contractor hereby authorizes and consents to an automatic deduction from the Contract Sum ("Lien Deduct Amount") in the sum of 150% of the Lien amount. Following such automatic Lien Deduct Amount, the Contractor acknowledges and agrees that the Owner may, at the Owner's sole option and discretion, have the right to: (a) place all or a portion of the Lien Deduct Amount in escrow with its title company and subsequently pay the Lien to the Lien claimant, including all accrued interest and penalties; or (b) immediately pay the Lien amount, including any accrued interest and penalties, to the Lien claimant.

(2) 9.7.2 The Contractor will have the right to contest and defend the Owner at the Contractor's sole expense, from and against any Lien which the Contractor contests in good faith. If the Contractor identifies qualified legal counsel to provide such defense and specifies the good faith reason to dispute the Lien, then the Owner agrees to hold the Lien Deduct Amount in escrow and not to exercise the Owner's right to pay the Lien pending resolution of such Lien claim and dispute. The Lien Deduct Amount is for the Owner's sole protection and is not for the benefit of the Contractor or any surety. The Owner may apply the Lien Deduct Amount in whole or in part to offset Owner's legal costs and to protect itself against the risk of paying twice for Work for which Contractor has been paid, and for improper claims asserted by Lien claimants.

(3) 9.7.3 The Contractor agrees and acknowledges that the Lien Deduct Amount, including any amount above the Lien amount paid, including all interest and penalties, will be retained by Owner until satisfactory resolution of such Lien without risk to the Owner or the Owner's property. If such Lien is not released, bonded or insured, and not fully and successfully defended by Contractor, the Owner may accept the full Lien Deduct Amount as liquidated damages. The parties recognize and agree that it would be extremely difficult to ascertain the extent of actual costs, expenses, time and damages associated with the recording of a mechanic's lien on the Property, and that any and all Lien Deduct Amounts above the Lien amount, including any and all interest and

penalty, represents as fair an approximation of the actual cost, expense, time and damage associated with resolving any Lien issues as the parties can now determine.

1.13 ADD the following new Paragraph 9.11:

A. 9.11 OWNER'S DIRECT PAYMENT TO SUBCONTRACTORS AND MATERIAL SUPPLIERS

(1) 9.11.1 The Owner reserves the right to make direct payments to any subcontractor or material supplier and to deduct such amounts from the Contract Sum due to the Contractor or to make payments jointly to the Contractor and to the Subcontractor as the Owner determines necessary to protect the Project Site from any liens.

(2) 9.11.2 The Owner is not obligated herein to make any direct payments to a Subcontractor or material supplier, and such payments do not create any obligation to make further payments to any Subcontractor or material supplier.

1.14 ADD to Subparagraph 11.1.1 the following:

A. Liability insurance must include all major divisions of coverage and must be on a comprehensive basis with specified limits listed below maintained specifically for this project. Coverages are to include: Personal Injury Liability with Employment Exclusion deleted, Contractual, including specified provisions for Contractor's obligation under Paragraph 3.18, Owned, non-owned and hired motor vehicles, and Broad Form Property Damage coverage. Premises-Operations, Independent Contractor's Protective, Products and Completed Operations, Owner's & Designers Protective Liability, and Broad Form Property Damage coverage. Property Damage Liability coverage must provide X, C, and U coverages, with Completed Operations and Products Liability coverage maintained for three (3) years after final payment. Include a “separation of insured” endorsement to provide cross-liability coverage. The following minimum limits are applicable to each incident occurrence as well as for the total annual aggregates - which must be dedicated to this project only. Minimum coverage amounts must be as listed below, or as required by law, whichever is greater:

	Prime Trade Contractor	Sub-contractors
Worker's Comp. & General Employer's Liability:	Statutory & $ 1,000,000.00	Statutory & $ 1,000,000.00
Comprehensive General Liability		
Property damage:	$ 2,000,000.00	$ 1,000,000.00
Bodily injury:	$ 2,000,000.00	$ 1,000,000.00
Contractual Liability:		
Property Damage:	$ 2,000,000.00	$ 1,000,000.00
Bodily injury:	$ 2,000,000.00	$ 1,000,000.00
Comprehensive Automobile Liability:		
Property Damage:	$ 1,000,000.00	$ 1,000,000.00
Bodily injury:	$ 1,000,000.00	$ 1,000,000.00
	$ 1,000,000.00	$ 1,000,000.00
Umbrella Excess Liability Insurance:	$ 5,000,000.00	
With an annual aggregate of:	$10,000,000.00	
Builder’s Risk insurance in the amount of the Contract Sum, insuring at a minimum against fire, lighting, vandalism, malicious mischief, explosion, riot and civil commotion, smoke, sprinkler leakage, water damages, windstorm, hail and property theft on the insurable portion of the Work on a 100% completed value basis, and including damage to equipment, structures or material.		

1.15 ADD to Subparagraph 11.1, the following:

A. 11.1.5 All certificates of insurance required herein must name the Owner and the Architect as additional insured.

B. 11.1.6 Provide “All Risk” property insurance on the Work of this Contract within the Contract Sum. Such insurance will include reasonable compensation for the Owner’s authorized agents including the Architect and the Architect’s Professional Consultants, and for the Contractor’s services and expenses required as a result of such insured loss.

1.16 MODIFY Subparagraph 12.2.2.1 by ADDING the following:

A. The "reasonable time" allowed for Correction of Work by the Contractor will be no more than thirty (30) days after receipt of notice.

1.17 ADD the following to Paragraph 15.1.5 Claims for Additional Cost:

A. Extensions of time for adverse weather conditions will not be considered justification for additional compensation to the Contractor for administrative or other ‘office overhead’ expenses.

PART 2 - ADDITIONAL OWNER REQUIREMENTS

2.01 The Contractor shall require all subcontractors to provide and maintain general commercial liability, automobile and workers’ compensation insurance coverage substantially similar to those required of the Contractor. The Contractor shall require certificates of insurance from all subcontractors as evidence of coverage. The Contractor will be the responsible party for any and all claims against or by a subcontractor if the subcontractor fails to have the insurance required by this Agreement.

2.02 The Contractor shall not commence work under this Contract until it has obtained all the bonds and insurance required, has filed the Certificates of Insurance with the Owner, and the certificates have been approved by the Owner. Each insurance policy shall contain a clause providing that it shall not be canceled by the insurance company without written notice to the Owner. All policies shall contain a waiver of the Contractor's right of subrogation against the Owner, the State of Arkansas, its departments, agencies, boards, commissions, colleges and its officers, officials, agents, and

employees for losses arising from work performed by or on behalf of the Contractor, and shall name the Owner as an additional insured or covered party.

END OF SECTION 00 73 00

DIVISION 01 – GENERAL REQUIREMENTS

SECTION 01 11 00 – SUMMARY OF WORK

PART 1 – PROJECT / WORK IDENTIFICATION:

1.01 SUMMARY BY REFERENCES: The Work of this Contract can be summarized by references to the Contract, General Conditions, Supplementary Conditions, Specification Sections, Drawings, Addenda and other modifications to the Contract Documents issued after the initial isse of this Project Manual, and including but not necessarily limited to printed material referenced by any of these. It is recognized that the Work of the Contract is also unavoidably affected or influenced by governing regulations, natural phenomenon including weather conditions and other forces in addition to these Contract Documents.

1.02 ABBREVIATED SUMMARY OF THE WORK: Briefly and without force and effect upon the Contract Documents, the Work of the Contract can be summarized to include the following, as indicated in the Drawings:

A. New Construction
B. SITEWORK, including site demolition, site improvements such as pavement, curbs and sitework appurtenances, installation or modification of site utilities; and new landscape and landscape irrigation system work throughout the Project site;
C. NEW BUILDING CONSTRUCTION to include general construction and finishes, with associated structural, fire-protection, mechanical, electrical and plumbing (MEP) systems:
D. ELECTRICAL POWER for phone/communications, controls, sound, security or data systems
E. FINAL CONNECTIONS of electrical, mechanical or plumbing services to casework, fixtures, signage, Food Service Equipment (FSE) and beverage dispensing equipment;
F. SELECTIVE DEMOLITION, to include removal and legal disposal of select, existing construction elements as required for installation of new work and not utilized within the new construction;
G. SUSTAINABILITY GOAL:

1.03 FOOD-SERVICE EQUIPMENT (FSE) COORDINATION AND WORK BY GENERAL CONTRACTOR: Unless otherwise indicated, FSE and beverage dispensing equipment will be furnished and installed by the Owner's FSE vendor and beverage suppliers, as applicable. The General Contractor is also required to provide the following:

A. FSE / BEVERAGE EQUIPMENT COORDINATION MEETING: Conduct an on-site meeting with the Owner's FSE and beverage equipment supplier representatives, and with applicable subcontractor representatives that will perform final service connections to such equipment. Coordinate with and notify the Owner not less than fourteen (14) calendar days prior to the proposed meeting time and date. Within the meeting, review equipment items being provided, and the required installation requirements and final connections necessary to make them operational – to assure that all components necessary will be available on-site for installation, with responsibility for installation coordinated between all parties. .
B. FINAL SERVICE CONNECTIONS of fire-protection, plumbing, mechanical / controls, and electrical systems to FSE and beverage dispensing equipment, as required by the equipment indicated to be provided, and as indicated below:

FOOD SERVICE EQUIPMENT RESPONSIBILITY SCHEDULE

ITEM / DESCRIPTION	CFCI	OFCI	NIC	NOTES:
Pest Control			X	By Owner's pest control vendor after Substantial Completion
Stainless Steel Wall Paneling			X	Furnish and install by Owner's FSE vendor, typically only at hoods unless otherwise indicated
Stainless Steel Corner Guards	X			Coordinate with S/S wall paneling installation
Building penetrations and weather seals of walls or roofs for equipment connections	X			GC to provide weather sealed openings for ductwork, refrigeration lines, electrical and control wiring, as applicable
Water filters at FSE, beverage equipment and ice-making equipment:		X		Owner's FSE or beverage equipment supplier to provide appropriate water filter – at each unit or manifolded when indicated, to be installed by the GC's plumbing subcontractor.
Hot and cold water service supplies and connections	X			GC's plumbing subcontractor: Provide quarter-turn lever-handled wall shut-off valves with escutcheons, water-supply strainers, and similar accessories. Provide approved backflow prevention devices with shut-offs at beverage-dispensing equipment (including coffee brewers, soda dispensers, and ice makers) manifolded as appropriate Provide "interconnection" piping from separate but related FSE units, such as: water piping from a booster heater to a dishwasher or power-wash sink basin; from a waste disposer to the disposer cone and sinks troughs; from a dishwasher drain tempering kit; from water

FOOD SERVICE EQUIPMENT RESPONSIBILITY SCHEDULE

ITEM / DESCRIPTION	CFCI	OFCI	NIC	NOTES:
				filters to ice machines, steamers and beverage dispensing equipment; and from control panels to water-wash hood systems.
Waste drains from FSE, beverage dispensing or ice-making equipment	X			GC's plumbing subcontractor: Install sink accessories such as basket-drains and lever-handled gate valves furnished by the Owner's FSE vendor and provide gate-valves at hot-food and soup wells in convenient, accessible locations below units. Typically provide "indirect connections" with a code-compliant air-gap to above a waste drain (floor drain or floor sink) , unless indicated to have a "direct connection" with a P-trap, and make all drain connections required for FSE and beverage equipment.
HAND SINKS (wall mounted or counter-mounted)		X		Furnished by Owner's FSE vendor – including faucets unless otherwise indicated. Mount to wall or countertop and seal to wall finish all around by GC's plumbing subcontractor.
- Soap dispenser, paper towel dispenser, waste receptacle, and hand-washing sign at hand sinks	X			GC to provide unless otherwise indicated. Install health-department approved "handwashing sign", at hand sinks or bathroom lavatories serving food-preparation areas.
SINKS: 3-compartment, vegetable prep and other food-service sinks			X	Install by Owner's FSE vendor (unless otherwise indicated) including anchorage and sealing to wall, with final water and drain connections installed by GC's plumbing subcontractor.
FSE with gas connections:		X		GC's plumbing subcontractor: Provide flexible gas hoses (unless otherwise indicated to be furnished by Owner's FSE vendor). Tighten and seal internal piping at manifolds of ranges, fryers, and similar equipment – which is typically provided only with "finger tight" internal connections.
Final electrical connections to FSE and beverage dispensing equipment	X			GC's electrical subcontractor: Provide flexible conduit, conductor and connections (except when FSE or beverage equipment is provided with a flexible power-cord "whip") and make final electrical power connection to a J-box unless furnished with a cord and plug. Provide power and control switches to booster heater at dishwashing equipment. Provide lamps in light fixtures within hoods and walk-in coolers and freezers.
Lamps in electrical light fixtures	X			GC's electrical subcontractor to provide appropriate lamps within light fixtures in exhaust hoods and walk-in coolers and freezers.
WALK-IN COOLERS / FREEZERS			X	Install by Owner's FSE vendor, including panel set-up and refrigeration system connections, except as follows:
- Floor preparation, insulated freezer floor, and floor finish at walk-in coolers and freezers	X			Provide level and smooth floor substrate aligned with floor finish outside of cooler / freezer units and provide floor finish inside walk-ins when a separate insulated floor is not indicated as part of walk-in system. Provide a separate, insulated floor-slab at walk-in freezers, unless a raised insulated floor is indicated in the FSE drawings.
- Building's Fire-suppression system at walk-in coolers / freezers (when exists)	X			Provide fire-suppression wet-pipe sprinklers inside walk-in coolers and freezers by GC's fire-system subcontractor. At freezers, provide freeze-resistant "glycol" protected heads, or a "pre-action" system that keeps water from entering the fire-suppression system piping inside the freezer compartment.
- Remote condensing units for walk-in coolers / freezers		X		Provide units by Owner's FSE vendor. GC to provide structural support and special inspections (when required), with final refrigerant connections by Owner's FSE vendor.
- Electrical door heater and light fixtures at walk-in coolers and freezers		X		Furnish as part of walk-in cooler system by Owner's FSE vendor, and connect to power by GC's electrical subcontractor
- Waste drains from walk-in cooler or freezer's condenser drip pans (located inside the walk-in compartment)	X			Provide by GC's plumbing subcontractor inside walk-in unit's compartments to nearest floor sink or drain outside of unit.
- Final electrical connections of walk-in coolers and freezers	X			GC's electrical subcontractor to make final electrical connections to both the interior walk-in's evaporator/fan coil unit, and to the condenser unit – whether on top of the unit, or remote on the roof.

FOOD SERVICE EQUIPMENT RESPONSIBILITY SCHEDULE

ITEM / DESCRIPTION	CFCI	OFCI	NIC	NOTES:
- Heat-trace wrap of walk-in freezer units condenser pan drain line	X			GC's electrical subcontractor to provide heat-trace tape and insulation wrap around freezer unit's evaporator pan drain line until it exits the freezer compartment
EXHAUST HOODS		X		Owner's FSE Vendor to furnish both NFPA Type I (grease) or Type II (non-grease) exhaust hoods. GC to provide structural support for hoods and Make-Up-Air (MUA) units and suspension rods for hoods and install / hang hood in place – including special inspections when required.
- Building's Fire-suppression systems at Type II exhaust hoods (when exists):	X			GC's wet-system fire-protection subcontractor to locate extinguisher heads of water-based sprinklers to protect space below Type II hoods without being blocked by the hood unit itself.
- Wet-chemical (Ansul) Fire-suppression systems at Type I exhaust hoods	X			GC's fire-system subcontractor: Provide system over (1) the cooking equipment, (2) within the hood (both sides of grease filters), and (3) inside Type I exhaust ductwork to the roof, Make connections from dry contacts in Type I hood system's fire-suppression control system to the building's fire-alarm system and provide appropriate programming of the building's fire-protection system necessary for hood operations. Provide functional testing of the fire-suppression system – completing all related MEP Work and with all FSE under the hood operational. Provide a portable "K-type" fire-extinguishers near the hood before requesting AHJ inspection.
- Gas shut-off valves to under-hood FSE		X		Furnish by Owner's FSE vendor (as part of hood system) – install by GC's plumbing subcontractor
- Gas regulators and lighting of gas pilot lights	X			Provide gas regulators unless indicated to be furnished by Owner's FSE vendor (on FSE drawings - FSE with up to one (1) inch gas pipe is typically provided with a regulator, but manifolded equipment is never furnished with a regulator). Light gas pilot lights when applicable. Furnish and install by GC's plumbing subcontractor, unless otherwise indicated to be furnished by Owner's FSE vendor
- Exhaust hood ductwork to exhaust units	X			GC's mechanical subcontractor must provide exhaust and MUA ductwork, to include duct sealing, duct insulation/wrap, and access panels for maintenance service and inspections, and make final connection to hoods and fans. Make final connections of hood controls to exhaust fans, as applicable.
- NFPA Type I exhaust hood ductwork:	X			GC must provide a 1-hour fire-rated drywall enclosure or approved thermal wrap from penetration of kitchen wall or ceiling, extending through concealed spaces and to forty (40) inches minimum above the roof. GC's mechanical subcontractor must fully weld seams and light-test ductwork after installation but before installation of fire-rated enclosure. Maintain minimum eighteen (18) inch clear to "combustible" materials including the paper face of drywall, or three (3) inches clear to non-combustible materials such as cement board or rock-wool insulation.
- Hood system make-up air supply system			X	Install by Owner's FSE vendor, with structural support and penetrations by GC, and final power connections by GC's electrical subcontractor.
- Electrical shunt-trip breakers to under-hood FSE	X			By GC's electrical subcontractor

1.04 CONTRACT TYPE: Unless otherwise indicated in the Owner / Contractor Agreement, this Work will be constructed under a single (prime) general construction contract.

1.05 PRE-APPROVED / REQUIRED / ASSIGNED SUBCONTRACTORS:

A. ENGAGE the following subcontractors that are specifically required and "pre-approved" by the Owner:

(1) N/A

B. RELATIONS AND RESPONSIBILITIES between the Contractor and the above Subcontractor(s) will be as defined in the Conditions of the Contract. In addition, the above subcontractors will provide to the Contractor:

1.06 BONDS: Labor and Material Payment bonds covering faithful performance of subcontracted work and payment of all obligations thereunder, if the Contractor is required to furnish such bonds to the Owner, and

1.07 LIABILITY INSURANCE purchased and maintained to protect the Contractor from claims for the same terms and liability limits that the Contractor is required to provide to Owner.

PART 2 - SEPARATE CONTRACTS:

2.01 THE OWNER RESERVES THE RIGHT TO AWARD Separate Contracts to furnish and/or to install portions of the Project, including but not necessarily limited to the following:

A. BUILDING SIGNAGE (except for building address numbers, and other code-required signs indicated herein
B. FOOD SERVICE EQUIPMENT (FSE) & Beverage Dispensing Equipment
C. FIXTURES AND FURNISHINGS including tables and chairs
D. TELECOMMUNICATIONS and/or data system network(s) within the building
E. CELL-PHONE ANTENNAS & SCREENS, including installation of cellular-equipment and accessory screens on the roof, and wiring connections from antennas to equipment in an equipment room within this Project
F. SECURITY SYSTEM, including card-access controls, surveillance cameras, and a monitoring control system

2.02 THE ABOVE LIST may be affected by Alternates accepted or rejected by the Owner.

2.03 COOPERATE FULLY WITH SEPARATE CONTRACTORS so that work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract.

2.04 REVIEW SHOP DRAWINGS prepared by separate contractor(s) or suppliers of related Work for general conformance with the intent of the Construction Documents, and for service-connections and clearances if required. Verify that required rough-ins, connections and clearances will be provided, and report any discrepancies.

2.05 PROVIDE SCHEDULED DATES for delivery and installation to Separate Contractors or suppliers, and notify them when construction is ready for their delivery and installation Work. Provide openings, delivery access, and staging space for installation. Contact the Owner if scheduling or communication problems arise regarding separate contractor(s).

PART 3 - CONTRACT DOCUMENT FORMATS AND CONVENTIONS

3.01 SECTION IDENTIFICATION: The Specifications use Section numbers and titles to help cross-referencing within the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete as not all numbers are used. Consult the Table Of Contents at the beginning of the Project Manual to determine Section numbers and names of Specification Sections within the Contract Documents.

3.02 DIVISION-01 “GENERAL REQUIREMENTS” Sections apply to the Work of the entire Project, and to all Sections of the Specifications. When a more specific requirement is indicated within an individual Specification Section or is indicated with a note on the Drawings, that requirement takes precedence over the Division-01 requirement for that Section’s Work only.

3.03 CONTRACT DOCUMENT LANGUAGE: The Contract Documents (including the Drawings and Specifications) use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

3.04 ABBREVIATED LANGUAGE: Language used in the Contract Documents is abbreviated. Words and meanings will be interpreted as appropriate. Words implied, but not stated, will be inferred as the sense requires. Singular words will be interpreted as plural, and plural words will be interpreted as singular where applicable as the context of the Contract Documents indicates.

3.05 IMPERATIVE MOOD AND STREAMLINED LANGUAGE are generally used in the Contract Documents. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

3.06 THE WORDS "SHALL," "SHALL BE,", "SHALL COMPLY WITH," or “WILL, “MUST” or “MUST COMPLY WITH” - depending on the context, are implied where a colon (:) is used within a sentence or phrase.

3.07 CONSTRUCTION DOCUMENT TERMINOLOGY:

A. **C F C I:** Contractor Furnished, Contractor installed
B. **FURNISH**: Supply and deliver to the site, ready for unloading, unpacking, assembly, installation, or as applicable in each case.
C. **INSTALL:** To perform construction operations at the Project site, including but not limited to: unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.
D. **N I C:** Not In Contract (Owner Furnished and Owner Installed)
E. **O F C I**: Owner Furnished, Contractor installed
F. **O F O I**: Owner Furnished and Owner installed
G. **PROVIDE**: To both furnish AND install by the Contractor (CFCI), complete and ready for the Owner’s use.
H. OWNER FURNISHED – CONTRACTOR INSTALLED (OFCI) PRODUCTS:

(1) COORDINATE WITH AND INSTALL all Owner-Furnished products, including but not limited to providing schedule information regarding completion of prior work and allowable time periods for performance by the Separate Contractors, receiving at site, verifying receipt, handling, storage on-site, and mechanical/electrical/plumbing service connections, as applicable. The Owner will pay directly for the product costs including delivery to the Project Site. Provide all OFCI suppliers with an accurate address with accurate delivery directions and instructions.
(2) AT DELIVERY, INSPECT PRODUCTS FOR DAMAGE at the Project Site. If items are damaged, defective or missing, mark the bill of lading as necessary. Contact the freight line and request a damage inspection of the

items and submit a damage claim. Notify the owner within five (5) days of receipt of any missing, damaged or otherwise defective products – or replace/repair items at no cost to the Owner.

(3) PROTECT PRODUCTS from damage, including damage from exposure to the elements. Replace or repair items damaged as a result of Construction operations. Damage resulting from inappropriate storage or handling, including but not limited to environmental conditions, will be the responsibility of the Contractor. No claim for additional costs due to damage to stored products or equipment will be considered. Repair damage to Owner-furnished products caused by construction operations to the Owner's satisfaction

END OF SECTION 01 11 00

SECTION 01 14 19 – USE OF SITE

PART 1 - CONTRACTOR WILL HAVE FULL USE of the Project Site for construction operations during the construction period. The Contractor's use of premises is limited only by the Owner's right to engage separate contractors for other work at the Project Site.

1.01 CONFINE OPERATIONS to areas within the Contract limits indicated and/or within the property lines of the site, and if not specifically indicated, within areas designated or approved for use by the Owner. Portions of the site beyond areas in which construction operations are indicated are not to be disturbed. Confine stockpiling of materials and location of storage sheds, if any, to areas approved for such use.

A. Do not unreasonably encumber the site with materials or equipment. If additional storage is necessary, obtain and pay for such storage areas off-site.
B. Parking of workers's automobiles will be confined to defined areas.
C. Keep driveways and existing site entrances clear and unobstructed at all times. Do not use these areas for parking or storage of materials, except as otherwise authorized.
D. Schedule deliveries to minimize requirements for storage of materials.

1.02 PUBLIC STREET LIMITATIONS: Comply with AHJ representatives regarding regulations and/or restrictions on use of public streets.

1.03 POTENTIALLY DISRUPTIVE CONSTRUCTION ACTIVITIES: Limit the time and duration of potentially disruptive construction operations involving noise, vibration, odors, or any other activities that MAY be considered as objectionable by adjacent residential neighbors, and comply with rules and regulations of the AHJ as applicable. Coordinate as follows:

1.04 WORK HOURS: Limit exterior operations to occur between 6:00 AM and 6:00 PM on Mondays through Fridays, with weekend hours between 8:00 AM and 5:00 PM, except as otherwise authorized by the Owner in writing.

1.05 NOTIFY THE OWNER and appropriate AHJ representatives not less than two (2) days in advance of ANY potentially disruptive operations.

1.06 OBTAIN THE OWNER’S WRITTEN PERMISSION before proceeding with potentially disruptive operations.

PART 2 - EXISTING UTILITY INTERRUPTIONS: Do not interrupt existing public utilities serving this site or other adjacent properties without the prior written approval of the Owner, and as follows:

2.01 NOTIFY OWNER AND UTILITY SERVICE PROVIDER not less than five (5) days in advance of the proposed utility interruption

2.02 OBTAIN WRITTEN AUTHORIZATION by the Utility Service provider before proceeding with utility interruptions.

2.03 PARTIAL OWNER’S USE: The Owner reserves the right to install fixtures, furnishings, equipment, signage, and communication systems, including phone, data networks, security or control systems within completed areas of the Work before Substantial Completion, provided that such use is acceptable to the AHJ, and it does not interfere with completion of the Work. This use will not constitute acceptance or partial acceptance of the Work.

PART 3 - OWNER OCCUPIED DURING CONSTRUCTION

3.01 None

PART 4 - DEVELOPER / LANDLORD APROVALS

4.01 None

END OF SECTION 01 14 19

SECTION 01 21 00 – ALLOWANCES

PART 1 - INCLUDE WITHIN THE CONTRACT SUM adequate budget and bonding (when required) for the following allowance amounts, covering products and materials not selected or well defined prior to bidding.

1.01 INCLUDE ALL COSTS for materials and equipment delivered to the site, including applicable taxes, less applicable trade discounts, unless otherwise indicated below. The cost of installation, including unloading, handling, labor, installation costs, overhead, profit and other expenses related to the following allowance amounts is to be included within the Contract Sum – and not within the following amounts.

PART 2 - SCHEDULE OF CASH ALLOWANCES:

2.01 ALLOWANCE ITEM # 1 – ADDITIONAL FOOTING OVER-EXCAVATION & ENGINEERED FILL: The Soils Engineer anticipates that there will be some localized areas of inadequate bearing materials at footings or foundations. Therefore, include the following cash allowance for additional footing over-excavation and engineered fill, in addition to the limit and scope as indicated in the Drawings: **$25,000, per "Unit Price" amounts above**

2.02 **QUANTITY ALLOWANCE ITEM # 2 – ADDITIONAL SOIL EXCAVATION & FILL:** Include an additional 2,500 cubic yards of unsatisfactory soil excavation and of-site disposal and replace with satisfactory off-site soil materials, in accordance with Division-31 Section "Earth Moving." Coordinate this allowance with Unit-Prices.

2.03 **QUANTITY ALLOWANCE ITEM # 3 – ROCK REMOVAL**: Include an addition 1.000 cubic yards of rock removal and replacement with satisfactory soil material, in accordance with Division-31 Section "Earth Moving." Coordinate this allowance with Unit Prices.

END OF SECTION 01 21 00

SECTION 01 22 00 – UNIT PRICES

PART 1 - INCLUDE all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit. Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections. The Owner reserves the right to reject the Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

1.01 UNIT PRICE NO. ONE (1) – ADDITIONAL SOIL EXCAVATION: ADD for additional excavation and legal disposal of unsatisfactory soil materials, to include replacement with engineered fill using satisfactory borrow materials in accordance with applicable Division-31 Section, requirements of the Geotechnical Report, and with the Owner's on-site geotechnical testing and inspection entity. Coordinate this unit price with applicable Allowance indicated above.

A. Unit of Measurement: Cubic yard of soil material excavated, based on survey of volume removed.

1.02 UNIT PRICE NO. TWO (2) – ADDITIONAL ROCK EXCAVATION: ADD for additional excavation and legal disposal of rock, to include replacement with engineered fill using satisfactory borrow materials in accordance with applicable Division-31 Section, requirements of the Geotechnical Report, and with the Owner's on-site geotechnical testing and inspection entity. Coordinate this unit price with applicable Allowance indicated above.

A. Unit of Measurement: Cubic yard of rock excavated, based on survey of volume removed.

1.03 UNIT PRICE NO. ONE (1) – BULK ROCK EXCAVATION: ADD for excavation and legal disposal of rock in open excavations, per cubic yard.

1.04 UNIT PRICE NO. TWO (2) – TRENCH ROCK EXCAVATION: ADD for excavation and legal disposal of rock in utility trenches, per cubic yard.

1.05 UNIT PRICE NO. THREE (3) – OVER-EXCAVATION & ENGINEERED FILL BELOW FOUNDATIONS: Change the quantity as indicated in the Drawings when directed by the Owner's Soil's Engineer for excavation, controlled backfill and compaction of engineered fill below foundations, including legal disposal of excess unsatisfactory soil materials, ADD or DEDUCT per cubic yard.

1.06 UNIT PRICE NO. FOUR (4) – OVER-EXCAVATION & ENGINEERED FILL BELOW FLOOR-SLABS AND PAVEMENT: Change the quantity indicated in the Drawings when directed by the Owner's Soil's Engineer for excavation, controlled backfill and compaction of engineered fill below floor-slabs and pavement, including legal disposal of excess unsatisfactory soil materials, ADD or DEDUCT per cubic yard.

END OF SECTION 01 22 00

SECTION 01 23 00 – ALTERNATES

PART 1 - PROVIDE alternative proposals to be added to or deducted from the amount of the Base Bid amount if the corresponding change in scope is accepted by the Owner, in accordance with requirements listed herein. Include within the alternative proposal all associated costs, including but not limited to materials, labor, equipment and fees required to provide the Work item.

PART 2 - COORDINATE related Work and modify or adjust adjacent elements as necessary to ensure that the Work affected by each accepted alternate is complete and fully integrated into the Project. Immediately following Contract award, prepare and distribute to each party involved, notification of the status of each alternate. Indicate whether alternates have been accepted, rejected or deferred for consideration at a later date. Include a complete description of negotiated modifications to alternates. Include as part of each alternate, miscellaneous devices, accessory objects and similar items incidental to or required for a complete installation whether or not mentioned as part of the Alternate.

PART 3 - ALTERNATES

3.01 ALTERNATE # 1 - PROVIDE PERFORMANCE & LABOR/MATERIAL PAYMENT BONDS: If this Alternate is accepted by the Owner, provide bonds covering faithful performance of the Contract and payment of obligations arising thereunder, in amounts equal to one hundred percent (100%) of the Contract Sum. Obtain bonds through the Contractor's usual sources pending approval of Surety by the Owner. Deliver bonds to the Owner not later than three (3) days following the date the Agreement is entered into, or if the Work is to be commenced prior thereto in response to a letter of intent, submit evidence satisfactory to the Owner that the bond will be provided.

3.02 ALTERNATE # 2 – PROVIDE LIGHTNING PROTECTION: Under the Base Bid amount, no lightning protection will be provided. If this Alternate is accepted by the Owner, provide lightning protection to include necessary air terminals, down-conductors with wide-sweep bends outside of the building enclosure, with thermal bonding to the building's structural steel framing system and to the electrical system, and to include a single point grounding system with transient voltage surge suppression at the main electrical panel, in accordance with requirements for a "Master Label Certificate" as tested by UL.

END OF SECTION 01 23 00

SECTION 01 25 00 – SUBSTITUTION PROCEDURES

PART 1 - THIS SECTION includes administrative and procedural requirements for substitutions of products, systems, equipment or installation methods, and product options.

1.01 DEFINITIONS:

A. BASIS-OF-DESIGN PRODUCT SPECIFICATION: Where a specific manufacturer's product is named and accompanied by the words "Basis Of Design", including make or model number or other designation, that product establishes the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for the purpose of evaluating comparable products of other named manufacturers, through the substitutions process.

B. COMPARABLE PRODUCT: A Product that is demonstrated and approved through the substitution process, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of a specified product.

C. NAMED PRODUCTS: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, current as of date of the Contract Documents.

D. SUBSTITUTION: A change in products, materials, equipment, or methods of construction from those required by the Contract Documents as proposed by Contractor.

E. SUBSTITUTIONS FOR CAUSE: Changes proposed by the Contractor that are required due to changed Project conditions, such as unavailability of a product, regulatory changes, or unavailability of required warranty terms.

F. SUBSTITUTIONS FOR CONVENIENCE: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but that may offer advantage to either the Contractor or to the Owner.

PART 2 - SUBSTITUTION REQUESTS:

2.01 SUBMIT ELECTRONIC MEDIA FORMATTED REQUESTS only from the Contractor for consideration by the Architect. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles, as applicable.

2.02 SUBSTITUTION REQUEST FORM: Use CSI Form 13.1A – most recent edition

2.03 DOCUMENTATION: Show compliance with requirements for substitutions and the following, as applicable:

2.04 A STATEMENT indicating why specified material or product cannot be provided.

2.05 COORDINATION INFORMATION including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.

2.06 DETAILED COMPARISON of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

2.07 PRODUCT DATA, including drawings and descriptions of products and fabrication and installation procedures.

2.08 SAMPLES, where applicable or requested.

2.09 LIST OF SIMILAR INSTALLATIONS for completed projects with project names and addresses and names and addresses of architects and owners.

2.10 MATERIAL TEST REPORTS from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

2.11 RESEARCH/EVALUATION REPORTS evidencing compliance with building code in effect for Project, from a model code organization acceptable to AHJ representatives.

2.12 DETAILED COMPARISON OF CONSTRUCTION SCHEDULE using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.

2.13 COST INFORMATION, including a proposal for change, if any, to the Contract Sum.

2.14 CONTRACTOR'S CERTIFICATION that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.

2.15 CONTRACTOR'S WAIVER OF RIGHTS TO ADDITIONAL PAYMENT OR TIME that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

PART 3 - CONTRACTOR'S SUBSTITUTION ACTION (AFTER AWARD):

3.01 SUBSTITUTIONS FOR CAUSE: Submit immediately upon discovery of the need for change, but not later than fifteen (15) days prior to time required for preparation and review of related submittals.

3.02 SUBSTITUTIONS FOR CONVENIENCE: Submit within sixty (60) days after award of contract or notice to proceed. After that period, requested will be considered or rejected at the sole discretion of the Architect. In addition to the above requirements, the proposed Substitution must provide a substantial advantage to the Owner in cost, time, energy conservation and other considerations after deducting the added Owner's costs, including but not limited to additional compensation to the Architect for evaluation and redesign, increased cost of other construction, and similar considerations.

PART 4 - CONSIDERATION OF SUBSTITUTION REQUESTS will be made only if in the Architect's opinion, the following items are well documented and substantiated with the Substitution Request:

4.01 It is consistent with the Contract Documents and will produce the indicated results, without extensive revision to the Contract Documents

4.02 That it will not adversely affect the Construction Schedule

4.03 That it has received necessary approvals of AHJ's

4.04 That it has been coordinated with other portions of the Work, and is compatible with other products or materials

4.05 That it provides the specified warranty

PART 5 - ARCHITECT'S ACTION: If necessary, the Architect may request additional information or documentation for evaluation within one week of receipt of a request for substitution. Contractor will be notified of acceptance or rejection of the proposed substitution within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later. Use the original product specified if no decision on use of a proposed substitution is made within the time indicated.

5.01 FORM OF ACCEPTANCE: Change Order.

END OF SECTION 01 25 00

SECTION 01 26 00 – CONTRACT MODIFICATION REQUIREMENTS

PART 1 - THIS SECTION SPECIFIES administrative and procedural requirements for handling and processing Contract modifications.

1.01 SUPPLEMENTAL INSTRUCTIONS will be issued by the Architect authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

PART 2 - PROPOSAL REQUESTS

2.01 OWNER-INITIATED PROPOSAL REQUESTS: The Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

2.02 PROPOSAL REQUESTS ISSUED BY ARCHITECT ARE FOR INFORMATION ONLY. Do not consider them instructions either to stop work in progress or to execute the proposed change.

2.03 SUBMIT A QUOTATION estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change, within the time specified in Proposal Request after receipt.

2.04 INCLUDE A LIST OF QUANTITIES of products required or eliminated and unit costs, with total amount of purchases and credits to be made.

2.05 IF REQUESTED, FURNISH SURVEY DATA to substantiate quantities. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

2.06 INCLUDE AN UPDATED CONTRACTOR'S CONSTRUCTION SCHEDULE that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

PART 3 - CONTRACTOR-INITIATED PROPOSALS: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change.

3.01 INCLUDE A STATEMENT OUTLINING REASONS FOR THE CHANGE and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

3.02 INCLUDE A LIST OF QUANTITIES OF PRODUCTS required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3.03 INDICATE APPLICABLE TAXES, delivery charges, equipment rental, and amounts of trade discounts.

3.04 INCLUDE AN UPDATED CONTRACTOR'S CONSTRUCTION SCHEDULE that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

3.05 COMPLY WITH DIVISION-01 SECTION "PRODUCT REQUIREMENTS" if the proposed change requires substitution of one product or system for product or system specified.

3.06 PROPOSAL REQUEST FORM: Use AIA Document G709 for Proposal Requests, or other form approved in advance by the Architect.

PART 4 - ALLOWANCE ADJUSTMENTS

4.01 TO ADJUST ALLOWANCE AMOUNTS, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

4.02 INCLUDE INSTALLATION COSTS in purchase amount only where indicated as part of the allowance.

4.03 PREPARE EXPLANATION AND DOCUMENTATION to substantiate distribution of overhead costs and other margins claimed, if requested.

4.04 SUBMIT SUBSTANTIATION OF A CHANGE IN SCOPE OF WORK, if any, claimed in Change Orders related to unit-cost allowances.

4.05 THE OWNER RESERVES THE RIGHT to establish the quantity of work-in-place by independent quantity survey, measure, or count.

4.06 SUBMIT CLAIMS FOR INCREASED COSTS because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 21 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. Owner will reject claims submitted later than 21 days after such authorization.

4.07 DO NOT INCLUDE CONTRACTOR'S OR SUB-CONTRACTOR'S INDIRECT EXPENSE in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.

4.08 NO CHANGE TO CONTRACTOR'S INDIRECT EXPENSE IS PERMITTED for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 5 - CHANGE ORDER PROCEDURES

5.01 THE ARCHITECT WILL ISSUE CHANGE ORDERS on AIA Document G701 on a monthly basis (if necessary) for execution by the Owner and Contractor. Only those Proposal Requests or Requests for Proposals that have been previously approved by the Owner will be included.

END OF SECTION 01 26 00

SECTION 01 26 13 – REQUESTS FOR INTERPRETATIONS (RFI'S)

PART 1 - SUBMIT REQUEST FOR INTERPRETATION (RFI's) immediately up discovery of the need for a clarification after review of the Contract Documents and the field conditions. Include a detailed description of the issue encountered, together with recommendations for changing the Contract Documents. Submit requests on CSI Form 13.2A – "Request for Interpretation" or equivalent form approved for use in advance. Submit RFI's only from the Contractor – RFI's from subcontractors or suppliers must be forwarded to, reviewed by, approved by, and submitted directly from the Contractor.

1.01 SUBMIT RFI'S ONLY AFTER a thorough review of ALL applicable Contract Documents and the field-conditions, and ONLY if the Contractor is still not able to resolve the problem or clarify the issue based on the information contained therein.

1.02 RESPONSIBILITY FOR ADDITIONAL COSTS: If the information requested by the Contractor is apparent from field observations, or is in fact contained within the Contract Documents, or is reasonably inferable from either, the Contractor will be responsible to the Owner for all reasonable costs expended by the Owner, including the hourly costs of the Owner's Construction Representative and/or the professional fees and expenses of the Architect/Engineer, for the Additional Services required to provide such information.

1.03 RESPONSE TO RFI'S IS NOT AN AUTHORIZATION to proceed with additional or extra Work.

END OF SECTION 01 26 13

SECTION 01 29 00 – PAYMENT PROCEDURES

PART 1 - 15 DAYS (MINIMUM) PRIOR TO SUBMITTAL OF THE INITIAL APPLICATION FOR PAYMENT, the following items must be submitted:

1.01 (1) listing of subcontractors and principal suppliers and fabricators,

1.02 (2) the progress schedule,

1.03 (3) preliminary schedule of values,

1.04 (4) performance and/or payment bonds, if required, and

1.05 (5) copies of acquired building permits for performance of the Work.

PART 2 - SCHEDULE OF VALUES: Provide a breakdown of the Contract Sum, as required by the General Conditions. Coordinate preparation and correlate line item breakdown with Specification Sections, and as required to facilitate continued evaluation of payment requests and progress reports. Break down principal subcontract amounts into several line items, to the approval of the Owner and/or Architect. Provide a separate line-item for each allowance, or for each unit-cost allowance as a product of the unit cost multiplied by the measured quantity. Indicate temporary facilities or other major cost items that are not a direct cost of actual work-in-place as separate line items. Show overhead and profit as a separate line item amount – to facilitate review of lien-waivers from sub-contractors and material suppliers. Round-off individual amounts to the nearest whole dollar, but with the total equal to the Contract Sum. Arrange the schedule with columns to indicate the generic name of the item, related specification sections, the subcontractor, supplier, manufacturer or fabricator, change orders (numbers) which have affected the value, the dollar value of the item, and the percentage of the Contract Sum to the nearest one- hundredth percent and adjusted to total 100 percent.

2.01 PRIOR TO INITIAL PAYMENT APPLICATION SUBMITTAL, the following are required:

A. List of subcontractors.
B. Schedule of Values.
C. Contractor's Construction Schedule.
D. Products list.
E. Schedule of unit prices.
F. Submittals Schedule .
G. List of Contractor's staff assignments, and principal consultants.
H. Copies of all applicable building permits (except for those obtained directly by the Owner)
I. Copies of authorizations and licenses from AHJ representatives for performance of the Work.
J. Initial progress report.
K. Report of preconstruction conference.
L. Certificates of Insurance (AIA G705) and evidence that Contractor's insurance has been secured.
M. Performance and payment bonds (if required).

2.02 APPLICATIONS FOR PAYMENTS: Submit AIA Document G702/G703–Current Edition "Application and Certificate for Payment" and Continuation Sheets as applicable or an equivalent document approved in advance to the Architect. Complete every entry on the form, matching data on the Schedule of Values and correlated with the Contractor's Construction Schedule – using updated schedules if revisions have been approved. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Each Application must be consistent with previous applications. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements. Include amounts of Change Orders and Construction Change Directives as separate line-items.

2.03 TIMING: Unless otherwise noted in the Agreement Form, the required date for submittal will be the tenth (10th) day of each month.

2.04 TIME PERIOD: Unless otherwise noted in the Agreement Form, the time-period covered by each Application for Payment starts on the first (1st) day of a month and ends on the last day of the same month.

2.05 SUBMIT an email and deliver THREE (3) notarized originals for receipt within 24 hours of the email

2.06 ATTACHMENTS: Include a transmittal letter listing attachment and appropriate information regarding the Application, with an updated Schedule-of-Values and Construction Progress Schedule (if applicable) and partial lien-waivers (if required by Owner).

2.07 PARTIAL LIEN WAIVERS: At any time throughout the project, the Owner reserves the right to require submittal of partial lien waivers indicating that lien rights are "unconditionally released" for all amounts previously paid, and "conditionally released" or contingent only upon receipt and bank clearance of the current payment-application amounts then due. Unless otherwise required by the Owner, provide partial waivers from the Contractor, and for all subcontractors, sub-subcontractors, suppliers and any other entities lawfully entitled to file a lien more than One Thousand Dollars ($1,000.00) arising out of the Work of the Construction Contract. The Owner reserves the right to designate which entities involved in the Work must submit waivers. Submit all waivers on the 1990 Edition of the "Waiver and Release of Lien" form as issued by the Construction Industry Affairs Council of Greater Kansas City Inc (CIAC) or other form provided or approved by the Owner, fully executed in a manner acceptable to Owner.

PART 3 - PAYMENT APPLICATION AT SUBSTANTIAL COMPLETION: After the Certificate of Substantial Completion is issued, submit an Application for Payment showing 100 percent completion. Provide a copy of the Certificate of Occupancy from the applicable AHJ indicating that the Project can be occupied by the Owner, and a current accounting statement showing all changes to the Contract Sum.

3.01 INCLUDE WITH THE FINAL PAYMENT APPLICATION the following:

A. Unconditional lien-releases for all subcontractors and material suppliers
B. Evidence of completion of Project closeout requirements.
C. Insurance certificates for products and completed operations
D. Proof that all taxes, fees, and similar obligations were paid.
E. Updated final statement, accounting for final changes to the Contract Sum.
F. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
G. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
H. AIA Document G707, "Consent of Surety to Final Payment." Evidence that claims have been settled.
I. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
J. Final, liquidated damages settlement statement.

END OF SECTION 01 29 00

SECTION 01 31 00 – MANAGEMENT & COORDINATION

PART 1 - CONTRACT DOCUMENTS

1.01 CAREFULLY STUDY AND COMPARE the Contract Documents and drawings of the existing building (if available), with the existing conditions at the project-site. Report errors, inconsistencies or omissions discovered for clarification. The Contractor will be responsible for repair or correction costs if work is executed with knowledge that it involves an error, inconsistency or omission - without this notice.

1.02 CONTRACT DOCUMENTS ON-SITE: Maintain a complete set of the most recent Construction Documents (Drawings and Specifications) at all times, with all applicable contract modification documents including Supplemental Instructions and approved Change Orders applicable to the Work.

PART 2 - COORDINATION AND ADMINISTRATION

2.01 SCHEDULE AND COORDINATE THE WORK to assure an efficient and orderly sequence of installation of construction elements, with provisions for accommodating items to be installed later. Prepare general coordination drawings, schedules, and control site utilization, from beginning of construction throughout project close-out.

2.02 COORDINATE CONSTRUCTION OPERATIONS included in the various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included that of other related Sections that depend upon each other for proper installation, connection, and operation.

2.03 SCHEDULE CONSTRUCTION OPERATIONS in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

2.04 COORDINATE INSTALLATION of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair. Make adequate provisions to accommodate items scheduled for later installation.

2.05 COORDINATE THE WORK of fire-suppression, HVAC, plumbing, electrical and communication / control systems so that conflicts do not occur. Do not relocate an exposed, finished surface unless approved in advance by the Architect.

2.06 PREPARE MEMORANDA for distribution to each party involved, outlining special procedures required for coordination, if necessary. Include such items as required notices, reports, and list of attendees at meetings. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

2.07 ADMINISTRATIVE PROCEDURES: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

A. Preparation of Contractor's Construction Schedule.
B. Preparation of the Schedule of Values.
C. Installation and removal of temporary facilities and controls.
D. Delivery and processing of submittals.
E. Progress meetings.
F. Pre-installation conferences.
G. Project closeout activities.

2.08 CONSERVATION: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

2.09 PREPARE COORDINATION DRAWINGS if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

A. Indicate relationship of components shown on separate Shop Drawings.
B. Indicate required installation sequences.
C. Refer to applicable Specification Sections for specific coordination drawing requirements for mechanical and electrical installations.

2.10 ADMINISTRATIVE AND SUPERVISORY PERSONNEL - STAFF NAMES: Within 15 days of starting construction operations, submit a list of principal staff assignments, including superintendent, personnel at Project site, and administrative and supervisory personnel at main office. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.

2.11 IN ADDITION to the Project superintendent, provide administrative and supervisory personnel as required for proper performance of the Work. Include special personnel required for coordination of operations with other contractors.

2.12 PRECONSTRUCTION CONFERENCE: Schedule and conduct an “on-site” Pre-Construction Conference before starting construction activities, at a time and location convenient to the Owner - but no later than 15 days after execution of the Agreement. Arrange for “on-line” participation by parties not required to be on-site, including the Owner and the Architect (at their option), and for sub-contractor and supplier representatives not involved in the initial construction activities. On-site attendance is required of the Contractor’s superintendent, and major sub-contractor representatives. Minor sub-contractors, sub-subcontractors, manufacturers, suppliers and other concerned parties are to participate in the meeting on-line. Participants at the conference must be familiar with the Project and authorized to conclude matters relating to the Work. Discuss items of significance that could potentially affect progress, including but not limited to the following:

A. Identify responsible personnel of the Contractor and sub-contractors, and review their duties and responsibilities

B. Verify that all sub-contractors have a complete set of Contract Documents
C. Review the initial Construction Schedule, and any critical work sequencing, if applicable.
D. Review working hours for the construction project, and procedures necessary to work in non-typical hours
E. Review available temporary field-office and storage areas available for use
F. Review use of the existing site and/or building facility, and available parking stalls for workers, if any
G. Review requirements and responsibilities for temporary facilities and controls, and requirements for maintenance thereof
H. Review requirements for material and equipment deliveries to the site
I. Review policies and requirements established for safety, first-aid, and security of the construction site.
J. Review requirements of daily progress cleaning
K. Review procedures for processing field decisions or directives, supplemental instructions, and Change Orders.
L. Review requirements for submitting and processing submittals of Product Data, Shop Drawings, and samples
M. Review requirements for processing Applications for Payment – both periodic and for substantial and final completion
N. Review maintenance of "as-built" drawings during construction, and their documentation at project completion
O. Review requirements for completion of Punch-List Work determined at Substantial Completion
P. Review submittal of closeout documents after Substantial Completion,

2.13 CONSTRUCTION PROGRESS MEETINGS: Schedule and conduct periodic progress meetings at not less than once every two (2) weeks at the Project Site, and hold various other pre-installation and coordination conferences as required by construction activities. Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times at least five (5) working days prior to meetings. Prepare a meeting agenda, and distribute to all invited attendees. Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within 3 days of the meeting. Discuss the following topics at each progress meeting, as appropriate:

A. Review and correct or approve minutes of previous progress meeting.
B. Review of work progress since previous meeting
C. Review the updating of the Record Documents of Work completed
D. Status of Contractor's Construction Schedule: Determine whether each activity is on time, ahead of schedule, or behind schedule. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
E. Review of pending work scheduled to be performed: If necessary, determine how construction behind schedule will be expedited; secure commitments from parties involved to do so.
F. Review construction quality, work standards and progress cleaning
G. Review any known problems and conflicts
H. Review status of Contractor's submittals
I. Review pending changes or Contract modifications, and documentation of supporting information
J. Proposed items for discussion at next meeting

END OF SECTION 01 31 00

SECTION 01 32 16 – CONSTRUCTION & SUBMITTAL SCHEDULE

PART 1 - SCHEDULE THE WORK OF THE ENTIRE PROJECT, including work performed by the Owner's separate contractors (as if affects the Work of this Contract) to assure an efficient and orderly sequence of installation of all elements – with provisions for accommodating items to be installed later.

1.01 CONSTRUCTION SCHEDULE: Prepare and submit a proposed progress schedule for the Work within fourteen (14) calendar days after award of Contract. Provide a separate line-item for each Work item listed in the Schedule of Values. Include appropriate time for project mobilization, procurement of products, review and approval of shop drawings, fabrication, installation, testing, and final cleanup. Identify each calendar day throughout the schedule. Highlight "critical path" elements of the schedule that are important to complete the Work on time. Correlate the schedule with critical "milestone dates" including but not limited to the Notice to Proceed, Substantial Completion, and the Final Completion dates.

1.02 REVISE CONSTRUCTION SCHEDULE after progress meetings when revisions to the schedule have been made or recognized. Issue a revised schedule concurrently with the report of each meeting.

1.03 COST-LOADED SCHEDULE: Show a two (2)-item cost correlation line, indicating both "pre-calculated" and "actual" costs as the Work progresses. This cost correlation line must show dollar-volume of work performed as of the same dates used for preparation of payment requests. In so far as it is practical, use the same units of Work in the Progress schedule as indicated in the "Schedule of Values" required by the General Conditions and further defined within these Specifications.

1.04 SUBMITTAL SCHEDULE: Submit a schedule of submittals, arranged in chronological order by dates required by the Construction Schedule. Coordinate the Submittal Schedule with the Construction Schedule, and include time required for review and re-submittal when establishing dates. Submit the Submittal Schedule concurrently with the Construction Schedule. Indicate if any submittals affect the "critical path" of the Construction Schedule, and those required early due to long lead time for manufacture or fabrication. Failure to provide a Submittal Schedule relieves the Architect and/or Engineer of responsibility for timely submittal review.

END OF SECTION 01 32 16

SECTION 01 32 26 – CONSTRUCTION PROGRESS REPORTING

PART 1 - SECTION INCLUDES administrative and procedural requirements for documenting the progress of construction during performance of the Work.

1.01 PROVIDE INFORMATIONAL SUBMITTALS, as follows:

A. Daily construction reports including count of all personnel at project site: submit at weekly intervals.
B. Material location reports: Submit at monthly intervals
C. Site condition reports: Submit at time of discovery of differing conditions
D. Special Conditions Reports: Submit at time of discovery of unusual event.
E. Work documentation, periodic site observations: Submit at weekly intervals.
F. Work documentation, construction progress photographs: submit at weekly intervals.

1.02 DAILY CONSTRUCTION REPORTS: Prepare daily construction reports recording the following information concerning events at Project site:

A. List of subcontractors at Project site.
B. List of separate contractors at Project site.
C. Approximate count of personnel at Project site.
D. Equipment at Project site.
E. Material deliveries.
F. High and low temperatures and general weather conditions, including presence of rain or snow.
G. Accidents.
H. Meetings and significant decisions.
I. Unusual events (see special reports).
J. Stoppages, delays, shortages, and losses.
K. Meter readings and similar recordings.
L. Emergency procedures.
M. Orders and requests of AHJ representatives.
N. Change Orders received and implemented.
O. Construction Change Directives received and implemented.
P. Services connected and disconnected.
Q. Equipment or system tests and startups.
R. Partial completions and occupancies.
S. Substantial Completions authorized.

1.03 MATERIAL LOCATION REPORTS: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

A. Material stored prior to previous report and remaining in storage.
B. Material stored prior to previous report and since removed from storage and installed.
C. Material stored following previous report and remaining in storage.

1.04 SITE CONDITION REPORTS: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

1.05 SPECIAL REPORTS: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Submit directly to Owner within one (1) day of the occurance, and advise the Owner in advance if these events are known or predictable. Distribute copies of report to parties affected by the occurrence.

1.06 UPDATE AND MAINTAIN THE RECORD-SET of Construction Documents at not less than weekly intervals, indicating differences between the Construction Documents and the actual installed Work. Mark revisions made during construction with colored pencil - do not conceal any Work before revisions have been recorded. Note actual routing of under-slab plumbing and utility lines, if different from design drawings. In addition, maintain copies of the Owner's separate contractor's submittals as applicable. Do not construct or install any portion of the Work related to these drawings at any time without such drawings being available at the site.

END OF SECTION 01 32 26

SECTION 01 32 33 – PHOTOGRAPHIC DOCUMENTATION

PART 1 - PROVIDE DIGITAL PHOTOGRAPHIC DOCUMENTATION of the work progress.

1.01 PROVIDE DIGITAL images in JPEG format, with minimum sensor size of 8.0 megapixels. Provide un-cropped digital images with date stamps typically. With each photo, digitally record the following information:

A. Project Name
B. Date
C. General Description - indicating location and direction (by compass point).

1.02 WALL ROUGH-IN PHOTOS: Before covering wall framing with drywall or other finishes, take photographs of the wall framing showing electrical devices, wiring, piping and other items that will be concealed in the final work.

1.03 PERIODIC CONSTRUCTION PHOTOGRAPHS: Take a minimum of TWENTY (20) photographs on a weekly basis. Select vantage points to best show status of construction and progress for that time period.

1.04 FINAL COMPLETION CONSTRUCTION PHOTOGRAPHS: Take a minimum of one (1) photo in each room or space and as many as are necessary to document finished conditions of the project before Owner occupancy. Take adequate exterior photos to indicate all areas of the outside of the completed building.

1.05 SUBMIT DIGITAL PHOTOS on a USB compatible flash-drive / memory stick on a monthly basis, coinciding with cutoff date associated with each Application for Payment.

1.06 RETAIN ONE PRINTED SET of photographs in Field Office at Project site, available at all times for reference.

END OF SECTION 01 32 33

SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 - PROCEDURE

1.01 MAKE SUBMITTALS of Product Data, Shop Drawings and Samples when required by other Sections of these Specifications (submittals not required may be returned without review or comment). Submittal review is a gratuitous assistance to the Contractor, for purposes of general information, and to verify conformance with the design intent of the Contract Documents. Review of submittals does not relieve the Contractor from responsibility for errors which may exist in the submitted data.

1.02 "APPROVAL" OF SUBMITTALS will not be provided by the Architect, as the General Contractor is to approve submittals before submitting to the Architect per requirements of the General Conditions. Submittals may be marked by the Architect as "No Exceptions, Exceptions Noted, Revise and Resubmit or Rejected. If errors or omissions in submittals are subsequently discovered after review, revise and resubmit submittals as expeditiously as necessary not to delay the Work progress.

1.03 COORDINATE each submittal with other submittals and related activities that require sequential activity. Group transmittal of different kinds of submittals for the same unit of work so that information is available for checking each item when it is received.

1.04 CONSECUTIVELY NUMBER all submittals. When an item is resubmitted for any reason, transmit under a new letter of transmittal and with a new transmittal number.

1.05 CONTENT: All submittals must contain the date of submission; the Project Title; the Contractor's name, the name of the sub-contractor, supplier or manufacturer, as applicable; identification of the product being submitted; clear identification of field dimensions, verified by the Contractor; relation to adjacent or critical features of the Work; applicable standards; identification of deviations from the Contract Documents; and a clear space for the Contractor's approval stamps.

1.06 STAMP & APPROVE all submittals with the Contractor's approval stamp, dated, and initialed or signed, certifying approval of the submittal, verification of the product being submitted, and verification that the product submitted complies with the requirements of the Contract Documents. Failure to properly verify conformance and conditions at the job site will not relieve the Contractor of the responsibility to properly install the Work.

1.07 ELECTRONIC PRODUCT-DATA & SHOP DRAWING SUBMITTALS: In order to conserve paper, limit delivery/courier expenses, and to expedite the review process, provide electronic Product-Data submittals. Maintain one (1) set of printed, approved Product-Data and shop-drawing submittals at the Project Site, complete with applicable review and approval comments, if they exist. Make and distribute as many copies of Product Data and Shop Drawings as necessary for records, coordination, construction operations, and for incorporation into the Operations and Maintenance Manual.

1.08 ARCHITECT'S ELECTRONIC MEDIA DATA (EMD) DRAWING FILES: Upon request and execution of an agreement form regarding use of EMD data files by the Contractor with the Architect, the Electronic Media Data (EMD) files of the Drawings will be provided one (1) time only from the Architect to the Contractor for use in preparing Shop Drawing Submittals at no cost. Per General Conditions Paragraph 1.6.2, the Architect makes no representations as to the accuracy or completeness of the EMD provided, as it is not considered to be a part of the Contract Documents. EMD information may be provided in either AutoCAD's .DWG format, or as a "Revit" electronic model. Additional transfers of EMD from the Architect will be provided upon receipt of a Service Fee of $250.00 per issue together with an executed EMD use agreement form (if not being issued to the Contractor directly).

1.09 QUANTITY OF SAMPLES TO BE SUBMITTED: Submit three (3) samples of products when required by the Contract Documents, for return of one (1) sample to the Contractor. Costs for submittal and return of samples must be paid by the Contractor. Approval of samples does not imply acceptance of the finished in-place product. Color, texture, and patterns must conform to the samples submitted and if the range of texture, color or pattern varies, the work will be rejected.

1.10 REQUIRED PROCESSING TIME: Allow time for submittal review, and time for re-submittals, within the Construction Schedule. Allow additional time if processing must be delayed to permit coordination with subsequent submittals – until that information is submitted. If submittals are incomplete, the Architect will advise the Contractor as soon as possible, and the processing time will start when the additional information is received. No extension of the Contract Time will be authorized because of failure to transmit submittals in advance of the Work to permit processing time.

A. ALLOW 10 BUSINESS DAYS for initial review of each submittal, and for processing each resubmittal.

END OF SECTION 01 33 00

SECTION 01 35 16 – ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.01 ALTERATION WORK includes demolition, cutting, patching, removal, refinishing and relocation of existing construction, systems and equipment.

1.02 PERFORM ALTERATION WORK to existing buildings in a manner that will preserve the aesthetic and structural integrity of the existing materials and construction elements intended to remain.

1.03 PERFORM ALTERATION WORK of existing operational “critical facilities” to minimize the risk of interruption of the Owner’s ongoing business critical operations.

1.04 PERFORM DISRUPTIVE, NOISE OR DUST PRODUCING ALTERATION WORK in existing occupied facilities only during non-business hours, and then only with the Owner’s advance approval.

1.05 RELATED SECTIONS: Division-01 Section “Cutting and Patching” applies to the Work of this Section, as applicable.

PART 2 - DEFINITIONS:

2.01 REMOVE: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

2.02 REMOVE AND SALVAGE: Detach items from existing construction and deliver them to Owner, ready for reuse.

2.03 REMOVE AND REINSTALL: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

2.04 SALVAGE: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

2.05 RECYCLE: Recovery of demolition waste for subsequent processing in preparation for reuse.

2.06 EXISTING TO REMAIN: Existing functional items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

PART 3 - CRITICAL FACILITIES & SYSTEMS:

3.01 CRITICAL SYSTEMS or EQUIPMENT

A. None

3.02 CRITICAL FACILITIES include existing occupied rooms or spaces that contain critical equipment or systems.

3.03 CRITICAL UTILITIES & SYSTEMS include the following associated support elements:

A. None

3.04 CRITICAL SYSTEMS WORK includes the shut-down or the potential risk of accidental shut-down of critical system, including the following:

A. None

3.05 NO DUST, WATER OR VIBRATION IS ACCEPTABLE

A. None

PART 4 - SUBMITTALS

4.01 SHUT-DOWN SCHEDULE: Submit a schedule of proposed shut-downs before starting Work at the Site. Notify the Architect and the Owner, in writing, of any planned utility outages required. Submit schedule not less than two (2) weeks in advance of need of planned shut-downs, and obtain the Owner’s approval before proceeding.

4.02 SUBMIT METHODS OF PROCEDURES (MOP’S):

A. PREPARE MOP’S for all activities related to “Critical Systems Work” and obtain the Owner’s “acceptance” before proceeding with the Work described. The Owner’s acceptance does not alter the Contractor’s sole responsibility for construction means and methods.

B. IDENTIFY ALL SUB-CONTRACTORS and their personnel that will be involved in the Work. Schedule Critical-System shut-downs no less than ninety-six (96) hours in advance of the Work. The Contractor’s Superintendent (or approved alternative with the same supervisory authority) must be present at the site during all Work covered by a MOP.

PART 5 - JOB CONDITIONS

5.01 VISIT THE PROJECT SITE to determine by inspection the existing conditions, including access to the Site, the nature of structures, objects, and materials to be encountered, and other salient facts concerning or affecting the Work. Information of existing conditions indicated on the Drawings does not constitute a guarantee that other conditions or items may not be found or encountered.

5.02 OBVIOUS EXISTING CONDITIONS, installations, and obstructions affecting the Work of this Section must be taken into consideration as being necessary Work and must be included as part of Work of this Section – as if completely shown or described.

PART 6 - PRODUCTS

6.01 TEMPORARY EQUIPMENT ENCLOSURES: Provide to prevent dust from construction operations to affect critical equipment. Construct with a framework of metal or fire-retardant wood studs with an 8 mil anti-static reinforced poly sheet (flame spread rating of 15 or less). Tape seal all internal and perimeter joints. Maintain existing critical system cooling

systems, or provide temporary cooling system with HEPA filters from the construction area, if necessary. Provide dustproof doors and walk-off mats.

6.02 TEMPORARY OVERHEAD PROTECTION PLATFORMS: Provide when any Work will be performed over critical equipment or systems. Construct with mineral-fiber board or fire-retardant wood plywood decking over metal or fire-retardant wood framing with a minimum 8-mil anti-static reinforced poly sheet (with a flame spread rating of 15 or less) enclosure, and a non-combustible walking surface above. Provide a toe-board on all sides to prevent tools and debris from falling onto critical equipment, and railings for worker's safety. Support temporary protection platforms without affecting existing critical equipment, maintaining all existing environmental cooling and exhaust systems ass applicable.

6.03 REPAIR AND MAINTAIN temporary protection of critical equipment during construction operations, and remove from site when no longer necessary.

PART 7 - EXECUTION

7.01 PERFORM THE WORK so that disruption to occupied areas is minimized and to maintain the Owner's ongoing use during normal hours of operations to the greatest extent feasible.

7.02 CAREFULLY REMOVE AND REPLACE EXISTING CONSTRUCTION indicated to remain upon completion, but which require removal to complete the Work. Match condition of construction prior to the start of the Work unless otherwise required. Carefully remove and store items indicated for relocations in new Work, or to be retained by Owner, to avoid damage. Thoroughly clean and reinstall as indicated or as directed. Protect and store items identified for reuse. Deliver salvaged items to a facility as directed by the Owner within ten (10) miles of the Project site.

7.03 EXISTING UTILITIES: Maintain existing utilities indicated to remain, and protect against potential damage during demolition operations. Do not interrupt existing utilities serving occupied facilities, except when so authorized in writing by the Owner. When necessary, provide temporary services during interruptions of existing utilities, acceptable to the local AHJ.

7.04 PREPARATION

A. Cut, move, or remove items as are necessary for access to alteration and renovation Work. Replace and restore at completion.
B. Remove unsuitable material not marked for salvage, such as rotted wood, corroded metals, and deteriorated masonry and concrete.
C. Replace materials as specified for finished Work.
D. Remove debris and abandoned items from area and from concealed spaces.
E. Prepare surface and remove surface finishes to provide for proper installation of new Work and finishes.
F. Close openings in exterior surfaces to protect existing Work and salvageable items from weather and extremes of temperature and humidity. Insulate ductwork and piping to prevent condensation in exposed areas.

7.05 INSTALLATION

A. Coordinate alteration and renovation Work to expedite completion, and in required sequences of Work to accommodate Owner occupancy, as applicable.
B. Remove, cut and patch Work in a manner to minimize damage and to provide restoring products and finishes to original and or specified condition.
C. Refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with neat transition to adjacent finishes.
D. Restore existing operational plumbing, heating, ventilation, air conditioning, and electrical systems to full operational condition, when exists.
E. Recover and refinish Work that exposes mechanical and electrical Work that is exposed accidentally during the Work.
F. Install products and finish materials as indicated within individual Specification Sections.

7.06 TRANSITIONS

A. Where new Work abuts or aligns with existing construction, perform a smooth and even transition. Patch work to match existing adjacent Work in texture and appearance.
B. When finished surfaces are cut so that a smooth transition with new Work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to the Architect.

7.07 ADJUSTMENTS

A. Where removal of partitions or walls result in adjacent spaces becoming one, rework floors, walls, and ceiling surfaces to a smooth plane without breaks, steps, or bulkheads.
B. Provide smooth transitions when a change of plane of 1/4 inch in twelve (12) inches occurs.
C. Trim existing doors as necessary to clear new floor finish. Refinish trim as required.
D. Fit Work at penetrations of surfaces to be flush and non-obtrusive.

7.08 REPAIR OF DAMAGED SURFACES: Patch or replace portions of existing surfaces that are damaged, lifted, discolored, or showing imperfections. Repair substrate prior to patching finishes.

7.09 FINISHES

A. Finish surfaces as specified in individual product specification sections.
B. Finish patches to produce uniform finish and texture over entire area. When finish cannot be matched, refinish entire surface to nearest intersections.

7.10 CRITICAL FACILITY CONSTRUCTION OPERATIONS:

A. DOWNTIME OR INTERRUPTION OF CRITICAL SYSTEMS must be kept to an absolute minimum. Electrical system shut-downs cannot exceed thirty (30) minutes unless a portable generator system is provided.

B. HAND DIG (POTHOLE) to locate critical utilities whenever excavation is required within five (5) feet of the marked, assumed position determined by the utility locator service.
C. CONSTRUCTION ABOVE CRITICAL FACILITIES (in ceiling plenum above or exposed directly above Critical Facilities): Provide sanitary waste, vent, and storm drainage piping with heavy-duty joint connections with a minimum 15 PSI pressure rating comply with requirements of Factory Mutual 1680.3. Provide cooling coil condensate and other piping conveying contents below 55 degrees F must be insulated and vapor sealed to prevent condensation. Locate HVAC equipment and fan-coil units outside of the Critical Facility area.

END OF SECTION 01 35 16

SECTION 01 35 61 – VOLUNTARY SUSTAINABILITY GOALS

PART 1 - COMPLY WITH REQUIREMENTS of this Section regarding sustainable design and construction requirements, and provide submittal documents and reports to verify conformance with the Owner's voluntary sustainability goals.

1.01 MAXIMUM VOC CONTENT REQUIREMENTS: For all field-applied applications inside the building envelope, provide products that do not exceed the following values, in accordance with Federal Standard 40 CFR 59, Subpart D:

Wood Glues: ..... 30 g/L.
Metal to Metal Adhesives: ..... 30 g/L.
Adhesives for Porous Materials (Except Wood): ..... 50 g/L.
Subfloor Adhesives: ..... 50 g/L.
Plastic Foam Adhesives: ..... 50 g/L.
Carpet Adhesives: ..... 50 g/L.
Carpet Pad Adhesives: ..... 50 g/L.
VCT and Asphalt Tile Adhesives: ..... 50 g/L.
Cove Base Adhesives: ..... 50 g/L.
Gypsum Board and Panel Adhesives: ..... 50 g/L.
Rubber Floor Adhesives: ..... 60 g/L.
Ceramic Tile Adhesives: ..... 65 g/L.
Multipurpose Construction Adhesives: ..... 70 g/L.
Fiberglass Adhesives: ..... 80 g/L.
Contact Adhesive: ..... 80 g/L.
Structural Glazing Adhesives: ..... 100 g/L.
Wood Flooring Adhesive: ..... 100 g/L.
Structural Wood Member Adhesive: ..... 140 g/L.
Top and Trim Adhesive: ..... 250 g/L.
Plastic Cement Welding Compounds: ..... 250 g/L.
ABS Welding Compounds: ..... 325 g/L.
CPVC Welding Compounds: ..... 490 g/L.
PVC Welding Compounds: ..... 510 g/L.
Adhesive Primer for Plastic: ..... 550 g/L.
Other Adhesives: ..... 250 g/L.
Architectural Sealants: ..... 250 g/L.
Nonmembrane Roof Sealants: ..... 300 g/L.
Single-Ply Roof Membrane Sealants: ..... 450 g/L.
Other Sealants: ..... 420 g/L.
Sealant Primers for Nonporous Substrates: ..... 250 g/L.
Sealant Primers for Porous Substrates: ..... 775 g/L.
Modified Bituminous Sealant Primers: ..... 500 g/L.
Other Sealant Primers: ..... 750 g/L.
Flat Paints, Coatings, and Primers: ..... 50 g/L.
Nonflat Paints, Coatings, and Primers: ..... 150 g/L.
Clear Wood Finishes, Varnishes: ..... 350 g/L.
Clear Wood Finishes, Lacquers: ..... 550 g/L.
Floor Coatings: ..... 100 g/L.
Shellacs, Clear: ..... 730 g/L.
Shellacs, Pigmented: ..... 550 g/L.
Stains: ..... 250 g/L.
Flat Interior Topcoat Paints: ..... 50 g/L.
Nonflat Interior Topcoat Paints: ..... 150 g/L.
Clear Wood Finishes, Lacquers: ..... 550 g/L.
Floor Coatings: ..... 100 g/L.
Shellacs, Clear: ..... 730 g/L.
Shellacs, Pigmented: ..... 550 g/L.
Primers, Sealers, and Undercoaters: ..... 200 g/L.
Dry-Fog Coatings: ..... 400 g/L.
Zinc-Rich Industrial Maintenance Primers: ..... 340 g/L
Special Purpose Contact Adhesive (used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
Aerosol Adhesive, General Purpose Mist Spray: ..... 65 percent by weight.
Aerosol Adhesive, General Purpose Web Spray: ..... 55 percent by weight.
Special Purpose Aerosol Adhesive (All Types): ..... 70 percent by weight.
Anticorrosive and Antirust Paints Applied to Ferrous Metals: ..... 250 g/L.
Anticorrosive and Antirust Paints Applied to Ferrous Metals: ..... 250 g/L.
Clear Wood Finishes, Varnishes and Sanding Sealers: ..... 350 g/L.
Pretreatment Wash Primers: ..... 420 g/L.

1.02 AROMATIC COMPOUNDS: Paints and coatings must not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

1.03 RESTRICTED COMPONENTS: Do not use any materials in the Project containing the following:

Acrolein
Acrylonitrile
Antimony
Benzene
Butyl benzyl phthalate
Cadmium
Di (2-ethylhexyl) phthalate
Di-n-butyl phthalate
Di-n-octyl phthalate
1,2-dichlorobenzene
Diethyl phthalate
Dimethyl phthalate
Ethylbenzene
Formaldehyde
Hexavalent chromium
Isophorone
Lead
Mercury
Methyl ethyl ketone
Methyl isobutyl ketone
Methylene chloride
Naphthalene
Toluene (methylbenzene)
1,1,1-trichloroethane
Vinyl chloride

1.04 DO NOT USE COMPOSITE WOOD or agrifiber products or adhesives that contain any urea-formaldehyde resin.

PART 2 - EXECUTION

2.01 CONSTRUCTION WASTE MANAGEMENT: Comply with Division-01 Section “Construction Waste Management and Disposal.".

2.02 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT: Comply with "SMACNA IAQ Guideline for Occupied Buildings under Construction."

A. If the Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period, provide filter media having a MERV 8 rating per ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction. Replace all air filters immediately prior to occupancy.

END OF SECTION 01 35 61

SECTION 01 42 00 – DEFINITIONS & REFERENCES

PART 1 - REFER TO THE GENERAL CONDITIONS for basic Contract definitions, and as follows:

1.01 DIRECTED: A command or instruction by the Architect or the Architect's consultants. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

1.02 INDICATED: Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

1.03 INSTALLER: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

1.04 EXPERIENCED: Having successfully completed a minimum of five (5) previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of AHJ representatives.

1.05 FURNISH: To supply and deliver to Project site, unload and inspect for damage, ready to install.

1.06 INDICATED: Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including 'shown', 'noted', 'scheduled', and 'specified' have the same meaning as 'indicated'.

1.07 INSTALL: Operations at the Project Site, including but not limited to: temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, start up, protecting, cleaning, and similar operations making ready for use.

1.08 PROJECT SITE (or SITE): The designated interior-space or land-area upon which construction activities will be performed. The extent of the Project Site may not be identical to the legal description of the land on which Project is to be built.

1.09 PROVIDE: To furnish and install, complete and ready for the intended use."

1.10 REGULATIONS: Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules,

1.11 conventions, and agreements within the construction industry that control performance of the Work.

1.12 SUPPLY: Same as Furnish.

1.13 CONSTRUCTION DOCUMENT SCOPE ABBREVIATIONS:

A. C F C I: Contractor Furnished, Contractor installed (typical unless otherwise indicated)
B. N I C: Not In Contract (O F O I)
C. O F C I: Owner Furnished, Contractor installed
D. O F O I: Owner Furnished and Owner installed, by the Owner or by separate Owner contractor(s)

1.14 ABBREVIATIONS AND ACRONYMS: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they mean the recognized name of the entities indicated in Thomson Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

1.15 INDUSTRY STANDARDS

A. APPLICABILITY OF STANDARDS: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
B. PUBLICATION DATES: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.
C. CONFLICTING REQUIREMENTS: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding. The quantity or quality level shown or specified will be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.
D. COPIES OF STANDARDS: Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

END OF SECTION 01 42 00

SECTION 01 43 39 – MOCKUPS

PART 1 - THIS SECTION INCLUDES administrative and procedural requirements of the Contractor, for temporary construction and demolition of mockups at the Project Site.

1.01 MOCKUPS are full-size physical assemblies constructed on-site, to verify color and finish selections made, to demonstrate the full range of aesthetic effects and workmanship, and: to indicated qualities of material finishes and application or execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

A. CONSTRUCT MOCKUPS using the same workers that will be used during the construction of the Work, and with the same supervisory personnel.
B. CONSTRUCT MATERIAL MOCKUPS when required by other “technical” Sections at locations on-site approved by the Architect.

1.02 INTEGRATED EXTERIOR MOCKUP: Provide an assembly erected separately from the building on the Project Site, consisting of multiple exterior products and materials, assemblies and sub-assemblies, and as follows:

A. Location: where indicated on the Drawings, or if not indicated, at location approved by the Architect and in accordance with requirements of the AHJ.
B. Location: Fabricate on the back-side of the temporary Project Site required in other Division-01 Sections.
C. Fabricate in accordance with the layout and elevation(s) as indicated on the Drawings, or if not indicated, in accordance with a layout subsequently provided by the Architect.
D. SIZE: 12 feet high x 18 feet wide (or as otherwise indicated in the Drawings)
E. Include exterior materials used throughout the Project, including but not limited to the following, as indicated:
   (1) Masonry assemblies
   (2) Decorative stone assemblies
   (3) EIFS assemblies, including reveal, control joints and colors
   (4) Decorative wood and metal assemblies, including windows, doors and storefront systems
   (5) Paints, sealants, and flashings coordinated with full range of project color selections
   (6) Decorative roof assemblies of roofing materials exposed to view by the public
   (7) Roof membrane and parapet
   (8) Roof edge sheet metal trim, with overlap of roof membrane onto building face
F. Typical exterior wall assemblies with various wood, plaster/stucco and fiber-cement cladding, including reveals, control and expansion joints, flashings and sealant joints
G. The intent of this integrated exterior mockup is to physically test the weather-resistant and air-barrier assemblies and their connections with adjacent materials, and to establish quality and workmanship standards for construction of the entire building facility.
H. Note that “partial” approval will not be provided – the Integrated Exterior Mockup must be complete with all required materials and finishes, before testing operations will proceed.

1.03 ROOM MOCKUPS: Construct room mockups incorporating required materials and assemblies, finished according to requirements indicated in the Drawings. Provide required lighting and additional lighting where required to enable the Architect and the Owner to evaluate quality of the Work. Provide room mockups of the following rooms:

A. Two (2) room mockups at locations to be determined..
B. TIME: Construct mockups as soon as contract is awarded, once Contractor is available at the project site, and mockup design is determined by Architect. Note that no "partial" approvals of mockup will be provided – the mockup must be complete with ALL indicated finishes, materials and colors as indicated before approval will be granted.

PART 2 - NOTIFY ARCHITECT not less than seven (7) days in advance of dates and times when mockups will be constructed, and ready for review and approval.

2.01 OBTAIN ARCHITECT’S APPROVAL OF MOCKUPS before starting any work, fabrication, or construction of finishes included within the mockup.

2.02 MAINTAIN MOCKUPS DURING CONSTRUCTION in an undisturbed condition as a standard for judging the completed Work.

2.03 APPROVAL OF MOCKUP DOES NOT CONSTITUTE approval of deviations from the Contract Documents unless such deviations are specifically approved by Architect in writing.

2.04 DEMOLISH AND REMOVE MOCKUP before Substantial Completion, except as otherwise permitted to remain as a part of the Work.

PART 3 - PERFORMANCE TESTING OF INTEGRATED EXTERIOR MOCKUP:

3.01 THE OWNER WILL ENGAGE a qualified building-enclosure testing entity to perform performance testing of the completed Integrated Exterior Mockup, as follows:

A. Test protocols require that air infiltration testing will precede water tests. If it is necessary for water testing to be performed before air testing, the mockup will be allowed to completely dry before the air testing begins.
B. Note that the wind machine used for dynamic water testing will generate wind speeds equivalent to 10 PSF.
C. Center deflection readings will be taken for glass during testing.

3.02 TESTS THAT MAY BE PERFORMED, in the order indicated, include the following:

A. Preliminary wind-loading at code-required wind load value at the highest building elevation.
B. Air Infiltration (Static Pressure) testing per ASTME E783, except that test pressure difference will be 6.24 PSF.

C. Water Penetration (Cyclic Pressure) testing per ASTM E 1105, testing to full design pressure without derating.
D. No water intrusion will be acceptable.
   (1) The definition of water intrusion includes any water visible from the finished building interior, whether or not defined as being “controlled.”
E. Water penetration testing of exterior wall cladding per CBC Section 1403.2, testing to the code prescribed minimum pressure or building design pressure, whichever is greater.
F. Oscillating, single 3/4 inch diameter garden-sprinkler hose spray testing over a twenty-four (24) hour period with a five (5) PSF wind pressure, with no water intrusion observed.

3.03 CORRECTIVE MEASURES: Correct deficiencies in the mock-up observed during testing and repeat tests as necessary to indicated compliance with the specified performance requirements and per the Contract Documents.

A. Resubmit submittals and shop drawings affected by these corrections, with changes made to assemblies necessary to successfully complete the testing operations.
B. Deficiencies requiring repair or modification to the mock-up will require complete retesting of the mock-up beginning with the initial tests unless otherwise requested by the testing entity.
C. If compliance with the performance standards is not achieved after two (2) complete retests, the Contractor must completely reconstruct the mock-up assembly with revised construction installation techniques and workmanship, and initiate new testing operations.

3.04 INCORPORATE CORRECTIVE MEASURES indicated by the test report into the final exterior wall assemblies.

END OF SECTION 01 43 39

SECTION 01 40 00 – QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.
B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document and AHJ requirements.
   (1) Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
   (2) Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
   (3) Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, Commissioning Authority or authorities having jurisdiction are not limited by provisions of this Section.
C. Related Requirements:
   (1) Section 012100 "Allowances" for testing and inspection allowances.

1.03 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of [**five**] <**Insert number**> previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
   (1) Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
D. Mockups: Full-size physical assemblies that are constructed either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
   (1) Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as [**freestanding temporary built elements**] [**as indicated in-place portions of permanent construction**], consisting of multiple products, assemblies, and subassemblies, with cutaways enabling inspection of concealed portions of the Work.
      (a) Include each system, assembly, component, and part of the exterior wall [**and roof**] to be constructed for the Project. Colors of components shall be those selected by the Architect for use in the Project.
   (2) Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes; doors; windows; millwork; casework; specialties; furnishings and equipment; and lighting.
   (3) Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
   (4) In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" shall have the same meaning as the term "testing agency."
I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.04 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

(1) If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.05 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

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

1.06 ACTION SUBMITTALS

A. Mockup Shop Drawings: For **integrated exterior** mockups.

(1) Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
(2) Indicate manufacturer and model number of individual components.
(3) Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.07 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
B. Qualification Data: For Contractor's quality-control personnel.
C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

(1) Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
(2) Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

(1) Specification Section number and title.
(2) Entity responsible for performing tests and inspections.
(3) Description of test and inspection.
(4) Identification of applicable standards.
(5) Identification of test and inspection methods.
(6) Number of tests and inspections required.
(7) Time schedule or time span for tests and inspections.
(8) Requirements for obtaining samples.
(9) Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.
G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.08 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within **10** days of **Notice to Proceed**, and not less than **five** days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.
B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

(1) Project quality-control manager [may also serve as Project superintendent] [shall not have other Project responsibilities].
(2) <Insert qualifications appropriate to Project>.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

(1) Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
(2) Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
(3) Owner-performed tests and inspections indicated in the Contract Documents[, including tests and inspections indicated to be performed by Commissioning Authority].

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.
F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.09 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections and herein. Include the following:

(1) Date of issue.
(2) Project title and number.
(3) Name, address, telephone number, and email address of testing agency.
(4) Dates and locations of samples and tests or inspections.
(5) Names of individuals making tests and inspections.
(6) Description of the Work and test and inspection method.
(7) Identification of product and Specification Section.
(8) Complete test or inspection data.
(9) Test and inspection results and an interpretation of test results.
(10) Record of temperature and weather conditions at time of sample-taking and testing and inspection.
(11) Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
(12) Name and signature of laboratory inspector.
(13) Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

(1) Name, address, telephone number, and email address of technical representative making report.
(2) Statement on condition of substrates and their acceptability for installation of product.
(3) Statement that products at Project site comply with requirements.
(4) Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
(5) Results of operational and other tests and a statement of whether observed performance complies with requirements.
(6) Statement of whether conditions, products, and installation will affect warranty.
(7) Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

(1) Name, address, telephone number, and email address of factory-authorized service representative making report.
(2) Statement that equipment complies with requirements.
(3) Results of operational and other tests and a statement of whether observed performance complies with requirements.
(4) Statement of whether conditions, products, and installation will affect warranty.
(5) Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged in the activities indicated.
    (1) Requirements of authorities having jurisdiction shall supersede requirements for specialists.
G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following Contractor's responsibilities, including the following:
    (1) Provide test specimens representative of proposed products and construction.
    (2) Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    (3) Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
    (4) Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
    (5) Build laboratory mockups at testing facility, using personnel, products, and methods of construction indicated for the completed Work.
    (6) When testing is complete, remove test specimens and test assemblies, [**and**]mockups[**, and laboratory mockups**]; do not reuse products on Project.
    (7) Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect[**and Commissioning Authority**][**, through Construction Manager**], with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
    (1) Build mockups of size indicated.
    (2) Build mockups in location indicated or, if not indicated, as directed by Architect[**or Construction Manager**].
    (3) Notify Architect[**and Construction Manager**] [**seven**] <**Insert number**> days in advance of dates and times when mockups will be constructed.
    (4) Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
    (5) Demonstrate the proposed range of aesthetic effects and workmanship.
    (6) Obtain Architect's[**and Construction Manager's**] approval of mockups before starting corresponding Work, fabrication, or construction.
        (a) Allow [**seven**] <**Insert number**> days for initial review and each re-review of each mockup.
    (7) Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
    (8) Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
    (9) Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
    (10) Demolish and remove mockups when directed unless otherwise indicated.
L. Integrated Exterior Mockups: Construct integrated exterior mockup **according to approved Shop Drawings**. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials. Comply with requirements in "Mockups" Paragraph.
    (1) Coordinate construction of the mockup to allow observation of air barrier installation, flashings, air barrier integration with fenestration systems, and other portions of the building air/moisture barrier and drainage assemblies, prior to installation of veneer, cladding elements, and other components that will obscure the work.

1.11 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility (typically “Special Inspections”), Owner will engage a qualified testing agency to perform these services.
   (1) Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
   (2) Payment for these services will be made directly by the Owner.
   (3) Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
   (1) Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
   (2) Engage a qualified testing agency to perform quality-control services.
      (a) Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
   (3) Notify testing agencies at least **24** hours in advance of time when Work that requires testing or inspection will be performed.
   (4) Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   (5) Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   (6) Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   (1) Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   (2) Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
   (3) Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
   (4) Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   (5) Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
   (6) Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   (1) Access to the Work.
   (2) Incidental labor and facilities necessary to facilitate tests and inspections.
   (3) Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
   (4) Facilities for storage and field curing of test samples.
   (5) Coordinate delivery of samples to testing agencies if required with appropriate chain of custody documentation.
   (6) Preliminary design mix proposed for use for material mixes that require control by testing agency.
   (7) Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
   (1) Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents[**as a component of Contractor's quality-control plan**]. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.
   (1) Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.

(2) Distribution: Distribute schedule to Owner, Architect,[**Commissioning Authority,**] [**Construction Manager,**] testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified testing agency or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner , as indicated in the Statement of Special Inspections attached to this Section, and as follows:

(1) Verifying that manufacturer maintains detailed fabrication and quality-control procedures, and reviewing the completeness and adequacy of those procedures to perform the Work.
(2) Notifying Architect, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
(3) Submitting a certified written report of each test, inspection, and similar quality-control service to Architect, Commissioning Authority, with copy to Contractor and to authorities having jurisdiction.
(4) Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
(5) Interpreting tests and inspections and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
(6) Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

(1) Date test or inspection was conducted.
(2) Description of the Work tested or inspected.
(3) Date test or inspection results were transmitted to Architect.
(4) Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's[**, Commissioning Authority's,**][**and Construction Manager's**] [**and**] [**authorities' having jurisdiction**] reference during normal working hours.

(1) Submit log at Project closeout as part of Project Record Documents.

3.02 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

(1) Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.
C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 40 10 – STRUCTURAL TESTING AND INSPECTIONS

PART 3 - EXECUTION

3.01 JOBSITE TESTING AND INSPECTION REQUIREMENTS - GENERAL

A. General:

(1) Scope of Work:

(a) The Owner will engage a qualified inspection and testing agency(s) to perform special inspections and testing for all structural members and assemblies as noted herein.
(b) Special inspections are in addition to inspections by the authority having jurisdiction required by IBC 2021 Section 110.
(c) Refer to architectural/mechanical/electrical/civil specifications and drawings for additional special inspection and testing that may be required.

(2) Special inspections and testing are applicable to all revisions and/or future work added by amendments to the construction documents.

(3) Definitions:

(a) Special inspector: the agency engaged by the Owner and approved by the authority having jurisdiction to act as the designated representative to perform inspections.
(b) Special inspection: inspection performed by the special inspector according to IBC 2021 Section 1704 to ensure compliance with approved construction documents and referenced standards.
(c) (P) Periodic inspection: the part-time or intermittent observation by the special inspector of work being performed. Special inspector shall be present in the area where the work is being performed. Observation of all work (100% visual) shall be made at the completion of the work.
(d) (C) Continuous inspection: the full-time observation by the special inspector of work being performed. Special inspector shall be present in the area where the work is being performed. Observation of all work (100% visual) shall be made at the completion of the work.
(e) (100%): 100% observation / testing prior to concealment of indicated element.
(f) Testing and Inspection Type 1: Material Verification and Workman Certifications.
(g) Testing and Inspection Type 2: Site Inspection for Layout and Quantities.
(h) Testing and Inspection Type 3: Site Inspection for Procedures and Workmanship.
(i) Testing and Inspection Type 4: Site Testing for Material Properties and Workmanship.
(j) Testing and Inspection Type 5: Fabrication Facility Inspection and Testing for Workmanship.

(4) Deficiencies in Work:

(a) Correct deficiencies in work that tests and inspections indicate do not comply with the contract documents and referenced standards.
(b) All cost of additional testing and/or inspections for corrective work shall be borne by the Contractor.

B. Shop Fabrications:

(1) General:

(a) Perform inspections and testing for all shop fabricated structural members and assemblies as noted herein. Special inspector shall perform special inspections and testing unless the fabricator is registered and approved by the authority having jurisdiction to perform such work without special inspection or fabrication has a current ICC-ES evaluation report.
(b) Special inspector shall verify the fabricator maintains and follows detailed shop fabrication and quality control procedures, unless fabricator is registered and approved.
(c) At the completion of fabrication, the approved fabricator shall submit a certificate of compliance to the authority having jurisdiction according to IBC 2021 Section 1704.2.5.1.
(d) Approved fabricators may perform testing noted herein except that nondestructive testing (NDT) shall only be performed by personnel with qualifications that meet or exceed the criteria of AWS D1.1 Subclause 6.14.6 and American Society for Nondestructive Testing (ASNT) SNT-TC-1A or ASNT CP-189.

(2) Shop Fabrications Included:

(a) Shop fabricated structural steel including stairs and railing elements
(b) Shop fabricated cold formed steel elements

3.02 JOBSITE TESTING AND INSPECTION REQUIREMENTS FOR SOILS AND FOUNDATIONS

A. Soils Inspection and Testing:

(1) Excavation Extents and Depths:

(a) Type 2: Site inspection for Layout and Quantities.
(b) Criteria: Verify excavations are extended to the proper depth and have reached the proper material.
(c) Frequency: (P) Periodic inspection.

(2) Subgrade Material Verification:

(a) Type 2: Site inspection for Layout and Quantities.
(b) Criteria: Prior to placement of compacted fill, inspect subgrade and verify that site has been prepared properly.
(c) Frequency: (P) Periodic inspection.

(3) Fill Materials:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Perform classification and testing of compacted fill materials.
  (c) Frequency: (P) Periodic inspection.

(4) Controlled Fill Placement:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Verify use of proper materials, densities, compaction, and lift thicknesses during placement and compaction of compacted fill.
  (c) Frequency: (C) Continuous inspection.

(5) Bearing Material Verification:
  (a) Type 4: Site Testing for Material Properties and Workmanship.
  (b) Criteria: Verify bearing material is adequate to achieve the design bearing capacity.
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: Geotechnical Investigation Report.

(6) See civil drawings and/or specifications for additional earthwork and utility inspection requirements.

(7) See civil drawings and/or specifications for classification and testing requirements for compacted fill and/or controlled low-strength material.

B. Drilled Piers Inspection and Testing:

(1) Shaft Location, Diameter, and Plumbness:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Verify placement, locations, and plumbness, confirm element diameters and bell diameters (if applicable). Inspect drilling operations and maintain complete and accurate records for each element.
  (c) Frequency: (C) Continuous inspection.

(2) Bearing Material Verification:
  (a) Type 4: Site Testing for Material Properties and Workmanship.
  (b) Criteria: Verify bearing material is adequate to achieve the design bearing capacity.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: Geotechnical Investigation Report.

(3) Penetration into Bedrock:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Verify depth of penetration into bearing material and overall length.
  (c) Frequency: (C) Continuous inspection.

(4) Reinforcing and Concrete Placement:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Inspect concrete and reinforcing steel per the jobsite testing and inspection requirements for concrete, record concrete volumes.
  (c) Frequency: See jobsite testing and inspection requirements for concrete.

3.03 JOBSITE TESTING AND INSPECTION REQUIREMENTS FOR CONCRETE

A. Cast-in-Place Concrete Inspection and Testing – Before Concrete Placement:

(1) Formwork Dimensional Layout:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Prior to placement of concrete inspect formwork of first pour of each type (grade beam, column, structural slab, slab-on-deck, etc.).
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: ACI 301-16 2.2-2.3

(2) Reinforcing Steel Placement:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Verify grade, finish, size, bar quantity, location, spacing, cover, hook lengths, splice lengths, splice locations, bend diameters, coating, surface conditions, and supports.
  (c) Frequency: 100% observation / testing.
  (d) Standard: ACI 301-16 3.2-3.3.

(3) Bolts and Embedments Placement:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Verify type, finish, diameter, length, quantity, embedment length, spacing and edge distances, use of placing template where specified.
  (c) Frequency: 100% observation / testing.

(4) Bolts and Embedments Welding:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Inspect per the jobsite testing and inspection requirements for steel.
  (c) Frequency: See jobsite testing and inspection requirements for steel.

(5) Reinforcement Welding:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify ASTM A706 reinforcing steel. Inspect all welds.
(c) Frequency: (C) Continuous inspection.
(d) Standard: AWS D1.4.

(6) Reinforcement Field Bending:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Inspect reinforcement field bending.
(c) Frequency: (P) Periodic inspection.
(d) Standard: ACI 301-16 3.3.2.8.

(7) Mechanical Connectors:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Inspect mechanical connectors.
(c) Frequency: (P) Periodic inspection.
(d) Standard: ICC-ES Report.

(8) Epoxy or Galvanized Reinforcing:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Inspect epoxy or galvanized reinforcing.
(c) Frequency: 100% observation / testing.
(d) Standard: ACI 301-16 3.2.1.2.

B. Cast-in-Place Concrete Inspection and Testing – During Concrete Placement:

(1) Verify Design Mix:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Verify use of approved design mixture for each truck load.
(c) Frequency: 100% observation / testing.
(d) Standard: ACI 318 Ch. 19, 26.4.3, 26.4.4.

(2) Concrete Placement Inspection:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Inspect placement of concrete per standard (see below).
(c) Frequency: (C) Continuous inspection.
(d) Standard: ACI 301-16 5.3.2.

(3) Concrete Curing Inspection:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Inspect curing of concrete per standard (see below).
(c) Frequency: (P) Periodic inspection.
(d) Standard: ACI 301-16 5.3.6.

C. Structural Concrete Testing:

(1) Note: Nondestructive testing may be permitted by the architect but will not be used as sole basis for approval or rejection of deficient concrete.
(2) Welding.

(a) Type 4: Site Testing for Material Properties and Workmanship;
(b) Criteria: Welding testing and inspection per the jobsite testing and inspection requirements for steel.
(c) Frequency: See jobsite testing and inspection requirements for steel.

(3) Composite Concrete Sample – f'c < 5000 PSI:

(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Obtain sample at point of placement. For drilled piers obtain near beginning of load prior to placement in shaft.
(c) Frequency: At least once a day or at least once for each 100 cubic yards of concrete or at least once for each 5,000 square feet of surface area for slabs and walls. Adjust frequency as required to provide minimum 5 total tests per mix but not more than one sample per truck load.
(d) Standard: ASTM C172.

(4) Composite Concrete Sample – f'c ≥ 5000 psi and Shotcrete:

(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Obtain sample at point of placement. For drilled piers obtain near beginning of load prior to placement in shaft.
(c) Frequency: At least once a day or at least once for each 50 cubic yards of concrete or at least once for each 5,000 square feet of surface area for slabs and walls. Adjust frequency as required to provide minimum 5 total tests per mix but not more than one sample per truck load.
(d) Standard: ASTM C172.

(5) Composite Concrete Sample – Drilled Piers:

(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Obtain sample at point of placement. For drilled piers obtain near beginning of load prior to placement in shaft.

(c) Frequency: Each shaft. Adjust frequency as required to provide minimum 5 total tests per mix but not more than one sample per truck load.
(d) Standard: ASTM C172.

(6) Slump/Slump Flow:
(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Specified slump shall be as submitted in the mix design ± 1 1/2". perform additional tests when concrete consistency appears to change.
(c) Frequency: Each composite sample (see above).
(d) Standard: ASTM C143 (slump) or ASTM C1611 (slump flow).

(7) Air content when air entrainment is specified and lightweight concrete:
(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Test per standard (see below).
(c) Frequency: Each composite sample (see above).
(d) Standard: ASTM C231 pressure method for normal weight concrete or ASTM C173 volumetric method for light weight concrete.

(8) Temperature:
(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Test per standard (see below). Required when air temperature is 40°F and below or 80°F and above.
(c) Frequency: Each composite sample (see above) and at 60 minute intervals.
(d) Standard: ASTM C1064.

(9) Unit weight for structural lightweight concrete:
(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Test per standard (see below).
(c) Frequency: Each composite sample (see above).
(d) Standard: ASTM C138.

(10) Cold Weather Curing:
(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Record maximum and minimum concrete temperature during curing period when daily average air temperature of 40°F or below is expected for 3 successive days during curing period.
(c) Frequency: N/A
(d) Standard: ASTM C1074.

(11) Compressive Strength:
(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Reports of compressive strength tests shall contain the following information: date of concrete placement, location of concrete batch in work, design 28-day compressive strength, concrete supplier and mixture ID number, time of batch and placement, ambient air temperature, site added water and admixtures, unit weight, and as required by ASTM C39. Acceptance criteria per ACI 318.
(c) Frequency: Test per schedule below:
(i) 7 days: 6x12 or 4x8
(ii) 28 days: 6x12 or 4x8
(iii) 56 days: 6x12 or 4x8 (if 28 day tests do not achieve specified 28 day strength).
(d) Standard: ASTM C31, ASTM C39. Either (4) 6x12 or (4) 4x8 cylinders.

D. Cast-in-Place Concrete Inspection and Testing - After Concrete Placement:
(1) Cold Weather Curing:
(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Inspect curing of concrete per standard (see below).
(c) Frequency: (P) Periodic inspection.
(d) Standard: ACI 301-16 5.3.6.
(e) Standard: ACI 301-16 9.3.6

(2) Floor Flatness and Levelness:
(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Perform measurements within 48 hours of finishing operations and prior to removal of shores or forms.
(c) Frequency: (P) Periodic inspection.
(d) Standard: ASTM E1155.

(3) Shore/Form Removal:
(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Inspect removal of shoring/forms for beams and structural slabs per standard (see below).
(c) Frequency: (P) Periodic inspection.
(d) Standard: ACI 301-16: 2.3.2.

E. Expansion, Sleeve and Screw Anchor Inspection and Testing – Before Anchor Installations:

(1) Verify Installation Procedure:
  (a) Type 1: Material Verification and Workman Certifications.
  (b) Criteria: Review contractor's installation procedure.
  (c) Frequency: 100% observation / testing.
  (d) Standard: ICC-ES Report.

(2) Verify Anchor Type, Diameter, and Materials:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: Verify anchor products to be used for compliance of anchor type, diameter, materials and product
  (c) Frequency: 100% observation / testing.
  (d) Standard: ICC-ES Report.

(3) Verify Max Allowed Impact Wrench Torque:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: For screw anchors, confirm the maximum allowed impact wrench torqued as defined by the manufacturer.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: ICC-ES Report.

F. Expansion, Sleeve and Screw Anchor Inspection and Testing – During Anchor Installations:

(1) Continuous inspection required regardless if periodic inspection is permitted by ICC-ES report.

(2) Verify Hole Layout:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Verify the hole layout matches the contract documents. Review of layout should include number of anchors, spacing, edge distances, and quantity.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: ICC-ES Report.

(3) Grout Extents Around Masonry Anchors:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: At masonry anchors, confirm the grout extents surrounding the anchor have been satisfied.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: ICC-ES Report.

(4) Verify Hole Diameter, Depth, Cleaning:
  (a) Type 2: Site inspection for Layout and Quantities.
  (b) Criteria: Verify the hole diameter and depth meet the manufacturer requirements and the requirements shown on the contract documents. Observe the hole cleaning procedure is in accordance with the anchor manufacturers recommendations.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: ICC-ES Report.

(5) Verify Anchor Installation:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify the anchor installation of the anchor is in accordance with the anchor manufacturer recommendations.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: ICC-ES Report.

G. Expansion, Sleeve and Screw Anchor Inspection and Testing – After Anchor Installations:

(1) Verify Installation of Attached Assembly:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify number, edge distances, and anchor flush with and perpendicular to the receiving surface.
  (c) Frequency: (C) Continuous inspection.

(2) Torque Test Anchors:
  (a) Type 4: Site Testing for Material Properties and Workmanship.
  (b) Criteria: Test anchor with calibrated torque wrench to 100% of the installation torque noted in ICC-ES report. Attain specified torque within 1/2 turn of the nut.
  (c) Frequency: 100% observation / testing.
  (d) Standard: ICC-ES Report.

H. Adhesive Anchors and Reinforcing Inspection and Testing - Before Anchor / Reinforcing Installation:

(1) Verify Installation Procedure:
  (a) Type 1: Material Verification and Workman Certifications.
  (b) Criteria: Review contractor's installation procedure. Verify adhesive to be used for product type, manufacturer recommendations, expiration dates, pot life, working temperature ranges for adhesives, substrates and anchors.
  (c) Frequency: 100% observation / testing.
  (d) Standard: ICC-ES Report.

(2) Verify Anchor Type, Diameter and Materials:

(a) Type 2: Site inspection for Layout and Quantities.
(b) Criteria: Verify anchor to be used for compliance of anchor type, diameter, length, finish, and base material. Verify solid grouted area around anchors in grouted masonry
(c) Frequency: 100% observation / testing.
(d) Standard: ICC-ES Report.

I. Adhesive Anchors and Reinforcing Inspection and Testing - During Anchor/Reinforcing Installation:

(1) Continuous inspection required regardless if periodic inspection is permitted by ICC-ES report.
(2) Verify Hole Layout:

(a) Type 2: Site inspection for Layout and Quantities.
(b) Criteria: Verify the hole layout matches the contract documents. Review of layout should include number of anchors, spacing, edge distances, and quantity.
(c) Frequency: (C) Continuous inspection.
(d) Standard: ICC-ES Report.

(3) Grout Extents Around Masonry Anchors:

(a) Type 2: Site inspection for Layout and Quantities.
(b) Criteria: At masonry anchors, confirm the grout extents surrounding the anchor have been satisfied.
(c) Frequency: (C) Continuous inspection.
(d) Standard: ICC-ES Report.

(4) Verify Hole Diameter, Depth and Cleaning:

(a) Type 2: Site inspection for Layout and Quantities.
(b) Criteria: Verify the hole diameter and depth meet the manufacturer requirements and the requirements shown on the contract documents. Observe the hole cleaning procedure is in accordance with the adhesive manufacturer's recommendations.
(c) Frequency: (C) Continuous inspection.
(d) Standard: ICC-ES Report.

(5) Verify Anchor Installation:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify the anchor installation of the anchor is in accordance with the adhesive manufacturer's recommendations. Verify the temperatures of the adhesive, substrate and anchors are within the manufacturer recommended ranges.
(c) Frequency: (C) Continuous inspection.
(d) Standard: ICC-ES Report.

J. Adhesive Anchors and Reinforcing Inspection and Testing - After Anchor / Reinforcing Installation:

(1) Verify Installation of Attached Assembly:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify number, edge distances, and anchor flush with and perpendicular to the receiving surface. Verify full cure time has elapsed prior to application of torque or load to anchor.
(c) Frequency: (C) Continuous inspection.

(2) Tension Test Anchors / Reinforcing:

(a) Type 4: Site Testing for Material Properties and Workmanship.
(b) Criteria: Test the installation of the first 3 of each type, base material, and position (down, horizontal, overhead). Observe ASTM E488 minimum edge distances for determining test locations. Submit Proposed test locations and requests for required tension test load values to engineer.
(c) Frequency: First 3 and 1% of remaining. 100% observation / testing.
(d) Standard: ASTM E488 Static Tension.

3.04 JOBSITE TESTING AND INSPECTION REQUIREMENTS FOR MASONRY – LEVEL 2

A. General:

(1) Compliance with Approved Submittals.

(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Verify Compliance with Approved Submittals.
(c) Frequency: (P) Periodic inspection.
(d) Standard: TMS 602, Art 1.5.

B. As Masonry Construction Begins:

(1) Verify f'm:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Verify Specified Compressive Strength of Masonry, f'm conforms to structural drawings and specifications.
(c) Frequency: 100% observation / testing.

(2) Proportions of Site-prepared Mortar:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Verify Proportions of Site-prepared Mortar conform to standard.
(c) Frequency: (P) Periodic inspection.

(d) Standard: TMS 602, Art. 2.1 and 2.6A.

(3) Construction of Mortar Joints:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify Construction of Mortar Joints conforms to standard.
(c) Frequency: (P) Periodic inspection.
(d) Standard: TMS 602, Art. 3.3B.

(4) Reinforcement, anchorages, connectors, embeds:

(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Grade, type, and size of reinforcement, connectors, anchor bolts, and prestressing tendons and anchorages.
(c) Frequency: (P) Periodic inspection.
(d) Standard: TMS602, Art 3.4.

(5) Sample Panel Construction:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Use of materials and procedures accepted for the work. Minimum panel dimensions are 4 feet by 4 feet. The acceptable standard for the work is established by the accepted panel.
(c) Frequency: (P) Periodic Inspection.
(d) Standard: TMS 602, Art. 1.6D.

C. During Construction:

(1) Placement of Masonry Units and Mortar Joint Construction:

(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Verify placement of masonry units and mortar joint construction is in compliance with the standard.
(c) Frequency: (P) Periodic inspection.
(d) Standard: TMS 602, Art. 3.3B.

(2) Size and Location of Elements.

(a) Type 2: Site Inspection for Layout and Quantities:
(b) Criteria: Verify Size and Location of Structural Elements conforms to drawings and specifications.
(c) Frequency: (P) Periodic inspection.
(d) Standard: TMS 602, Art. 3.3F.

(3) Type, size and location reinforcement and embeds:

(a) Type 2: Material Verification and Workman Certifications.
(b) Criteria: Verify type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames, or other constructions.
(c) Frequency: (P) Periodic inspection.

(4) Welding of Reinforcement:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Inspection and testing of welding of reinforcement per Steel table and specifications.
(c) Frequency: (C) Continuous inspection.
(d) Standard: Per Steel table and specifications.

(5) Cold (<40F) and Hot (>90F) Weather:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify Preparation, construction, and protection of masonry during hot and cold weather conform to standard.
(c) Frequency: (P) Periodic inspection.
(d) Standard: TMS 602, Art. 1.8C and 1.8D.

D. Prior to Grouting:

(1) Grout space:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify grout space is free of mortar droppings and debris, and cleanouts provided as required.
(c) Frequency: (P) Periodic inspection.
(d) Standard: TMS 602, Art. 3.2D and 3.2F.

(2) Reinforcement, Anchorages, Connectors, Embeds:

(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Verify type, size, quantity, location, spacing, cover, splice length, splice location, surface condition, support, and securing. See structural concrete table and specifications for field bending, coated reinforcement, and mechanical connectors.
(c) Frequency: (P) Periodic inspection, 100% observation/testing.
(d) Standard: TMS602, Art. 2.4 and 3.4, Structural concrete table and specifications.

(3) Proportions of Site Mixed Grout:

(a) Type 1: Material Verification and Workman Certifications.

(b) Criteria: Verify Proportions of Site Mixed Grout conform to ASTM C476.
(c) Frequency: (P) Periodic inspection.
(d) Standard: TMS 602, Art. 2.6B, ASTM C476.

(4) Mix Design for Off-Site Prepared Grout:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Verify Mix Design for Off-Site Prepared Grout conforms to standard.
(c) Frequency: 100% observation / testing.
(d) Standard: TMS 602, Art. 2.6B, ASTM C476.

(5) Construction of Mortar Joints:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify Construction of Mortar Joints conforms to standard.
(c) Frequency: (P) Periodic inspection.
(d) Standard: TMS 602, Art. 3.3B.

3.05 JOBSITE TESTING AND INSPECTION REQUIREMENTS FOR STEEL

A. Steel Testing and Inspection Definitions:

(1) UT – Ultrasonic Testing.
(2) MT – Magnetic Particle Testing.
(3) PT – Penetration Testing.
(4) SFRS – Seismic Force Resisting System.
(5) TTT – Tension Through Thickness.

B. Steel Framing – General:

(1) HDAS, HAS, DAS, Threaded studs.

(a) Type 5: Fabrication Facility Inspection and Testing for Workmanship.
(b) Criteria: Review manufacturer certifications for fastener materials.
(c) Frequency: 100% observation / testing.
(d) Standard: AISC 360, Chapter N.

(2) Non-USA Material ≥3/4" loaded in tension through-thickness (ASTM A435):

(a) Type 5: Fabrication Facility Inspection and Testing for Workmanship.
(b) Criteria: Not required for steel produced in USA. Any discontinuity causing a total loss of back reflection that cannot be contained within a circle 3 inches in diameter shall be rejected. Required where noted as 'TTT' in drawings.
(c) Frequency: 100% observation / testing.
(d) Standard: AISC 360, Chapter N, ASTM A435.

(3) Non-USA Material ≥3/4" embedded plate assemblies - UT Testing:

(a) Type 5: Fabrication Facility Inspection and Testing for Workmanship.
(b) Criteria: Not required for steel produced in USA. Test along centerline of plate width after welding.
(c) Frequency: 100% observation / testing.
(d) Standard: AISC 360, Chapter N.

(4) Non-USA Material ≥1 1/2" loaded in tension through-thickness (ASTM A898):

(a) Type 5: Fabrication Facility Inspection and Testing for Workmanship.
(b) Criteria: Not required for steel produced in USA. Criteria to be met 6 inches above and below each weld. Required where noted as 'TTT' in drawings
(c) Frequency: 100% observation / testing.
(d) Standard: AISC 360, Chapter N, ASTM A898 (Level 1 Criteria).

(5) MT or PT for thermally cut beam copes and access holes where material ≥2":

(a) Type 5: Fabrication Facility Inspection and Testing for Workmanship.
(b) Criteria: MT or PT for thermally cut beam copes and access holes where material ≥2". Any crack shall be deemed unacceptable regardless of size or location.
(c) Frequency: 100% observation / testing.
(d) Standard: AISC 360, Chapter N.

C. Prior to Bolting:

(1) Verify Manufacturer's Certifications:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Verify manufacturer's certifications available for fastener materials.
(c) Frequency: (C) Continuous inspection.
(d) Standard: AISC 360, Chapter N.

(2) Preinstallation bolt testing:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used. Not applicable for snug tight joints.
(c) Frequency: (C) Continuous inspection.
(d) Standard: AISC 360, Chapter N.

(3) Verify bolt material, diameter, handling:
  (a) Type 1: Material Verification and Workman Certifications.
  (b) Criteria: Verify bolt material, diameter, and handling. Verify proper storage for fastener components. Verify fasteners marks in accordance with ASTM requirements.
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: AISC 360, Chapter N.

(4) Verify bolting procedure:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify proper fasteners (grade, type, bolt length if threads are to be excluded from shear plane) and bolting procedure selected for joint detail.
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: AISC 360, Chapter N.

(5) Verify connecting element preparation:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify connecting elements meet requirements (if specified), including hole preparation and faying surface condition.
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: AISC 360, Chapter N.

D. During Bolting:

(1) Verify bolts in all holes.
  (a) Type 3: Site Inspection for Procedures and Workmanship:
  (b) Criteria: Verify fastener assemblies of suitable condition placed in all holes and washers are positioned as required.
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: AISC 360, Chapter N.

(2) Verify bolts positioned as required:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify fasteners placed in all holes and positioned as required.
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: AISC 360, Chapter N.

(3) Installation at pretensioned and slip-critical:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Joint brought in snug-tight condition prior to pre-tensioning, fastener prevented from rotating. Fasteners pretensioned in proper sequence (from the most rigid point toward the free edges). Pretensioned and slip-critical joints using calibrated wrench or turn-of-nut method without matchmarking. Inspector shall be present during installation of fasteners.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: AISC 360, Chapter N, RCSC Specification.

E. After Bolting:

(1) Document acceptance/rejection of joints:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Document acceptance/rejection of bolted connections, member or joint.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: AISC 360, Chapter N.

F. Prior to Welding:

(1) Verify welder qualifications and ID system:
  (a) Type 1: Material Verification and Workman Certifications:
  (b) Criteria: Review manufacturer certifications for welding consumables and welding procedure specifications. Verify welder identification system. Note: The fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: AISC 360, Chapter N.

(2) Verify WPS available:
  (a) Type 1: Material Verification and Workman Certifications.
  (b) Criteria: Verify Welding Procedure Specification available.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: AISC 360, Chapter N.

(3) Verify base material and weld material:
  (a) Type 1: Material Verification and Workman Certifications.
  (b) Criteria: Verify base material and weld material are in conformance with approved documents.
  (c) Frequency: (P) Periodic inspection.

(d) Standard: AISC 360, Chapter N.

(4) Verify weld procedures and weld equipment:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Verify weld procedures and weld equipment are in conformance with approved documents.
(c) Frequency: (C) Continuous inspection.
(d) Standard: AISC 360, Chapter N.

(5) Verify joint fit-up, prep, backing, etc:

(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Verify fit up of groove welds (including joint geometry) meet requirements for joint preparation, dimensions (alignment, root opening, root face, bevel), cleanliness (condition of steel surfaces), tacking (tack weld quality and location), and backing type and fit (if applicable). Verify fit up of fillet welds meet requirements for dimensions (alignment, gaps at root), cleanliness (condition of steel surfaces), and tacking (tack weld quality and location). Verify configuration and finish of access holes.
(c) Frequency: (P) Periodic inspection.
(d) Standard: AISC 360, Chapter N.

G. During Welding:

(1) Use of qualified welders:

(a) Type 1: Material Verification and Workman Certifications:
(b) Criteria: Verify welder certifications.
(c) Frequency: (P) Periodic Inspection.
(d) Standard: AISC 360, Chapter N.

(2) Handling of welding consumables:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify proper control and handling of welding consumables including packaging and exposure control.
(c) Frequency: (P) Periodic inspection.
(d) Standard: AISC 360, Chapter N.

(3) No welding over cracked tack welds:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify no welding over cracked tack welds.
(c) Frequency: (P) Periodic inspection.
(d) Standard: AISC 360, Chapter N.

(4) Environment conditions (wind/temp, etc.):

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify Welding Procedure Specification is followed for Environment conditions. Verify wind speed, precipitation, and temperature are within limits.
(c) Frequency: (P) Periodic inspection.
(d) Standard: AISC 360, Chapter N.

(5) Verify WPS followed:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify use of qualified welders. Verify Welding Procedure Specification is followed for settings on welding equipment, travel speed, selected welding materials, shielding gas type/flow rate, preheat applied, interpass temperature maintained (minimum and maximum), proper position (F, V, H, OH).
(c) Frequency: (P) Periodic inspection.
(d) Standard: AISC 360, Chapter N.

(6) Welding techniques:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify proper welding techniques for single and multi-pass welds (interpass and final cleaning, each pass within profile limitations, each pass meets quality requirements).
(c) Frequency: (P) Periodic inspection.
(d) Standard: AISC 360, Chapter N.

H. After Welding:

(1) Verify welds cleaned:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify welds cleaned in accordance with standard.
(c) Frequency: (P) Periodic inspection.
(d) Standard: AISC 360, Chapter N.

(2) Verify weld size, length and location:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify weld size, length and location conform to approved documents.
(c) Frequency: (C) Continuous inspection.
(d) Standard: AISC 360, Chapter N.

(3) Welds meet visual acceptance criteria:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify welds meet visual acceptance criteria for crack prohibition, weld/base metal fusion, crater cross section, weld profiles, weld size, undercut, and porosity. Where inspector observes questionable welds, non-destructive testing shall be performed.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: AISC 360, Chapter N, AWS D1.1.

(4) Arc strikes:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify no arc strikes are present in the base material. Arc strikes shall be tested using non-destructive methods and repaired if necessary.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: AISC 360, Chapter N.

(5) Verify no cracking in k-areas and at weld access holes:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: When welding of doubler plates, continuity plate, or stiffeners has been performed in the k-area, visually inspect the web k-area for cracks within 3 inches of the weld.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: AISC 360, Chapter N.

(6) Repair activities:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify repair activities conform to standard. Backing and weld tabs removed, and fillet welds added where required.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: AISC 360, Chapter N.

(7) Document acceptance/rejection of joints:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Document acceptance/rejection of welded joints and/or members.
  (c) Frequency: (C) Continuous inspection.
  (d) Standard: AISC 360, Chapter N.

(8) UT CJP welds, material ≥5/16":
  (a) Type 4: Site Testing for Material Properties and Workmanship.
  (b) Criteria: Only applies for buildings assigned to Risk Category I or II. Ultrasonic testing of complete joint penetration groove welds subject to transversely applied tension loading in butt, T- and corner joints, in materials thicker than 5/16".
  (c) Frequency: 10% observation / testing. The rate of UT shall be increased to 100% if the reject rate of the first 20 inspections is greater than 5%.
  (d) Standard: AISC 360, Chapter N.

I. Inspection of Steel Composite Construction Prior to Concrete Placement:

(1) Verify installation of steel deck:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify placement and installation of steel deck is in conformance with the approved documents. Document acceptance or rejection of steel elements.
  (c) Frequency: 100% observation / testing.
  (d) Standard: AISC 360, Chapter N.

(2) Shear stud layout, count and testing:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: Verify shear stud layout, count, and testing are in conformance with the approved documents. Document acceptance or rejection of steel elements.
  (c) Frequency: 100% observation / testing.
  (d) Standard: AISC 360, Chapter N.

J. Steel Deck Inspections and Testing - Prior to Deck Placement:

(1) Verify deck profile, grade and thickness:
  (a) Type 1: Material Verification and Workman Certifications.
  (b) Criteria: Verify compliance of materials (deck and all deck accessories) with construction documents, including profiles, material properties, and base metal thickness.
  (c) Frequency: 100% observation / testing.
  (d) Standard: SDI QA/QC.

(2) Document acceptance/rejection of deck:
  (a) Type 1: Material Verification and Workman Certifications.
  (b) Criteria: Document acceptance/rejection of deck and deck accessories.
  (c) Frequency: 100% observation / testing.

(d) Standard: SDI QA/QC.

(3) Fastener manufacturer installation instructions are available:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Verify fastener manufacturer installation instructions are available for mechanical fasteners.
(c) Frequency: (P) Periodic inspection.
(d) Standard: SDI QA/QC.

(4) Verify proper tools are available for deck installation:

(a) Type 1: Material Verification and Workman Certifications.
(b) Criteria: Verify proper tools are available for deck installation.
(c) Frequency: (P) Periodic inspection.
(d) Standard: SDI QA/QC.

(5) Verify deck fastener storage and handling:

(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Verify proper storage for mechanical fasteners.
(c) Frequency: (P) Periodic inspection.
(d) Standard: SDI QA/QC.

K. Steel Deck Inspections and Testing - During Deck Installation:

(1) Verify deck type and layout:

(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Verify deck type and layout conforms to approved documents.
(c) Frequency: (P) Periodic inspection.
(d) Standard: SDI QA/QC.

(2) Verify deck fastening (PAF / Screws / Welds) type, size, spacing and layout:

(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Verify deck fastening (PAF / Screws / Welds) type, size, spacing and layout conform to approved documents.
(c) Frequency: (P) Periodic inspection.
(d) Standard: SDI QA/QC.

(3) Verify fasteners are installed per manufacturer instructions and are fully seated:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify fasteners are installed per manufacturer instructions and are fully seated and positioned correctly.
(c) Frequency: (P) Periodic inspection.
(d) Standard: SDI QA/QC.

(4) Welding requirements - See welding requirements in Structural Steel:

(a) Type: See welding requirements in Structural Steel.
(b) Criteria: See welding requirements in Structural Steel.
(c) Frequency: See welding requirements in Structural Steel.
(d) Standard: See welding requirements in Structural Steel.

L. Steel Deck Inspections and Testing - After Deck Installation:

(1) Verify compliance of deck and deck accessories:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify compliance of deck and deck accessories comply with construction documents. Verify deck materials are represented by the mill certifications that comply with the construction documents.
(c) Frequency: 100% observation / testing.
(d) Standard: SDI QA/QC.

(2) Verify support and sidelap connection type, size, spacing and layout:

(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Check spacing, type, diameter, and installation of support, sidelap, and perimeter fasteners. Verify screws adequately penetrate base material (3 threads min). Verify repair activities. No popped screw heads or stripped screws are permitted. All damage screws shall be replaced. Verify PAF's are fully driven.
(c) Frequency: 100% observation / testing.
(d) Standard: SDI C, SDI NC, SDI RD, ICC-ES Reports.

(3) Inspect connection installation:

(a) Type 3: Site Inspection for Procedures and Workmanship.
(b) Criteria: Verify connection installation conforms to standard.
(c) Frequency: 100% observation / testing.
(d) Standard: SDI QA/QC, SDI C, SDI NC, SDI RD, ICC-ES Reports.

(4) Document acceptance/rejection of deck connections:

(a) Type 2: Site Inspection for Layout and Quantities.

(b) Criteria: Document acceptance/rejection of deck, accessories, and connections. Verify materials have been drawn together.
(c) Frequency: 100% observation / testing.
(d) Standard: SDI C, SDI NC, SDI RD.

3.06 JOBSITE TESTING AND INSPECTION REQUIREMENTS FOR COLD FORMED STEEL

A. Note: Martin/Martin recommends the special inspections in this section for load bearing framing and non-load bearing framing supporting the gravity loads of heavy veneers. The actual code requirements per IBC 2018 are listed below:
(1) Where a cold-formed steel truss clear span is 60 feet or greater, the special inspector shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.
(2) In wind Exposure Category B, where Vasd is 120 mph or greater or in wind exposure C or D, where Vasd is 110 mph or greater:
(a) Periodic special inspection is required for welding operations of elements of the main windforce-resisting system.
(b) Periodic special inspection is required for screw attachment, bolting, anchoring, and other fastening of elements of the main windforce-resisting system, where the specified fastener spacing at panel edges is more than 4 inches on center.
(c) Exception: Special inspections are not required for cold-formed steel light-frame shear walls and diaphragm, including screwing, bolting, anchoring, and other fastening to components of the windforce-resisting system where either of the following applies:
(i) The sheathing is gypsum board or fiberboard.
(ii) The sheathing is wood structural panel or steel sheets on only one side of the shear wall, shear panel, or diaphragm assembly and the fastener spacing of the sheathing is more than 4 inches on center.
(3) For the seismic force-resisting systems assigned to Seismic Design Category C, D, E, or F:
(a) Periodic special inspection is required for welding operations of elements of the seismic force-resisting system.
(b) Periodic special inspection is required for screw attachment, bolting, anchoring, and other fastening of elements of the seismic force-resisting system, including shear walls, braces, diaphragms, collectors (drag struts), and hold-downs.
(c) Exception: Special inspections are not required for cold-formed steel light-frame shear walls and diaphragm, including screwing, bolting, anchoring, and other fastening to components of the seismic force-resisting system where either of the following applies:
(i) The sheathing is gypsum board or fiberboard.
(ii) The sheathing is wood structural panel or steel sheets on only one side of the shear wall, shear panel, or diaphragm assembly and the fastener spacing of the sheathing is more than 4 inches on center.
(d) Exception: The above special inspections are not required if:
(i) The structure consists of light-frame construction, SDS does not exceed 0.5, and the building height of the structure does not exceed 35 feet.
(ii) The structure is a detached one or two family dwelling not exceeding two stories above grade plane and does not have any of the following horizontal or vertical irregularities in accordance with ASCE 7: torsional or extreme torsional irregularity, nonparallel systems irregularity, stiffness-soft story or stiffness-extreme soft story irregularity, discontinuity in lateral strength-weak story irregularity.
(4) Periodic special inspection shall be provided for the installation of cold-formed steel special bolted moment frames in the seismic force-resisting systems of structures assigned to Seismic Design Category D, E, or F.
(a) Exception: The above special inspections are not required if:
(i) The structure consists of light-frame construction, SDS does not exceed 0.5, and the building height of the structure does not exceed 35 feet.
(ii) The structure is a detached one or two family dwelling not exceeding two stories above grade plane and does not have any of the following horizontal or vertical irregularities in accordance with ASCE 7: torsional or extreme torsional irregularity, nonparallel systems irregularity, stiffness-soft story or stiffness-extreme soft story irregularity, discontinuity in lateral strength-weak story irregularity.

B. Framing:
(1) Members and connections:
(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Verify type, size, location, spacing.
(c) Frequency: (P) Periodic inspection.
(2) Bridging and blocking layout and connections:
(a) Type 2: Site Inspection for Layout and Quantities.
(b) Criteria: Verify type, location, and attachment.
(c) Frequency: (P) Periodic inspection.

(3) No field cuts / notches through flanges:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: No cuts or notches through section flanges permitted.
  (c) Frequency: (P) Periodic inspection.

(4) No member splices except where shown:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: No splicing of structural members permitted unless specified on the construction documents.
  (c) Frequency: (P) Periodic inspection.

(5) Punchouts are away from bearings/connections:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: Verify spacing requirements from bearings and connections and reinforcing is used where required.
  (c) Frequency: (P) Periodic inspection.

(6) Studs seated in tracks per details:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: Verify stud seated tightly within the top and bottom track with gap not exceeding permitted dimension, where gap is exceeded verify shims are provided.
  (c) Frequency: (P) Periodic inspection.

C. Welded Attachments:

(1) Procedures, materials, qualifications:
  (a) Type 1: Material Verification and Workman Certifications.
  (b) Criteria: Verify filler materials, welding procedures, welder qualifications, and manufacturer's certificate of compliance.
  (c) Frequency: 100% observation / testing.
  (d) Standard: AWS D1.1/D1.3.

(2) During welding:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify welds type, size, layout, and procedure are in accordance with the approved documents.
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: AWS D1.3.

(3) After welding:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify welds type, size, layout, and procedure are in accordance with the approved documents.
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: AWS D1.3.

(4) Corrosion resistance treatment:
  (a) Type 3: Site Inspection for Procedures and Workmanship.
  (b) Criteria: Verify welded areas are treated with approved treatment to match corrosion resistance of effected area.
  (c) Frequency: (P) Periodic inspection.

D. Screwed Attachments:

(1) Type, diameter, length, spacing, edge distance:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: Verify type, diameter, length, spacing, and edge distance are installed in accordance with the approved documents. Verify installation is in conformance with ICC-ES Report.
  (c) Frequency: (P) Periodic inspection.
  (d) Standard: ICC-ES Report.

(2) Penetration:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: Verify screws are fully driven with a minimum penetration of 3 threads through the last material joined.
  (c) Frequency: (P) Periodic inspection.

(3) Connected materials drawn together:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: Verify connected materials have been drawn together.
  (c) Frequency: (P) Periodic inspection.

(4) No popped screw heads/stripped threads:
  (a) Type 2: Site Inspection for Layout and Quantities.
  (b) Criteria: No popped screw heads/stripped threads are permitted. All damaged screws shall be replaced.
  (c) Frequency: (P) Periodic inspection.

E. Power-Actuated Fasteners:

(1) Type, diameter, length, spacing, edge distance:
   (a) Type 2: Site Inspection for Layout and Quantities.
   (b) Criteria: Verify type, diameter, length, spacing, finish, base material, and edge distance are installed in accordance with the approved documents. Verify connected materials have been drawn together.
   (c) Frequency: (P) Periodic inspection. First of each fastener type and base material type.

(2) Conformance with ICC-ES Report:
   (a) Type 1: Material Verification and Workman Certifications.
   (b) Criteria: Verify installation is in conformance with ICC-ES Report.
   (c) Frequency: (P) Periodic inspection.
   (d) Standard: ICC-ES Report.

END OF SECTION 01 40 10

SECTION 01 45 35 – STATEMENT OF SPECIAL INSPECTIONS

PART 1 - GENERAL

The project requires Special Inspections as required by 2021 ICC Chapter 17: Section 1705 and as follows:

PART 2 - SCHEDULE OF SPECIAL INSPECTIONS

2.01 Section 1705.1.1: Special cases.
Special inspections and tests shall be required for proposed work that is, in the opinion of the building official, unusual in its nature, such as, but not limited to, the following examples:

A. Construction materials and systems that are alternatives to materials and systems prescribed by this code.
B. Unusual design applications of materials described in this code.
C. Materials and systems required to be installed in accordance with additional manufacturer's instructions that prescribe requirements not contained in this code or in standards referenced by this code.

2.02 Section 1705.2: Steel construction.
The special inspections and non-destructive testing of steel construction in buildings, structures, and portions thereof shall be in accordance with this section.

A. Section 1705.2.1: Structural steel
Special inspections and nondestructive testing of structural steel elements in buildings, structures and portions thereof shall be in accordance with the quality assurance inspection requirements of AISC 360.
B. Section 1705.2.2: Cold-formed steel deck
Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck shall be in accordance with the quality assurance inspection requirements of SDI QA/QC. Section 1705.2.3: Open-web steel joist and joist girders
C. Section 1705.2.3: Open-web steel joists and joist girders.
Special inspections of open-web steel joists and joist girders in buildings, structures and portions thereof shall be in accordance with Table 1705.2.3.

TABLE 1705.2.3: REQUIRED SPECIAL INSPECTIONS OF OPEN-WEB STEEL JOISTS AND JOIST GIRDERS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARD
1.Installation of open-web steel joists and joist girders.			
a. End connections – welding or bolted.	—	X	SJI specifications listed in Section 2207.1.
b. Bridging – horizontal or diagonal.	—	—	
1. Standard bridging.	—	X	SJI specifications listed in Section 2207.1.
2. Bridging that differs from the SJI specifications listed in Section 2207.1.	—	X	

D. Section 1705.2.4: Cold-formed steel trusses spanning 60 feet or greater
Where a cold-formed steel truss clear span is 60 feet (18 288 mm) or greater, the special inspector shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

2.03 Section 1705.3: Concrete construction.
Special inspections and tests of concrete construction shall be performed in accordance with this section and Table 1705.3.

TABLE 1705.3
REQUIRED SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARDa	IBC REFERENCE
1. Inspect reinforcement, including prestressing tendons, and verify placement.	—	X	ACI 318: Ch. 20, 25.2, 25.3, 26.6.1-26.6.3	1908.4
2. Reinforcing bar welding: a. Verify weldability of reinforcing bars other than ASTM A706; b. Inspect single-pass fillet welds, maximum $^{5}/_{16}$²; and c. Inspect all other welds.	— X	X X	AWS D1.4 ACI 318: 26.6.4	—
3. Inspect anchors cast in concrete.	—	X	ACI 318: 17.8.2	—
4. Inspect anchors post-installed in hardened concrete members.b a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads. b. Mechanical anchors and adhesive anchors not defined in 4.a.	X	X	ACI 318: 17.8.2.4 ACI 318: 17.8.2	—
5. Verify use of required design mix.	—	X	ACI 318: Ch. 19, 26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X	—	ASTM C172 ASTM C31 ACI 318: 26.5, 26.12	1908.10
7. Inspect concrete and shotcrete placement for proper application techniques.	X	—	ACI 318: 26.5	1908.6, 1908.7, 1908.8
8. Verify maintenance of specified curing temperature and techniques.	—	X	ACI 318: 26.5.3-26.5.5	1908.9
9. Inspect prestressed concrete for: a. Application of prestressing forces; and b. Grouting of bonded prestressing tendons.	X X	— —	ACI 318: 26.10	—
10. Inspect erection of precast concrete members.	—	X	ACI 318: 26.9	—
11. For precast concrete diaphragm connections or reinforcement at joints classified as moderate or high deforability elements (MDE or HDE) in structures assigned to Seismic Design Category C, D, E or F, inspect such connections and reinforcement in the filed for: a. Installation of the embedded parts b. Completion of the continuity of reinfoecment across joints. c. Completion of connections in the field.	X X X	— — —	ACI 318: 26.13.1.3 ACI 550.5	—
12. Inspect installation tolerances of precast concrete diaphragm connections for compliance with ACI 550.5	—	X	ACI 318: 26.13.1.3	—
13. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	—	X	ACI 318: 26.11.2	—
14. Inspect formwork for shape, location and dimensions of the concrete member being formed.	—	X	ACI 318: 26.11.1.2(b)	—
For SI: 1 inch = 25.4 mm.				

a. Where applicable, see Section 1705.12, Special inspections for seismic resistance.
b. Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.

A. Section 1705.3.1: Welding of reinforcing bars. Special inspections of welding and qualifications of special inspectors for rein-forcing bars shall be in accordance with the requirements of AWS D1.4 for special inspection and of AWS D1.4 for special inspector qualification.
B. Section 1705.3.2: Material Tests. In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapters 19 and 20 of ACI 318, the building official shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapters 19 and 20 of ACI 318.

2.04 Section 1705.4: Masonry construction:
Special inspections and tests of masonry construction shall be performed in accordance with the quality assurance program requirements of TMS 402 and TMS 602.

A. Section 1705.4.1: Glass unit masonry and masonry veneer in Risk Category IV. Special inspections and tests for empirically designed masonry, glass unit masonry or masonry veneer designed in accordance with Section 2109, 2110 or Chapter 14, respectively, where they are part of a structure classified as Risk Category IV shall be performed in accordance with TMS 402, Level B Quality Assurance.
B. Section 1705.4.2: Vertical masonry foundation elements. Special inspections and tests of vertical masonry foundation elements shall be performed in accordance with Section 1705.4.

2.05 Section 1705.5: Wood construction.
Special inspections of prefabricated wood structural elements and assemblies shall be in accordance with Section 1704.2.5. Special inspections of site-built assemblies shall be in accordance with this section.

A. Section 1705.5.1: High-load diaphragms.
High-load diaphragms designed in accordance with Section 2306.2 shall be installed with special inspections as indicated in Section 1704.2. The special inspector shall inspect the wood structural panel sheathing to ascertain whether it is of the grade and thickness shown on the approved construction documents. Additionally, the special inspector must verify the nominal size of framing members at adjoining panel edges, the nail or staple diameter and length, the number of fastener lines and that the spacing between fasteners in each line and at edge margins agrees with the approved construction documents.
B. Section 1705.5.2: Metal-plate-connected wood trusses.
Special inspections of wood trusses with overall heights of 60 inches (1524 mm) or greater shall be performed to verify that the installation of the permanent individual truss member restraint/bracing has been installed in accordance with the approved truss submittal package. For wood trusses with a clear span of 60 feet (18 288 mm) or greater, the special inspector shall verify during construction that the temporary installation restraint/bracing is installed in accordance with the approved truss submittal package.

2.06 Section 1705.6: Soils.
Special inspections and tests of existing site soil conditions, fill placement and load-bearing requirements shall be performed in accordance with this section and Table 1705.6. The approved geotechnical report and the construction documents prepared by the registered design professionals shall be used to determine compliance. During fill placement, the special inspector shall verify that proper materials and procedures are used in accordance with the provisions of the approved geotechnical report.

TABLE 1705.6: REQUIRED SPECIAL INSPECTIONS AND TESTS OF SOILS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	—	X
2. Verify excavations are extended to proper depth and have reached proper material.	—	X
3. Perform classification and testing of compacted fill materials.	—	X
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill.	X	—
5. Prior to placement of compacted fill, inspect subgrade and verify that site has been prepared properly.:	—	X

2.07 Section 1705.7: Driven deep foundations.
Special inspections and tests shall be performed during installation of driven deep foundation elements as specified in Table 1705.7. The approved geotechnical report and the construction documents prepared by the registered design professionals shall be used to determine compliance.

TABLE 1705.7: REQUIRED SPECIAL INSPECTIONS AND TESTS OF DRIVEN DEEP FOUNDATION ELEMENTS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Verify element materials, sizes and lengths comply with the requirements.	X	—
2. Determine capacities of test elements and conduct additional load tests, as required.	X	—
3. Inspect driving operations and maintain complete and accurate records for each element.	X	—
4. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element.	X	—
5. For steel elements, perform additional special inspections in accordance with Section 1705.2.	—	—
6. For concrete elements and concrete-filled elements, perform tests and additional special inspections in accordance with Section 1705.3.	—	—
7. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	—	—

2.08 Section 1705.8: Cast-in-place deep foundations.
Special inspections and tests shall be performed during installation of cast-in-place deep foundation elements as specified in Table 1705.8. The approved geotechnical report and the construction documents prepared by the registered design professionals shall be used to determine compliance.

TABLE 1705.8: REQUIRED SPECIAL INSPECTIONS AND TESTS OF CAST-IN-PLACE DEEP FOUNDATION ELEMENTS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Inspect drilling operations and maintain complete and accurate records for each element.	X	—
2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata capacity. Record concrete or grout volumes.	X	—
3. For concrete elements, perform tests and additional special inspections in accordance with Section 1705.3.	—	—

2.09 Section 1705.9: Helical pile foundations.
Continuous special inspections shall be performed during installation of helical pile foundations. The information recorded shall include installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation data as required by the registered design professional in responsible charge. The approved geotechnical report and the construction documents prepared by the registered design professional shall be used to determine compliance.

2.10 Section 1705.10: Fabricated items.
Special inspections of fabricated items shall be performed in accordance with Section 1704.2.5.

2.11 Section 1705.11: Special inspections for wind resistance.
Special inspections for wind resistance specified in Sections 1705.11.1 through 1705.11.3, unless exempted by the exceptions to Section 1704.2, are required for buildings and structures constructed in the following areas:
In wind Exposure Category B, where V_{asd} as determined in accordance with Section 1609.3.1 is 120 miles per hour (52.8 m/sec) or greater.
In wind Exposure Category C or D, where V_{asd} as determined in accordance with Section 1609.3.1 is 110 mph (49 m/sec) or greater.

A. Section 1705.11.1: Structural wood.
Continuous special inspection is required during field gluing operations of elements of the main windforce-resisting system. Periodic special inspection is required for nailing, bolting, anchoring and other fastening of elements of the main wind force-resisting system, including wood shear walls, wood diaphragms, drag struts, braces and hold-downs.

B. Section 1705.11.2: Cold-formed steel light-frame construction.
Periodic special inspection is required for welding operations of elements of the main windforce-resisting system. Periodic special inspection is required for screw attachment, bolting, anchoring and other fastening of elements of the main wind-force-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

C. Section 1705.11.3: Wind-resisting components.
Periodic special inspection is required for fastening of the following systems and components:

(1) Roof covering, roof deck and roof framing connections.
(2) Exterior wall covering and wall connections to roof and floor diaphragms and framing.

2.12 Section 1705.12: Special inspections for seismic resistance.
Special inspections for seismic resistance shall be required as specified in Sections 1705.12.1 through 1705.12.9, unless exempted by the exceptions of Section 1704.2.

A. Section 1705.12.1: Structural steel.
Special inspections for seismic resistance shall be in accordance with Section 1705.12.1.1 or 1705.12.1.2, as applicable.

(1) Section 1705.12.1.1: Seismic force-resisting systems.
Special inspections of structural steel in the seismic force-resisting systems in buildings and structures assigned to Seismic Design Category B, C, D, E or F shall be performed in accordance with the quality assurance requirements of AISC 341.
(2) Section 1705.12.1.2: Structural steel elements.
Special inspections of structural steel elements in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B, C, D, E or F other than those covered in Section 1705.12.1.1, including struts, collectors, chords and foundation elements, shall be performed in accordance with the quality assurance requirements of AISC 341.

B. Section 1705.12.2: Structural wood.
For the seismic force-resisting systems of structures assigned to Seismic Design Category C, D, E or F:

(1) Continuous special inspection shall be required during field gluing operations of elements of the seismic force-resisting system.
(2) Periodic special inspection shall be required for nailing, bolting, anchoring and other fastening of elements of the seismic force-resisting system, including wood shear walls, wood diaphragms, drag struts, braces, shear panels and hold-downs.

C. Section 1705.12.3: Cold-formed steel light-frame construction.
For the seismic force-resisting systems of structures assigned to Seismic Design Category C, D, E or F, periodic special inspection shall be required for both:

(1) Welding operations of elements of the seismic force-resisting system.
(2) Screw attachment, bolting, anchoring and other fastening of elements of the seismic force-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.

D. Section 1705.12.4: Designated seismic systems.
For structures assigned to Seismic Design Category C, D, E or F, the special inspector shall examine designated seismic systems requiring seismic qualification in accordance with Section 13.2.2 of ASCE 7 and verify that the label, anchorage and mounting conform to the certificate of compliance.

E. Section 1705.12.5: Architectural components.
Periodic special inspection is required for the erection and fastening of exterior cladding, interior and exterior nonbearing walls and interior and exterior veneer in structures assigned to Seismic Design Category D, E or F.

(1) Section 1705.12.5.1: Access floors. Periodic special inspection is required for the anchorage of access floors in structures assigned to Seismic Design Category D, E or F.

F. Section 1705.12.6: Plumbing, mechanical and electrical components.
Periodic special inspection of plumbing, mechanical and electrical components shall be required for the following:

(1) Anchorage of electrical equipment for emergency and standby power systems in structures assigned to Seismic Design Category C, D, E or F.
(2) Anchorage of other electrical equipment in structures assigned to Seismic Design Category E or F.
(3) Installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units in structures assigned to Seismic Design Category C, D, E or F.
(4) Installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to Seismic Design Category C, D, E or F.
(5) Installation and anchorage of vibration isolation systems in structures assigned to Seismic Design Category C, D, E or F where the approved construction documents require a nominal clearance of 1/4 inch (6.4 mm) or less between the equipment support frame and restraint.
(6) Installation of mechanical and electrical equipment, including duct work, piping systems and their structural supports, where automatic fire sprinkler systems are installed in structures assigned to Seismic Design Category C, D, E or F to verify one of the following:
(7) Minimum clearances have been provided as required by Section 13.2.3 ASCE/SEI 7.
(8) A nominal clearance of not less than 3 inches (76 mm) has been provided between fire protection sprinkler system drops and sprigs and: structural members not used collectively or independently to support the sprinklers; equipment attached to the building structure; and other systems' piping.
(9) Where flexible sprinkler hose fittings are used, special inspection of minimum clearances is not required.

G. Section 1705.12.7: Storage racks.
Periodic special inspection is required for the anchorage of storage racks that are 8 feet (2438 mm) or greater in height in structures assigned to Seismic Design Category D, E or F.

H. Section 1705.12.8: Seismic isolation systems.
Periodic special inspection shall be provided for seismic isolation systems in seismically isolated structures assigned to Seismic Design Category B, C, D, E or F during the fabrication and installation of isolator units and energy dissipation devices.

I. Section 1705.12.9: Cold-formed steel special bolted moment frames.
Periodic special inspection shall be provided for the installation of cold-formed steel special bolted moment frames in the seismic force-resisting systems of structures assigned to Seismic Design Category D, E or F.

2.13 Section 1705.13: Testing for seismic resistance.
Testing for seismic resistance shall be required as specified in Sections 1705.13.1 through 1705.13.4, unless exempted from special inspections by the exceptions of Section 1704.2.

A. Section 1705.13.1: Structural steel.
Nondestructive testing for seismic resistance shall be in accordance with Section 1705.13.1.1 or 1705.13.1.2, as applicable.

(1) Section 1705.13.1.1: Seismic force-resisting systems.
Nondestructive testing of structural steel in the seismic force-resisting systems in buildings and structures assigned to Seismic Design Category B, C, D, E or F shall be performed in accordance with the quality assurance requirements of AISC 341.

(2) Section 1705.13.1.2: Structural steel elements.
Nondestructive testing of structural steel elements in the seismic force-resisting systems of buildings and structures assigned to Seismic Design Category B, C, D, E or F other than those covered in Section 1705.13.1.1, including struts, collectors, chords and foundation elements, shall be performed in accordance with the quality assurance requirements of AISC 341.

B. Section 1705.13.2: Nonstructural components.
For structures assigned to Seismic Design Category B, C, D, E or F, where the requirements of Section 13.2.1 of ASCE 7 for nonstructural components, supports or attachments are met by seismic qualification as specified in Item 2 therein, the registered design professional shall specify on the approved construction documents the requirements for seismic qualification by analysis, testing or experience data. Certificates of compliance for the seismic qualification shall be submitted to the building official as specified in Section 1704.5.

C. Section 1705.13.3: Designated seismic systems.
For structures assigned to Seismic Design Category C, D, E or F and with designated seismic systems that are subject to the requirements of Section 13.2.2 of ASCE 7 for certification, the registered design professional shall specify on the approved construction documents the requirements to be met by analysis, testing or experience data as specified therein. Certificates of compliance documenting that the requirements are met shall be submitted to the building official as specified in Section 1704.5.

D. Section 1705.13.4: Seismic isolation systems.
Seismic isolation systems in seismically isolated structures assigned to Seismic Design Category B, C, D, E or F shall be tested in accordance with Section 17.8 of ASCE 7.

2.14 Section 1705.14: Sprayed fire-resistant materials.
Special inspections and tests of sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be performed in accordance with Sections 1705.14.1 through 1705.14.6. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents. The tests set forth in this section shall be based on samplings from specific floor, roof and wall assemblies and structural members. Special inspections and tests shall be performed after the rough installation of electrical, automatic sprinkler, mechanical and plumbing systems and suspension systems for ceilings, where applicable.

A. Section 1705.14.1: Physical and visual test.
The special inspections and tests shall include the following to demonstrate compliance with the listing and the fire-resistance rating:

(1) Condition of substrates.
(2) Thickness of application.
(3) Density in pounds per cubic foot (kg/m 3).
(4) Bond strength adhesion/cohesion.
(5) Condition of finished application.

B. Section 1705.14.2: Structural member surface conditions.
The surfaces shall be prepared in accordance with the approved fire-resistance design and the written instructions of approved manufacturers. The prepared surface of structural members to be sprayed shall be inspected by the special inspector before the application of the sprayed fire-resistant material.

C. Section 1705.14.3: Application.
The substrate shall have a minimum ambient temperature before and after application as specified in the written instructions of approved manufacturers. The area for application shall be ventilated during and after application as required by the written instructions of approved manufacturers.

D. Section 1705.14.4: Thickness.
Not more than 10 percent of the thickness measurements of the sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be less than the thickness required by the approved fire-resistance design, and none shall be less than the minimum allowable thickness required by Section 1705.14.4.1.

(1) Section 1705.14.4.1: Minimum allowable thickness.
For design thicknesses 1 inch (25 mm) or greater, the minimum allowable individual thickness shall be the design thickness minus 1/4 inch (6.4 mm). For design thicknesses less than 1 inch (25 mm), the minimum allowable individual thickness shall be the design thickness minus 25 percent. Thickness shall be determined in accordance with ASTM E605. Samples of the sprayed fire-resistant materials shall be selected in accordance with Sections 1705.14.4.2 and 1705.14.4.3.

(2) Section 1705.14.4.2: Floor, roof and wall assemblies.
The thickness of the sprayed fire-resistant material applied to floor, roof and wall assemblies shall be determined in accordance with ASTM E605, making not less than four measurements for each 1,000 square feet (93 m 2) of the sprayed area, or portion thereof, in each story.

(3) Section 1705.14.4.4: Fluted decks.
Thickness measurements shall be selected from a square area, 12 inches by 12 inches (305 mm by 305 mm) in size. Not fewer than four measurements shall be made, located symmetrically within the square area, including one each of the following: valley, crest and sides. The average of the measurements shall be reported.

(4) Section 1705.14.4.5 Structural members.
The thickness of the sprayed fire-resistant material applied to structural members shall be determined in accordance with ASTM E605. Thickness testing shall be performed on not less than 25 percent of the structural members on each floor.

(5) Section 1705.14.4.6: Beams and girders.
At beams and girders thickness measurements shall be made at nine locations around the beam or girder at each end of a 12-inch (305 mm) length.

(6) Section 1705.14.4.7: Joists and trusses.
At joists and trusses, thickness measurements shall be made at seven locations around the joist or truss at each end of a 12-inch (305 mm) length.

(7) Section 1705.14.4.8: Wide-flanged columns.
At wide-flanged columns, thickness measurements shall be made at 12 locations around the column at each end of a 12-inch (305 mm) length.

(8) Section 1705.14.4.9: Hollow structural section and pipe columns.
At hollow structural section and pipe columns, thickness measurements shall be made at not fewer than four locations around the column at each end of a 12-inch (305 mm) length.

E. Section 1705.14.5: Density.
The density of the sprayed fire-resistant material shall be not less than the density specified in the approved fire-resistance design. Density of the sprayed fire-resistant material shall be determined in accordance with ASTM E605. The test samples for determining the density of the sprayed fire-resistant materials shall be selected as follows:

(1) From each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet (232 m2) or portion thereof of the sprayed area in each story.

(2) From beams, girders, trusses and columns at the rate of not less than one sample for each type of structural member for each 2,500 square feet (232 m 2) of floor area or portion thereof in each story.

F. Section 1705.14.6: Bond strength.
The cohesive/adhesive bond strength of the cured sprayed fire-resistant material applied to floor, roof and wall assemblies and structural members shall be not less than 150 pounds per square foot (psf) (7.18 kN/ m2). The cohesive/adhesive bond strength shall be determined in accordance with the field test specified in ASTM E736 by testing in-place samples of the sprayed fire-resistant material selected in accordance with Sections 1705.14.6.1 through 1705.14.6.3.

(1) Section 1705.14.6.1: Floor, roof and wall assemblies.
The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet (232 m2) of the sprayed area, or portion thereof, in each story.

(2) Section 1705.14.6.2: Structural members.
The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from beams, girders, trusses, columns and other structural members at the rate of not less than one sample for each type of structural member for each 2,500 square feet (232 m2) of floor area or portion thereof in each story.

(3) Section 1705.14.6.3: Primer, paint and encapsulant bond tests.
Bond tests to qualify a primer, paint or encapsulant shall be conducted where the sprayed fire-resistant material is applied to a primed, painted or encapsulated surface for which acceptable bond-strength performance between these coatings and the fire-resistant material has not been determined. A bonding agent approved by the SFRM manufacturer shall be applied to a primed, painted or encapsulated surface where the bond strengths are found to be less than required values.

2.15 Section 1705.15 Mastic and intumescent fire-resistant coatings.
Special inspections and tests for mastic and intumescent fire-resistant coatings applied to structural elements and decks shall be performed in accordance with AWCI 12-B. Special inspections and tests shall be based on the fire-resistance design as designated in the approved construction documents.

2.16 Section 1705.16: Exterior insulation and finish systems (EIFS).
Special inspections shall be required for all EIFS applications.

A. Section 1705.16.1 Water-resistive barrier coating.
A water-resistive barrier coating complying with ASTM E2570 requires special inspection of the water-resistive barrier coating where installed over a sheathing substrate.

2.17 Section 1705.17: Fire-resistant penetrations and joints.
In high-rise buildings or in buildings assigned to Risk Category III or IV, special inspections for through-penetrations, membrane penetration firestops, fire-resistant joint systems and perimeter fire barrier systems that are tested and listed in accordance with Sections 714.4.1.2, 714.5.1.2, 715.3 and 715.4 shall be in accordance with Section 1705.17.1 or 1705.17.2.

A. Section 1705.17.1: Penetration firestops.
Inspections of penetration firestop systems that are tested and listed in accordance with Sections 714.4.1.2 and 714.5.1.2 shall be conducted by an approved agency in accordance with ASTM E2174.

B. Section 1705.17.2: Fire-resistant joint systems.
Inspection of fire-resistant joint systems that are tested and listed in accordance with Sections 715.3 and 715.4 shall be conducted by an approved agency in accordance with ASTM E2393.

2.18 Section 1705.18: Testing for smoke control.
Smoke control systems shall be tested by a special inspector.

A. Section 1705.18.1: Testing scope.
The test scope shall be as follows:

(1) During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
(2) Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements and detection and control verification.

B. Section 1705.18.2: Qualifications.
Approved agencies for smoke control testing shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

END OF SECTION 01 45 35

SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide temporary construction facilities and controls, and remove upon completion of the Work.

1.02 INCLUDE ALL COSTS within the Contract Sum for installation, maintenance, fuel, operation and removal. Adjustments to costs or usage charges will be made only if the Contract Time is adjusted due to scope changes, and then through a Change Order.

1.03 ALLOW OTHER ENTITIES TO USE TEMPORARY FACILITIES without cost, including, but not limited to, the following:

A. Owner's separate contractors.
B. Architect and consulting Engineers,
C. Testing and Inspection agencies.
D. Personnel of AHJ's.

1.04 QUALITY ASSURANCE

A. STANDARDS: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities," and NFPA 241.
B. TRADE JURISDICTIONS: Assigned responsibilities for installation and operation of temporary utilities are not intended to interfere with trade regulations and union jurisdictions.
C. ELECTRIC SERVICE: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
D. TESTS AND INSPECTIONS: Arrange for representatives of AHJ's to test and/or inspect temporary utilities before use when required, and obtain required certifications and permits.
E. COMPLY WITH GOVERNING REGULATIONS and rules or recommendations of utility companies. Comply with specific requirements indicated and with applicable local industry standards including but not limited to the following:
   (1) Building codes, including local requirements for permits, testing and inspection
   (2) Health and safety regulations, including applicable federal statues, laws or regulations
   (3) Police and Fire department rules and recommendations
   (4) Environmental protection regulations governing use of water and energy, and the control of dust, noise and other nuisances.

1.05 PROVIDE NONCOMBUSTIBLE CONSTRUCTION for offices, shops and sheds located within the construction area, or within 30 feet of building lines.

1.06 OPERATE temporary services and facilities in a safe and efficient manner. Do not overload temporary services or facilities, and do not permit them to interfere with the progress of the work. Do not allow unsanitary conditions, public nuisances or hazardous conditions to develop or persist on the site.

1.07 TEMPORARY SITE UTILITIES: For electrical, sewer, water or other utility services necessary for construction operations, engage the appropriate local utility service providers to bring temporary services to the Project Site. Obtain and pay for temporary permits or easements necessary, if permanent easements cannot be utilized for that purpose. Pay for all service, use and removal costs required.

1.08 UTILITY CHANGEOVER: At earliest feasible time, when acceptable to Owner, change over from use of temporary utility service to use of permanent services. Contractor will be responsible for operation, maintenance, and protection of permanent utility services until Substantial Completion.

1.09 CONDITIONS OF USE: Keep temporary services and facilities clean and neat. Relocate temporary utility services as required by progress of the Work.

1.10 CONNECT TO EXISTING BUILDING SYSTEMS for water, electrical power, lighting and heat necessary for construction operations, unless otherwise indicated. The Owner will pay for service / use costs through their existing service agreements.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT – GENERAL: Provide new or undamaged, previously used items in serviceable condition, suitable for use intended.

2.02 FIELD OFFICE: Maintain an on-site office for the management of the Work. Provide space to review project drawings and for storage of construction documents, shop drawings, and samples. Provide table, chairs and and on-site meeting room space for conferences for up to 10 people minimum. Costs of the space and furnishing thereof, including heating, cooling, power and lighting must be included in the Contract Sum.

2.03 TEMPORARY EXTERIOR ENCLOSURE: Provide a temporary weather-resistant building enclosure when existing building enclosure elements are removed. Enclosure must consist of a minimum 10 mil polyethylene sheet attached to a solid sheathing panel (non-combustible if existing building is non-combustible) with the supporting framework filled with minimum 3-1/2 inch thick fiberglass insulation when exterior temperatures are typically below 40 degrees.

2.04 TEMPORARY INTERIOR ENCLOSURE SCREEN (when applicable): Provide a dust-proof enclosure/screen separating the construction area from existing occupied areas. Relocate as required to facilitate construction operations. Completely remove at completion of the Work and arrange for legal disposal. Comply with Landlord requirements, when applicable.

A. Dust-resistant Barrier: Reinforced, fire-resistive 10-mil minimum thick polyethylene sheet, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.

2.05 DUST-RESISTANT WALK-OFF MATS: Provide minimum 36 inch wide x 60 inch deep mats with dust-control adhesive surface at all entrances to construction work areas from existing interior finished areas, and at exterior entrances to finished new construction work.

2.06 EXTERIOR PROJECT IDENTIFICATION SIGN: Provide and maintain one (1) project identification sign at location indicated in the Drawings, or if not indicated, provide at a location approved by the Owner and applicable AHJ representatives, including but not limited to code and zoning officials. Construct sign as a part of the Construction Mockup required in other Division-1 Sections. Engage an experienced signage company to provide PSV graphics on the panel in accordance with a design designated by the Architect. In general, the sign will include the project name & logo (1/2 of total area), the name and logo of the Architect (1/4 of total area), and the name and logo of the General Contractor. No other signs will be allowed to be displayed at the project site.

A. Size: 8 feet high by 12 feet wide

2.07 INTERIOR PROJECT IDENTIFICATION SIGN: Provide a project identification sign at location indicated in the Drawings, or if not indicated, provide at a location approved by the Landlord. The sign will include the project name & logo (1/2 of total area), the name and logo of the Architect (1/4 of total area), and the name and logo of the General Contractor (1/4 of total area). No other signs will be allowed to be displayed at the project site.

A. Size: 4 feet high by 8 feet wide (verify with Architect prior to construction start).

2.08 FIRE EXTINGUISHERS: Provide UL rated Type ABC fire extinguishers mounted at locations reasonably effective in extinguishing fires, by personnel at project site. Comply with NFPA No. 10. Post warning and instructions at each extinguisher, and instruct personnel on proper use. Post fire department call number on each telephone at project site.

2.09 TEMPORARY HEAT AND VENTILATION: Unless the Owner authorizes use of permanent HVAC systems per requirements as follows, provide temporary units to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for the installation and proper curing of materials, to protect materials and finishes from damage due to temperature or humidity, and to prevent hazardous accumulations of dust, fumes, vapors or gases.

A. For new building areas, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control. Provide listed and labeled units, by a testing agency acceptable to the AHJ, and marked for intended use for type of fuel being consumed.
B. When new systems are operational, they may be used for temporary heating and cooling only if: (1) all registers diffusers and filters are cleaned before substantial completion, and (2) warranty periods remain unchanged, starting from the date of Substantial Completion.

2.10 POTABLE WATER: Provide portable containers of potable water for construction operations, except when specifically authorized to utilize existing systems by the Owner. If connecting to existing systems, provide branch piping with outlets located so that water is available by the use of hoses.

2.11 EXTERIOR SANITARY FACILITIES: Provide temporary exterior toilets, wash facilities and drinking water fixtures for the use of workers on the job site. Provide single-occupant units of chemical, aerated recirculation, or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material. Provide separate facilities for male and female personnel when both sexes are working at project site. Provide containerized tap-dispenser, bottled-water drinking-water units, including paper cup supply. Comply with all applicable regulations of OSHA or health departments for the type, number, location, operation and maintenance of fixtures and facilities. Provide toilet tissue, paper towels, paper cups and similar disposable materials for each facility. Provide covered waste containers for used material.

2.12 EXISTING SANITARY FACILITIES may not be used by construction personnel, unless specifically approved by the Owner. If so used, such facilities must be checked by Contractor's supervisory personnel not less than two (2) times per day, and cleaning must be performed at completion of each day's construction operations.

2.13 TEMPORARY ELECTRICAL POWER: Provide a grounded power distribution system with overload protection, sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, lighting, and start-up testing of permanent electric-powered equipment prior to its permanent connection to electrical system.

A. Locate multiple outlets (minimum of 4-gang) spaced so that the entire area of construction can be reached by power tools on a single extension cord of 50' maximum length.
B. Provide properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-V plugs into higher-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.
C. Where permitted and when overhead and exposed for surveillance, wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic sheathed cable.

2.14 TEMPORARY LIGHTING: Provide temporary lighting fixtures in areas where ceilings and existing fixtures are removed. Re-use existing lighting fixtures when possible and suspend from the existing structure. Remove temporary lighting fixtures when permanent fixtures are operational.

2.15 PROVIDE TEMPORARY COMMUNICATIONS EQUIPMENT as follows:

A. Computer for use by and communications with the Contractor's Superintendent
B. Broadband internet service, and a secured, wireless router for use by the Architect and Owner's representatives

2.16 WASTE DISPOSAL: Provide dumpsters and collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 deg F. Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.

2.17 TEMPORARY SITE ENCLOSURE FENCE: Before construction operations begin, install a site enclosure fence around the entire Project site (or portion sufficient to accommodate construction operations), to prevent people and animals from easily entering except at gates. Maintain security by limiting the number of keys to gates and restricting distribution to authorized personnel, with one set of keys provided to the Owner. At partially completed Work, provide lockable entrances

to prevent unauthorized entrance, vandalism, theft and similar violations of security, and lock entrances at end of each work day.

A. TEMPORARY CHAIN-LINK FENCING: Minimum 2-inch (opening) x 0.148-inch- thick, galvanized-steel, chain-link fabric fencing mounted to a galvanized-steel pipe post framework of minimum 2-3/8-inch- OD line posts with 2-7/8-inch-OD corner and pull posts and 1-5/8-inch- OD top rails. When necessary, provide portable fencing units with galvanized-steel base supports.
B. Minimum Height: Eight (8) feet

2.18 TEMPORARY ROADS AND PAVED AREAS: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

A. TEMPORARY USE OF PERMANENT ROADS AND PAVED AREAS: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

(1) Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
(2) Prepare subgrade and install subbase and base for temporary roads and paved areas according to applicable Division-31 “Earthwork” Sections.
(3) Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
(4) Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course per requirements of applicable Division-32 “Paving” Sections.

PART 3 - EXECUTION

3.01 REVIEW site conditions and factors which affect construction procedures and temporary facilities, including adjacent properties and public facilities which may be affected by execution of the Work.

3.02 INSTALLATION - GENERAL: Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.03 INSPECT and test services before placing temporary utilities in use. Arrange for required inspections and tests by AHJ representatives, and obtain required certifications and permits for use.

3.04 OPERATE temporary services and facilities in a safe and efficient manner. Do not overload temporary services or facilities, and do not permit them to interfere with the progress of the work. Do not allow unsanitary conditions, public nuisances or hazardous conditions to develop or persist on the site.

3.05 SUPERVISION: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

3.06 MAINTENANCE: Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage. Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

3.07 PROGRESS CLEANING: At all times, keep the project areas free from accumulation of waste materials or rubbish caused by construction operations. Maintain the premises and site in a reasonably neat and order condition. Keep electrical closets, pipe or duct shafts or chases, furred spaces and similar areas clean and free from rubbish, construction material debris, or dust and dirt at all times. Clean-up immediately upon completion of each trade’s Work.

3.08 LOCK UP all site parked mobile equipment or make otherwise inoperable when not in use.

3.09 TEMPORARY FIRE PROTECTION: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; and manage fire-prevention program by:

A. Prohibit smoking in construction areas.
B. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of AHJ’s.

3.10 TEMPORARY CONSTRUCTION CONTROLS:

A. BARRIERS: Provide barriers required to prevent public entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.
B. POST DANGER SIGNS warning against hazards created by construction operations including but not limited to protruding nails, hoists, well holes, elevator hatchways, scaffolding, window openings, stairways and falling materials.
C. PROVIDE RED WARNING LIGHTS for night time hours at such hazards that can be dangerous to foot traffic and vehicular traffic.

3.11 RAMPS: Provide temporary ramps if access is through existing parking area, to completely protect existing curbs, underground fuel storage tanks, etc.

3.12 SCAFFOLDING: Provide all scaffolding and construction aids required, including guard rails, lights and platforms necessary for the completion of the Work, and for the protection of the workmen and the public.

3.13 SITE ACCESS: Provide temporary access to the site from public thorough fares. Repair all damage to existing property, roads, curbs and parking areas by job related vehicles or personnel at no cost to the Owner. Provide temporary fencing with lockable gates to match existing to ensure that the facility remains secure at all times.

3.14 DEWATERING FACILITIES AND DRAINS: Comply with requirements of AHJ, maintaining Project Site, excavations, and construction free of water. Dispose of rainwater in a lawful manner that will not result in flooding the Project or adjoining properties or endanger permanent Work or temporary facilities. Remove snow and ice as required to minimize accumulations.

3.15 TEMPORARY EROSION, SEDIMENTATION & STORMWATER CONTROLS: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, in accordance with requirements of 2003 EPA's "Construction General Permit" or other requirements of the AHJ, whichever is more stringent. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant- protection zones. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.16 CONSTRUCTION NOISE: Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

3.17 MOISTURE & MOLD CONTROL:

A. PREPARE A MOISTURE-PROTECTION PLAN, to avoid trapping water in the finished work. Document visible signs of mold that may appear during construction. Comply with the following, as applicable:

B. AT EXPOSED CONSTRUCTION and before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect the Work as follows:

(1) Protect porous materials from water damage.
(2) Protect stored and installed material from flowing or standing water.
(3) Keep porous and organic materials from coming into prolonged contact with concrete.
(4) Remove standing water from decks.
(5) Keep deck openings covered or dammed.

C. AT PARTIALLY ENCLOSED CONSTRUCTION after installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

(1) Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
(2) Keep interior spaces reasonably clean and protected from water damage.
(3) Periodically collect and remove waste containing cellulose or other organic matter.
(4) Discard or replace water-damaged material.
(5) Do not install material that is wet.
(6) Discard, replace, or clean stored or installed material that begins to grow mold.
(7) Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. AFTER BUILDING ENCLOSURE but before full operation of permanent HVAC systems, maintain as follows:

(1) Control moisture and humidity inside building by maintaining effective dry-in conditions.
(2) Use permanent HVAC system to control humidity.
(3) Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
(4) Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 24 hours are considered defective.
(5) Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
(6) Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.18 TERMINATION AND REMOVAL:

A. REMOVE TEMPORARY FACILITIES when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

(1) Materials and facilities that constitute temporary facilities are the property of Contractor. The Owner reserves right to take possession of the Project identification signs – at the sole option of the Owner.
(2) Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil.
(3) Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns.
(4) Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by AHJ representatives.
(5) At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements in Division-01 Section "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 60 00 – PRODUCT REQUIREMENTS

PART 1 - THIS SECTION includes administrative and procedural requirements for products, including delivery, storage, and handling; and manufacturers' warranties on products or special warranties. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1.01 DEFINITIONS

A. MANUFACTURER'S WARRANTY: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
B. SPECIAL WARRANTY: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.02 SUBMITTALS

A. SUBMIT A PRODUCT LIST, in tabular from, showing products, systems or equipment to be furnished. Include generic names of products, and manufacturer's name and proprietary product names for each product.
B. COORDINATE PRODUCT LIST with Contractor's Construction Schedule and the Submittals Schedule.
C. FORM: Tabulate information for each product, system or equipment item under the following column headings:
   (1) Specification Section number and title.
   (2) Generic name used in the Contract Documents.
   (3) Proprietary name, model number, and similar designations.
   (4) Manufacturer's name and address.
   (5) Supplier's name and address.
   (6) Installer's name and address.
   (7) Projected delivery date or time span of delivery period.
   (8) Identification of items that require early submittal approval for scheduled delivery date.
D. INITIAL SUBMITTAL: WITHIN THIRTY (30) DAYS after date of commencement of the Work, submit an initial product list. Include a written explanation for omissions of data and for variations from Contract requirements. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.
E. COMPLETED PRODUCT LIST: WITHIN SIXTY (60) DAYS after date of commencement of the Work, submit two (2) copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
F. ARCHITECT'S ACTION: The Architect will respond in writing to Contractor within fifteen (15) days of receipt of the initial Product List. Response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Lack of response does not constitute a waiver of requirement that products comply with the Contract Documents.

1.03 PRODUCT WARRANTIES

A. WARRANTIES SPECIFIED in other Sections are in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
B. SPECIAL WARRANTIES: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
   (1) Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   (2) Specified Form: Forms are included with the Specifications. Prepare a written document using appropriate form properly executed.
   (3) Refer to other Sections for specific content requirements and particular requirements for submitting special warranties.

1.04 SUBMITTAL TIME: Comply with requirements in Division-01 Section "Closeout Procedures."

1.05 QUALITY ASSURANCES FOR PRODUCTS

A. DELIVER, STORE, AND HANDLE PRODUCTS using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
B. SCHEDULE DELIVERY to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
C. COORDINATE DELIVERY WITH INSTALLATION time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
D. DELIVER PRODUCTS in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
E. INSPECT PRODUCTS ON DELIVERY to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
F. STORE PRODUCTS to allow for inspection and measurement of quantity or counting of units, and as follows:
   (1) Store materials in a manner that will not endanger the existing building structure.
   (2) Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering; with ventilation to avoid condensation
   (3) Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

(4) Protect stored products from damage.

G. COMPATIBILITY OF OPTIONS: If Contractor is given option of selecting between two or more products for use, product selected must be compatible with products previously selected, even if previously selected products were also options.

H. PRODUCTS IN QUANTITIES must be alike and interchangeable. Where additional amounts of a product are likely to be needed by the Owner at a later date for maintenance and repair, provide standard, domestically produced products which are likely to be available to the Owner at such later date.

I. SUPPLY PRODUCTS COMPLETE with all standard devices, trim finish, and all accessories indicated in the latest edition of the manufacturer's catalog or brochure published at the date of the award of the Contract. Furnish such items complete with component parts necessary for the obvious and intended use and installation, whether or not descriptions or catalog numbers contain all supplemental information and/or numbers of such components.

J. EQUIPMENT NAMEPLATES: Provide permanent nameplates on each item of service-connected or power operated equipment. Indicate manufacturer, product name, model number, serial number, capacity, speed, rating, and similar essential operating data. Locate nameplates on an easily accessible surface.

K. LABELS: Locate required labels and stamps on an accessible surface which, in occupied spaces, is not conspicuous.

END OF SECTION 01 60 00

SECTION 01 62 00 – PRODUCT OPTIONS

PART 1 - WHEN PRODUCTS, SYSTEMS OR EQUIPMENT are identified in the Construction Document, they are indicated to establishing a standard of required function, availability, physical properties, dimension, color, appearance, quality, in-service performance, operation and maintenance.

1.01 NO SUBSTITUTIONS OF NAMED OR BASIS-OF-DESIGN PRODUCTS: When Construction Documents indicate a single product (including systems or equipment), manufacturer, or supplier (by reference to a manufacturer's or supplier's name or product name, make or model number, as applicable), provide only the indicated product that complies with indicated requirements. If multiple manufacturers or vendors are indicated, provide products only by one of the listed manufacturers or vendors.

1.02 SUBMIT OTHER PRODUCTS or Manufacturers only as a "Substitution for Cause" / Substitution Request per other Sections of the General Requirements, and substantiate the cause in detail. Unless approved in advance by the Architectd, other products or manufacturers will not be considered, and are not acceptable.

1.03 FOR "OR-EQUAL" or "PERFORMANCE-BASED" products specified by performance requirements, characteristics, and/or referenced standards, provide products of any manufacturer or vendor meeting those requirements and characteristics, which will perform adequately the duties imposed by the specified item, and which will not cause a delay in the construction schedule due to procurement of such item. The burden of suitability is upon the Contractor, and products not meeting the intent of the Construction Documents may be rejected by the Architect.

END OF SECTION 01 62 00

SECTION 01 71 23 – FIELD ENGINEERING

PART 1 - GENERAL REQUIREMENTS

1.01 ESTABLISH REFERENCE LINES AND PERMANENT BENCH MARKS from which building lines and elevations will be taken. Identify existing survey control points and property line corner stakes, or building reference grids, as applicable. Verify layout information indicated within the Drawings, in relation to the property survey and existing benchmarks, before proceeding to lay out the Work. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction.

1.02 ENGAGE A LAND SURVEYOR registered in the state where the Project is located, to perform the initial building-layout and verification, and to set new benchmarks and other control points at the site.

1.03 BENCHMARKS: Establish and maintain a minimum of 2 permanent benchmarks, referenced to data established by survey control points. Promptly replace lost or destroyed Project control points. Base replacements on the original survey control points. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

1.04 EXISTING UTILITIES AND EQUIPMENT: The existence and location of underground and other utilities and construction indicated as existing is not guaranteed. Before beginning any work at the site, investigate and verify the existence and location of underground utilities and other construction. Prior to construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping. Furnish information necessary to adjust, move, or relocate existing structures, utility poles, lines, services, or other appurtenances located in or affected by construction. Coordinate with applicable AHJ representatives.

1.05 WORK FROM LINES AND LEVELS established from the property survey or existing building information. Establish benchmarks and markers to set lines and levels at each story of construction and elsewhere as needed to locate each element of the Project.

1.06 CALCULATE AND MEASURE required dimensions by instrumentation or other appropriate means, within indicated or recognized tolerances.

1.07 DO NOT SCALE DRAWINGS to determine dimensions unless directed to do so.

1.08 ADVISE ENTITIES ENGAGED IN CONSTRUCTION ACTIVITIES of marked lines and levels provided for their use. As construction proceeds, check every major construction component or element for line, level, and plumb.

1.09 MAINTAIN A LOG of controls and other survey work. Make this log available for reference. Record deviations from required lines and levels, and notify if deviations that exceed indicated or recognized tolerances are detected. On Project Record Drawings, record deviations that are accepted and not corrected.

1.10 UPON COMPLETION of foundation walls, major site improvements, and other work requiring field-engineering, record actual dimensions, locations, angles, and elevations of construction and site-work, noting all deviations from the design intent.

1.11 FOR SITE IMPROVEMENTS, locate and lay out site improvements, including pavements, stakes for grading, fill and topsoil placement, utility slopes, and invert elevations.

1.12 FOR BUILDING LINES AND LEVELS, locate and lay out batter boards for structures, building foundations, column grids and locations, floor levels, and control lines and levels.

1.13 WORK LAYOUT: Establish and maintain new benchmarks, chalk-lines or other markers to set lines and levels for the Work as needed to properly locate all elements of the Project, including partitions, casework, electrical and plumbing connections and “fixed” casework or fixtures.

1.14 PREPARE EQUIPMENT AND CASEWORK-FIXTURE TEMPLATES cut from stiff cardboard for each size of equipment or fixture unit being installed. To verify layout of the project, place templates on the floor where indicated, and permanently mark their locations with paint as soon as feasible.

1.15 TAKE FIELD MEASUREMENTS as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.16 MARK CASEWORK & FIXTURE locations with ceiling light fixtures temporarily marked on the floor substrate before construction of any partitions. Coordinate with casework or fixture shop drawings for size of units and alignment to fit the space as indicated.

END OF SECTION 01 71 23

SECTION 01 73 00 – EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.01 PERFORM INSTALLATION WORK by persons qualified to produce workmanship of specified quality, in accordance with manufacturer's installation recommendations and requirements.

1.02 UPON REQUEST BY THE ARCHITECT, arrange for the product, system or equipment manufacturer's representative to visit the site, to instruct tradespersons or mechanics in the recommended means and methods for installation, and to verify that the product, system or equipment item is installed in accordance with the Manufacturer's recommendations.

1.03 EXAMINATION AND ACCEPTANCE OF CONDITIONS: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present, for compliance with requirements for installation tolerances and other conditions affecting performance of the installed Work, and record observations:

A. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
B. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
C. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
D. Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
   (1) Description of the Work.
   (2) List of detrimental conditions, including substrates.
   (3) List of unacceptable installation tolerances.
   (4) Recommended corrections.
E. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work constitutes acceptance of that Work and assumption of responsibility for satisfactory installation.

1.04 INSPECT EACH ITEM OF MATERIAL OR EQUIPMENT immediately prior to installation. Reject damaged and defective items.

PART 2 - PREPARATION

2.01 FIELD MEASUREMENTS: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

2.02 SPACE REQUIREMENTS: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

2.03 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a Request for Interpretation (RFI) to Architect per other Division-01 Sections.

PART 3 - GENERAL INSTALLATION REQUIREMENTS (applies to all Work and Specification Sections):

3.01 INSTALL DURING CONDITIONS of temperature, humidity, exposure, forecasted weather, and status of the project completion that will ensure the best possible results for each unit of Work. Maintain such conditions until Substantial Completion.

3.02 LOCATE THE WORK and components of the Work accurately, in correct alignment and elevation. Make vertical work plumb and make horizontal work level. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.

3.03 CONCEAL PIPES, DUCTS, AND WIRING in finished areas unless otherwise indicated. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces unless otherwise noted.

3.04 COMPLY WITH MANUFACTURER'S WRITTEN INSTRUCTIONS and recommendations for installing products in applications indicated.

3.05 CONDUCT CONSTRUCTION OPERATIONS so that no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

3.06 SEQUENCE THE WORK and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

3.07 HARMFUL NOISE: Do not use tools or equipment that produce harmful noise levels.

3.08 TEMPLATES: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

3.09 ATTACHMENT: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

3.10 MOUNTING HEIGHTS: Where mounting heights are not indicated, mount components at industry-recognized standard mounting heights for the applications indicated. Refer questionable mounting height choices to Architect for final direction.

3.11 ALLOW FOR BUILDING MOVEMENT, including thermal expansion and contraction. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

3.12 JOINTS AND VISUAL EFFECT: Provide uniform joint widths in exposed Work, organized for the best possible visual effect. Fit exposed connections together to form hairline joints. Recheck measurements and dimensions of the Work, as an integral step of starting each installation. Refer questionable visual-effect choices to Architect for final decision of acceptability.

3.13 NON-HAZARDOUS MATERIALS: Use products, cleaners, and installation materials that are not considered hazardous.

3.14 BRACE PARTITIONS, suspend ceilings or soffits, and brace platforms, suspended items or similar construction only to structural elements – even if not specifically noted. Do not brace elements to the roof deck, plumbing / sprinkler pipes, ductwork, electrical conduit or similar elements.

3.15 AT PROJECTIONS OF FINISHED SURFACES, including pilasters or thickened walls, return all exposed surface finishes back to the primary surface even if not specifically noted.

3.16 ALIGN SURFACES of new finishes with existing finishes and match existing finish-surface conditions except as otherwise indicated. Patch existing surfaces and refinish to match adjacent existing surfaces, as applicable.

3.17 PROVIDE TEMPORARY COVERINGS AND PROTECTION after installation, to protect installed products from damage from traffic and construction operations, and remove when no longer required. Repair and replace damaged items, at no additional cost to the Owner. Additional time required to secure replacements and to make repairs will not be considered as justification for an extension of time to complete the Work.

PART 4 - PROGRESS CLEANING

4.01 SUPERVISE CONSTRUCTION OPERATIONS to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposures during the construction period.

4.02 CLEAN WORK AREAS DAILY, including the project site and common areas, as applicable. Enforce cleaning requirements strictly. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations. Use containers intended for holding waste materials of type to be stored.

4.03 CLEAN AREAS where work is in progress to the level of cleanliness necessary for proper execution of the Work. Remove liquid spills promptly. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

4.04 KEEP INSTALLED WORK CLEAN, cleaning surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

4.05 IN CONCEALED SPACES, remove debris before enclosing the space.

4.06 CLEAN EXPOSED SURFACES in finished areas and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

4.07 DURING HANDLING AND INSTALLATION, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

PART 5 - STARTING AND ADJUSTING

5.01 START EQUIPMENT AND OPERATING COMPONENTS to confirm proper operation. Remove malfunctioning units, replace with new units, and retest. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

5.02 TEST EACH PIECE OF EQUIPMENT to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5.03 PROVIDE FINAL PROTECTION AND MAINTAIN CONDITIONS that ensure installed Work is without damage or deterioration at time of Substantial Completion. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 01 73 00

SECTION 01 73 29 – CUTTING & PATCHING

PART 1 - GENERAL

1.01 DEFINITION: "Cutting and patching" includes cutting into construction elements (either new or existing) to provide for the installation or performance of other work and the subsequent fitting and patching required to restore surfaces to their original condition. "Cutting and patching" is performed for coordination of the Work, to uncover Work for access or inspection, to obtain samples for testing, to permit alterations to be performed, or for other similar purposes.

1.02 DO NOT cut and patch structural elements in a manner that would reduce their load-carrying capacity or load-deflection ratio. Do not cut and patch operating elements or safety related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance, or decreased operational life or safety. Do not cut and patch construction exposed on the exterior or in occupied spaces, in a manner that would, in the Architect's

opinion, reduce the building's aesthetic qualities, or result in visual evidence of cutting and patching. Remove and replace Work cut and patched in a visually unsatisfactory manner.

1.03 "CUTTING AND PATCHING" DOES NOT INCLUDE work performed during the manufacturing of products. It does not include the drilling of holes for installation of fasteners or similar operations. Demolition of selected portions of the building for alterations is included in Division-2 Specification Sections.

1.04 USE MATERIALS that are identical to existing materials. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance will equal or surpass that of existing materials.

1.05 INSPECTION: Before cutting existing surfaces, examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed. Take corrective action before proceeding, if unsafe or unsatisfactory conditions are encountered.

1.06 PROVIDE TEMPORARY SUPPORT AND PROTECTION of Work to be cut. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.

1.07 TAKE ALL PRECAUTIONS necessary to avoid cutting existing pipe, conduit or ductwork serving the building, but scheduled to be removed or relocated until provisions have been made to bypass them. Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.

1.08 CUT existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition. Cut existing construction using methods least likely to damage elements to be retained or adjoining construction.

1.09 IN GENERAL, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill.

1.10 BY-PASS UTILITY SERVICES such as pipe or conduit, before cutting, where services are shown or required to be removed, relocated or abandoned. Cut-off pipe or conduit in walls or partitions to be removed. Cap, valve or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting.

1.11 PATCH with durable seams that are as invisible as possible. Comply with specified tolerances. Where feasible, inspect and test patched areas to demonstrate integrity of the installation. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

1.12 THOROUGHLY CLEAN all areas and spaces where cutting and patching is performed or used as access. Remove completely paint, mortar, oils, putty and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Restore damaged pipe covering to its original condition.

END OF SECTION 01 73 29

SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT

PART 1 - GENERAL

1.01 SUMMARY:

A. Waste Management Requirements: This section specifies diversion of Construction and Demolition (C&D) waste from the landfill.

(1) Owner requires that this project generate the least amount of trash and waste possible.
(2) Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.
(3) Waste Management Goals:

(a) Identify at least 5 materials targeted for diversion and how they will be separated.
(b) A minimum of 75% of the total project waste should be diverted from landfill, calculated by either 1) weight or 2) volume, whichever shows a larger percentage at the end of the project.

(4) Provide contract documents, including a waste management plan, to show evidence of recycling, and reuse of recovered materials.
(5) Inform owner and architect where Construction and Demolition (C&D) Waste Management requirements could detrimentally impact C&D schedule.
(6) Provide separate itemization of cost related to C&D Waste Management.
(7) Effect optimum management of solid wastes via a materials management hierarchy.
(8) The materials management hierarchy shall be: reduce, reuse, and recycle.
(9) Prevent environmental pollution and damage.
(10) Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
(11) Owner may decide to pay for additional recycling, salvage, and/or reuse based on Landfill Alternatives Proposal specified below.
(12) Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:

(a) Aluminum and plastic beverage containers.
(b) Corrugated cardboard.
(c) Wood pallets.
(d) Clean dimensional wood: May be used as blocking or furring.
(e) Land clearing debris, including brush, branches, logs, and stumps: See Section 02 23 00 for use options.
(f) Concrete: May be crushed and used as riprap, aggregate, sub-base material, or fill.
(g) Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
(h) Glass.
(i) Gypsum drywall and plaster.
(j) Plastic buckets.
(k) Fluorescent lamps (light bulbs).

(13) LEED Certification for this project is dependent on diversion of at least 75 percent, by weight, of potential landfill trash/waste by recycling and/or salvage.
(14) Contractor shall submit periodic Waste Disposal Reports; all landfill disposal, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.
(15) Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.
(16) Methods of trash/waste disposal that are not acceptable are:

(a) Burning on the project site.
(b) Burying on the project site.
(c) Dumping or burying on other property, public or private.
(d) Other illegal dumping or burying.
(e) Incineration, either on- or off-site.

(17) Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, State and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 ENVIRONMENTAL CONSIDERATIONS: This project is designed and constructed with practices and procedures to meet the project's environmental considerations and goals. These considerations and goals are to establish a facility which is environmentally responsible, profitable, and a healthy place to live and work. To guide this process, this project is pursuing LEED Silver certification per the v4 Green Building Design and Construction Reference Guide for New Construction. Compliance with all credits and prerequisites shown in the checklist attached to section 01 81 81.02 is required. All team members will be required to perform some amount of associated documentation. Refer to Sections listed below for environmental considerations and goals, and applicable paragraphs of this specification section. The Contractor shall ensure that the requirements related to these considerations and goals, as defined in the Contract Documents, are implemented to the fullest extent.

1.03 RELATED SECTIONS

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

B. Related Sections include the following:

(1) Divisions 2 through 16 Sections for LEED Requirements specific to the Work of each of those Sections.
(2) Section 01 35 04 - LEED Requirements
(3) Section 01 81 19 - Indoor Air Quality Management
(4) Section 07 25 00 - Building Envelope Testing
(5) Section 01 91 13 - General Commissioning Requirements
(6) Section 01 79 00 - Commissioning Training Requirements
(7) Document Number - Summary of the Work.
(8) Document Number - Submittals.
(9) Document Number - Construction Facilities and Temporary Controls.
(10) 01 74 19 - Construction Waste Management.

1.04 DEFINITIONS:

A. Inert Fill – A permitted facility that accepts inert waste such as asphalt and concrete exclusively.
B. Class III Landfill - A landfill that accepts non-hazardous waste such as household, commercial, and industrial waste, including construction, remodeling, repair, and demolition operations.
C. Construction and Demolition Waste – Including solid wastes, such as building materials, packaging, rubbish, debris, and rubble resulting from construction, remodeling, repair, and demolition operations.

(1) Rubbish: Including both combustible and noncombustible wastes, such as paper, boxes, glass, crockery, metal and lumber scrap, tin cans, and bones.
(2) Debris: Including both combustible and noncombustible wastes, such as leaves and tree trimmings that result from construction or maintenance and repair work.

D. Weight Conversion Factor – It is the rate set forth in the standardized Weight Conversion Table 1 approved by the US Green Building Council for the use in estimating the volume or weight of materials identified in the Waste Management Plan.
E. Deconstruction - The process of removing existing building materials from renovation and demolition projects for the purposes of reuse, and recycling, in a efficient and safe manner possible.
F. Divert – Using material for any purpose other than disposal in a landfill.
G. Waste Materials – Large and small pieces of listed materials which are excess to contract requirements and generally include materials to be recycled and/or recovered from existing construction and items of trimmings, cuttings, and damaged goods resulting from new installations, which can be effectively used in the Work.
H. Reuse – Using a material or product that is recovered from construction, renovation, or demolition activities.
I. Recycling – The process of collecting and preparing recyclable materials in their original form or in manufacturing processes that do not cause the destruction/contamination of recyclable materials in a manner that precludes further use.
J. Recovery – Any process that reclaims materials, substances, energy, or other products contained within or derived from waste on-site. It includes waste-to-energy, composting, and other processes.
K. Sources Separation – Sorting the recovered materials into specific material types with no or a minimum amount of contamination on site.
L. Time-Based Separation – Collecting waste during each phase of construction or deconstruction which results in primarily one major type of recovered material. The material is removed before it becomes mixed with the material from the next phase of construction.
M. Commingled or Off-site Separation – Collecting all material types into a single bin or mixed collection system and separating the waste materials into recyclable material types in an off-site facility.

1.05 SUBMITTALS:

A. See Section 01 30 00 – Administrative Requirements, for submittal procedures
B. Landfill Alternatives Proposal: Within 10 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner, submit a projection of trash/waste that will require disposal and alternatives to landfilling, with net costs.

(1) Submit to Architect for Owner's review and approval.
(2) If Owner wishes to implement any cost alternatives, the Contract Sum will be adjusted as specified elsewhere.
(3) Include an analysis of trash/waste to be generated and landfill options as specified for Waste Management Plan described below.
(4) Describe as many alternatives to landfilling as possible:

(a) List each material proposed to be salvaged, reused, or recycled
(b) List the proposed local market for each material.
(c) State the estimated net cost resulting from each alternative, after subtracting revenue from sale of recycled or salvaged materials and landfill tipping fees saved due to diversion of materials from the landfill.

C. Once Owner has determined which of the landfill alternatives addressed in the Proposal above are acceptable, prepare and submit Waste Management Plan; submit within 10 calendar days after notification by Architect.
D. Waste Management Plan: Include the following information:

(1) Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
(2) Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
(3) Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.

(4) List each material proposed to be salvaged, reused, or recycled. Alternative Daily Cover (ADC) does not qualify as material diverted from disposal. Land clearing debris cannot be included.
(5) List the local market for each material.
(6) State the estimated net cost, versus landfill disposal.
(7) Estimate at least 4 material streams that will be diverted.
(8) Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
(9) Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
(10) Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

E. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.

(1) Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
(2) Submit Report on a form acceptable to Owner.
(3) Landfill Disposal: Include the following information:

(a) Identification of material and material stream.
(b) Amount, in tons and cubic yards, of trash/waste material from the project disposed of in landfills.
(c) State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
(d) Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.

(4) Recycled and Salvaged Materials: Include the following information for each:

(a) Identification of material, including those retrieved by installer for use on other projects.
(b) Amount, in tons and cubic yards, date removed from the project site, and receiving party.
(c) Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
(d) Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
(e) Certification by receiving party that materials will not be disposed of in landfills or by incineration.

(5) Material Reused on Project: Include the following information for each:

(a) Identification of material and how it was used in the project.
(b) Amount, in tons and cubic yards.
(c) Include weight tickets as evidence of quantity.

(6) Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

F. C&D Waste Management Plan: Before the start of demolition, submit a C&D waste management plan to the Owner and the architect for approval. The attached sample plan can be used as an example, but the final plan shall include the following:

(1) Indicate how the Contractor proposes to recover at least 75% of the C&D wastes for reuse and recycling.
(2) The C&D Waste Management Plan should coordinate the recovery effort with the construction, and renovation / demolition schedule.
(3) Indicate compliance with Section 1.7 QUALITY ASSURANCE.
(4) Include a list of reuse facilities, recycling facilities and processing facilities that will be receiving the recovered materials (including take back by Owner or on-site auctions.)
(5) If some of the materials will be donated or sold on-site auctions, describe the process and identify the organizations that may receive the materials.
(6) Identify materials that are not recyclable or not recovered which will be disposed of in a landfill (or other means acceptable by state and local ordinance and regulations) and explain why the materials are not recovered.
(7) List the permitted landfill, or other permitted disposal facilities, that will be accepting the disposed waste materials.
(8) Indicate instances or situations where compliance with the requirements of this specification do not apply or do not appear to be possible.
(9) Identify each type of waste material to be reused or recycled and estimate the amount, by weight.
(10) Provide estimate of time requirements for demolition and for the removal of valuable reusable items and materials.
(11) Prepare building engineering survey and worker safety plan, assessment of building condition and all potential hazards.
(12) Provide a C&D site management plan.
(13) Provide final accounting of disposition of recovered materials upon completion of project for final payments.

G. C&D Waste Management Summary Reports: Provide the C&D Waste Management Coordinator with delivery receipts for the recovered materials and waste materials sent to the permitted recycling facilities, processing facilities, or landfill with the following information:

(1) Name of firm accepting the recovered materials or waste materials
(2) Specify type of facility (e.g. retail facility, recycler, processor, Class III landfill, MRF)
(3) Location of the facility

(4) Type of materials
(5) Net weights and volume of each type of material
(6) Date of delivery
(7) Value of the materials or tipping fee paid
This information will be collated in the "Contractor Tracking Document" tab for waste tracking. This tab will be submitted for the Application for Progress Payment as stated below.

H. Application for Progress Payment: The following should be submitted with the Application for Progress Payment:

(1) C&D Waste Management Summary Report as stated above in section 1.5 SUBMITTALS, B. C&D Waste Management Summary Reports, with the C&D Waste Manager approval on each of the report.
(2) Payment could be withheld until diversion goals are met. The Contractor is ultimately responsible for implementation of the C&D Waste Management Plan and achieving the diversion goals.

1.06 RECYCLING PROGRAM:

A. The recycling program could utilize one or a combination of any of the following common waste diversion strategies:

(1) Sources Separation
(2) Time-Based Separation
(3) Commingled or Off-site Separation
(4) Back haul of packaging
(5) On-site sales auctions and removal.

B. Waste Material management hierarchy can be viewed as: reuse on-site, recycle on-site, reuse off-site, and recycle off-site.

C. Other innovative approaches to achieve the minimum diversion rate are encouraged and should be specified and described in the C&D Waste Management Plan.

D. Minimum diversion rate may be achieved by recovering and recycling the following materials:

(1) Asphalt
(2) Concrete and concrete blocks
(3) Brick, tile and masonry materials
(4) Ferrous metal
(5) Non-ferrous metals: copper, aluminum … etc
(6) Untreated lumber
(7) Plywood, OSB and particle board
(8) Gypsum wallboard scrap
(9) Paper and cardboard
(10) Beverage containers
(11) Insulation
(12) Rigid foam
(13) Glass
(14) Carpet and pad
(15) Trees and shrubs
(16) Soil
(17) Plumbing fixtures
(18) Windows
(19) Doors
(20) Cabinets
(21) Architectural fixtures
(22) Millwork, paneling and other similar interior finishes
(23) Electric fixtures, motors, switch gear and other similar equipment
(24) HVAC equipment, duct work, control systems, switches and other similar equipment
(25) Others as appropriate

1.07 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with applicable requirements of the State, local ordinances and regulations concerning management of construction, clearing, and inert materials.

B. Disposal Site, Recyclers and Waste Materials Processors: Use only facilities properly permitted by the State, and/or by local authorities where applicable.

C. Pre-C&D Waste Management Meeting

(1) Prior to beginning work at the site, schedule and conduct a meeting to review the C&D Waste Management Plan and discuss procedures, schedules, coordination and specific requirements for waste materials recycling and disposal. Discuss coordination and interface between Contractor, sub-contractors, architect, engineers, project manager, Owner, and other C&D activities. Identify and resolve problems of compliance with requirements. Record minutes of the meeting, identifying conclusions reached and matters requiring further resolution. Maintain waste management as an agenda item at future construction meetings.
(2) Attendees: Contractor and related contractor personnel associated with work of this section, including personnel in charge of the waste management program; C&D Quality Manager; architect; engineers; material and equipment suppliers where appropriate; and such additional Owner personnel as Owner deems appropriate.
(3) Plan Revision: Make revisions to C&D Waste Management Plan agreed upon during the meeting and incorporate resolutions agreed to be made subsequent to the meeting. Submit revised plan to architect or the Owner personnel as Owner deems appropriate for approval.

D. Implementation
   (1) Designate an on-site party responsible for instructing workers and implementing the C&D Waste Management Plan.
   (2) Distribute copies of C&D Waste Management Plan to job site foreman and each subcontractor.
   (3) Include waste management and recycling in worker orientation.
   (4) Provide on-site instruction on appropriate separation, handling, recycling, and recovery methods to be used by all parties at the appropriate stages of the work at the site.
   (5) Also include discussion of waste management and recycling in regular job meeting and job safety meetings conducted during the course of work at the site.

E. The Contractor will be responsible for ensuring that the appropriate governmental entities are notified of the work.
F. Remove and relocate reusable materials to be reinstalled or retained in a manner to prevent damage or contamination.
G. Conduct construction and demolition in such a manner to minimize damage to trees, plants and natural landscape environment.
H. Arrange for adequate collection, and transportation to deliver the recovered materials to the approved recycling center or processing facility. Maintain records accessible to the architect or C&D Quality Manager for verification of diversion of recovered waste materials.

1.08 STORAGE AND HANDLING:

A. Site Storage
   (1) Remove materials for recycling and recovery from the work locations to approved containers or storage area as required. Failure to remove waste or recovered materials will be considered cause for withholding payment and termination of Contract.
   (2) Position containers for recyclable and recoverable waste materials at a designated location on the Project Site. If materials are sorted on site, also provide a sorting area and necessary storage containers.
   (3) Change-out loaded containers for empty containers, as demand requires.
   (4) If recovered materials are stored on-site for project duration provide adequate security from pilferage.

B. Handling
   (1) Deposit indicated recyclable, and recoverable materials in storage areas or containers in a clean (no mud, adhesive, solvents, petroleum contamination), debris-free condition. Do not deposit contaminated materials into the containers until such time as such materials have been cleaned.
   (2) Insure all recovered materials are made safe for handling and storage.
   (3) If the contamination chemically combines with the material so that it cannot be cleaned, do not deposit into the recycle containers. In such case, request resolution by the C&D Quality Manager for disposal of the contaminated material. Directions from the C&D Quality Manager do not relieve the Contractor of responsibility for compliance with all legal and regulatory requirements for disposal, nor shall such directions cause a request for modification of the Contract.

1.09 PROJECT CONDITIONS:

A. Environmental Requirements:
   (1) Transport recyclable and recoverable waste materials from the Work Area to containers and carefully deposit in the containers without excess noise and interference with other activities, to minimize noise and dust.
   (2) The Contractor shall ensure adequate erosion control and storm water control, if required, to prevent or minimize the negative impact to its surrounding environment.
   (3) Provide measures to insure the containment of lead-based paint and dust, nails, asbestos-based products and any biological contaminants that may affect environmental health and safety conditions.

B. Site Condition:
   (1) Signs and instructions should be clear, and easy to understand. All recycling containers should be clearly labeled and lists of acceptable and unacceptable materials will be posted throughout the site. Whenever possible, they should be in multiple-languages, especially in Spanish, and in graphic symbols.
   (2) The Contractor shall ensure the safety of all personnel involved in the C&D process.
   (3) A C&D site management plan shall be created including: work areas, materials processing areas, materials storage and disposal areas, worker hand-washing and changing stations, first aid and medical information.

PART 2 - PRODUCTS

2.01 SALVAGED AND REUSE MATERIALS:

A. The following components and fixtures are collected for reuse:
   (1) Plumbing fixtures
   (2) Windows
   (3) Doors
   (4) Cabinets
   (5) Bricks
   (6) Millwork, paneling and other similar interior finishes
   (7) Electric fixtures, motors, switch gear and other similar equipment
   (8) HVAC equipment, duct work, control systems, switches and other similar equipment
   (9) Architectural fixtures
   (10) Others as appropriate

B. Wood collected for reuse is sorted by:
   (1) Type
   (2) Size, dimension
   (3) Protected from the ground, bending, and moisture

2.02 RECYCLED MATERIALS:

A. The following materials are collected for recycling:
   (1) Asphalt
   (2) Concrete and concrete blocks
   (3) Tile and masonry materials
   (4) Ferrous metal
   (5) Non-ferrous metals: copper, aluminum … etc
   (6) Untreated lumber
   (7) Plywood, OSB and particle board
   (8) Gypsum wallboard scrap
   (9) Paper and cardboard
   (10) Beverage containers
   (11) Insulation
   (12) Rigid foam
   (13) Glass
   (14) Carpet and pad
   (15) Trees and shrubs
   (16) Soil
   (17) Others as appropriate

PART 3 - EXECUTION

3.01 N/A

END OF SECTION 01 74 19

SECTION 01 75 00 – OPERATION AND MAINTENANCE DATA INTEGRATION

PART 1 - GENERAL

A. SECTION INCLUDES

1. General Requirements
2. Related Documents
3. Definitions and Abbreviations
4. Operations and Maintenance Data Integration Team
5. Team Member Responsibilities
6. Operations and Maintenance Data Integration Submittals
7. Scheduling
8. Specific Asset Data Requirements

B. General Requirements

1. The work under this Section is subject to requirements of the Contract Documents including the Owner's General Conditions and articles of the Construction Manager's General Conditions.
2. General Commissioning of the project will be executed outside of the general contract by an independent consultant to the University of Arkansas. This document states the requirements of the Construction Manager/General Contractor to assist the Commissioning Agent in the executionof their work.
3. This section shall in no way diminish the responsibility of the Contractors, Subs and Suppliers in performing all aspects of work and testing as outlined in the contract documents. Any requirements outlined in this section are in addition to requirements outlined in other divisions within the project specifications.

C. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
2. The requirements in this section are in addition to those specifically outlined in:
    a. Section 01 81 13 – LEED Requirements
    b. Section 01 79 00 – Minimum Owner Training Requirements
    c. Section 07 08 00 – Commissioning of Building Envelope
    d. Section 22 08 00 – Commissioning of Plumbing Systems
    e. Section 23 08 00 – Commissioning of HVAC Systems
    f. Section 26 08 00 – Commissioning of Electrical Systems

D. DEFINITIONS & ABBREVIATIONS

1. AD: Asset Documents
2. A/E: Architect/Engineer
3. Asset: Refers to any System or Sub-System included in this section.
4. Acceptance Phase: Phase of construction after startup and initial checkout when Functional Performance Testing, O&M documentation review and training occurs.
5. BAS: Building Automation System
6. CC: Controls Contractor
7. CMMS: Computerized Maintenance Management System
8. Commissioning Authority (CxA): An independent party, not otherwise associated with the A/E team members or the GC/CM oversees, though he/she may be hired as a subcontractor to them. The CxA directs the day-to-day commissioning activities.
9. Construction Phase: Phase of construction that begins once construction commences and continues until TAB and Functional Performance Testing. This phase includes the commissioning submittal review, development and execution of Pre-Functional Checklists, site observations and equipment startup.
10. EC: Electrical Contractor
11. FAMA: Facilities Management
12. FAMIS: Facility Asset Management Information System
13. GC/CM: General Contractor / Construction Manager
14. HVAC: Heating, Ventilating and Air Conditioning
15. MC: Mechanical Contractor
16. O&M: Operation and Maintenance
17. Occupancy Phase: Phase of the project after the Acceptance Phase. During this phase, commissioning requirements are to correct any remaining Commissioning Issues, carry out any required re-testing, deferred or seasonal testing, close-out documentation review and warranty review.
18. OR: Owner's Representative
19. PC: Plumbing Contractor
20. Subs: Subcontractors
21. Subsystem: A portion of a system with characteristics similar to a system.
22. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

E. OPERATIONS AND MAINTENANCE DATA INTEGRATION TEAM

1. To ensure successful Operations and Maintenance data integration, it requires the participation of all project team members to be an effective and efficient process. This team is made of individuals from the University of Arkansas FAMA, Commissioning and Construction teams as identified in this section.
2. Operations and Maintenance Data Integration Team members appointed by the University of Arkansas FAMA:

a. CxA – Commissioning Authority
b. CMMS Administrator
c. Maintenance Coordinator
d. Director of Operations and Maintenance
e. Construction Coordinator
f. Asset Coordinator

3. Operations and Maintenance Data Integration Team members appointed by the Contractor(s):

(1) Note: Edit as necessary to align with the project scope

b. GC/CM – General Contractor/Construction Manager
c. MC – Mechanical Contractor
d. EC – Electrical Contractor
e. PC – Plumbing Contractor
f. CC – Controls Contractor
g. TABC – TAB Contractor
h. Equipment Suppliers and Vendors

F. TEAM MEMBER RESPONSIBILITIES

1. The general responsibilities of various parties in the Operations and Maintenance Data Integration process are provided in this subsection.
2. Owner's Responsibilities:

a. Attend initial Operations and Maintenance Data Integration meeting and additional meetings as necessary.
b. Provide the necessary type and quantity of barcodes to the GC/CM.
c. As applicable, provide to the GC/CM the current asset list for the project. This will be reviewed during the initial Operations and Maintenance Data Integration meeting.
d. Provide the Operations and Maintenance Data Integration document to the GC/CM. This will be provided in a cloud-based collaborative spreadsheet or sent directly to the GC/CM by the CMMS Administrator.
e. Review and approve the GC/CM submitted Operations and Maintenance Data Integration document once completed by the GC/CM.

3. General Contractor/Construction Manager Responsibilities:

a. Schedule and facilitate the initial Operations and Maintenance Data Integration meeting. Provide meeting minutes after meeting is completed.
b. Obtain barcodes from the Owner.
c. Install the barcodes for the project specific assets. The location of the barcode in relation to the asset is dependent on the type of asset receiving the barcode.
d. Document the required data for each asset in the Operations and Maintenance Data Integration document provided by the Owner and provide all the necessary information as required.
e. If GC/CM is removing asset equipment from the project that includes existing barcodes, the GC/CM shall document that information on the Operations and Maintenance Data Integration document.
f. Submit the Operations and Maintenance Data Integration documentation to the CxA for review and verification.

4. Commissioning Authority (CxA) Responsibilities:

a. Attend initial Operations and Maintenance Data Integration meeting and additional meetings as necessary.
b. Review and verify through sampling the Operations and Maintenance Data Integration documentation submitted by the GC/CM.
c. Recommend approval, and submit the documentation to the CMMS Administrator for final approval.

G. OPERATIONS AND MAINTENANCE DATA INTEGRATION SUBMITTALS

1. This section identifies the Operations and Maintenance Data Integration submittals that the GC/CM is responsible for providing to the CxA and/or FAMA for completion of related tasks.
2. Completed Operations and Maintenance Data Integration Documentation:

a. The GC/CM shall provide an electronic copy of the completed Operations and Maintenance Data documentation to the CxA for review and verification prior to the final submission to FAMA. Once the CxA approves the completed documentation, the GC/CM shall provide the final documentation to the CMMS Administrator of FAMA for approval.

H. SCHEDULING

1. All completed Operations and Maintenance Data Integration documentation must be submitted and approved prior to substantial completion of the project. Failure to adhere to this requirement will result in retainage being withheld.
2. The initial Operations and Maintenance Data Integration meeting shall be scheduled by the GC/CM prior to installation of any asset belonging to an asset type identified by section 1.9 of this specification.
3. The GC/CM shall provide a list of all asset types of new assets being installed by the project as well as the respective quantity of each asset type following both the initial Operations and Maintenance Data Integration meeting and approval of equipment submittals. Anticipated startup dates for each asset type should be identified as part of this list.
4. The owner will provide necessary type and quantity of barcodes to the GC/CM at least 2 weeks prior to scheduled startup of the assets.

I. Specific Asset Data Requirements

1. Each asset listed below applies to this specification as applicable to the project, and the following sections outline the data to be recorded for each asset, as well as the required location of the barcode for the asset.
    1. Acid Neutralization System
    2. ADA Access Door Opener
    3. Air Compressor, Building
    4. Air Compressor, Lab
    5. Air Compressor, Plant
    6. Air Compressor, Portable
    7. Air Dryer, Building
    8. Air Dryer, Plant
    9. Appliance, Dishwasher, Commercial
    10. Appliance, Dishwasher, Residential
    11. Appliance, Ice Machine
    12. Appliance, Refrigerator
    13. Automated External Defibrillator (AED)
    14. Backflow Preventer
    15. Backflow Preventer Test Gauge
    16. Blow Down Drain, Fire Sprinkler
    17. Boiler, Domestic Hot Water
    18. Boiler, Heating Water
    19. Boiler, Steam
    20. Chemical Feeder
    21. Chemical Pot
    22. Chemical Treatment System
    23. Chemical Water Softener System
    24. Condenser, Air Cooled
    25. Condenser, Water Cooled
    26. Cooler, Evaporative
    27. Cooler, Oil
    28. Cooling Tower System
    29. Curtain, Fire, Sliding
    30. Deaerator, Boiler Feed Water
    31. Disposal, Garbage
    32. Door, Emergency Egress
    33. Door, Exterior
    34. Door, Fire, Rollup
    35. Door, Fire, Sliding
    36. Door, Fire, Swinging
    37. Door, Interior
    38. Door, Overhead, Electric
    39. Door, Overhead, Manual
    40. Elevator
    41. Environmental Chamber
    42. Eyewash Station, Emergency
    43. Eyewash/Facewash Station, Emergency
    44. Eyewash/Facewash/Shower Combo, Emergency
    45. Eyewash/Shower Combo, Emergency
    46. Fan, Ceiling Industrial
    47. Fan, Exhaust, Fume Hood
    48. Fan, Exhaust, Kitchen
    49. Fan, Exhaust, Plant
    50. Fan, Exhaust, Smoke
    51. Fan, Exhaust, Space / Restroom
    52. Fan, Make-up Air
    53. Fan, Portable
    54. Fan, Return Air
    55. Filter Heater Skid, Natural Gas
    56. Filter, HEPA
    57. Fire Alarm System
    58. Fire Extinguisher
    59. Fire Hydrant
    60. Fire Suppression System, Chemical
    61. Fire Suppression System, Dry Pipe
    62. Fire Suppression System, Wet Pipe
    63. Flag Pole
    64. Fume Hood, Biological
    65. Fume Hood, Chemical
    66. Fume Hood, Radiological
    67. Furnace, Electric
    68. Furnace, Natural Gas

69. Gate
70. Generator, Gas Turbine
71. Generator, Installed (Emergency)
72. Generator, Portable
73. Heat Exchanger, Domestic Hot Water
74. Heat Exchanger, Plate Frame
75. Heat Exchanger, Steam
76. HVAC Unit, Air Handling
77. HVAC Unit, Air Handling UV Sterilization
78. HVAC Unit, CRAC
79. HVAC Unit, Fan Coil
80. HVAC Unit, Heater, Electric
81. HVAC Unit, Heater, Hydronic
82. HVAC Unit, Heater, Natural Gas
83. HVAC Unit, Make-up Air
84. HVAC Unit, Package
85. HVAC Unit, Rooftop
86. HVAC Unit, Split Air Conditioner
87. HVAC Unit, Window Air Conditioner
88. HVAC, Air Compressor
89. HVAC, Chilled Beam
90. HVAC, Chiller
91. HVAC, Chiller System, Departmental
92. HVAC, Dehumidifier, Installed
93. HVAC, Dehumidifier, Portable
94. HVAC, Heat Pump
95. HVAC, Humidifier, Installed
96. HVAC, Humidifier, Portable
97. HVAC, VAV Terminal Unit Non Fan-Powered
98. HVAC, VAV Terminal Unit Fan-Powered
99. Inverter
100. Landscape Feature (fountain, statue, etc.)
101. Lift, Materials
102. Lift, Stage
103. Lift, Wheelchair
104. Light, Emergency Egress
105. Light, Emergency Exit
106. Light, Exterior, Building Mounted
107. Light, Exterior, Crosswalk
108. Light, Exterior, Ground
109. Light, Exterior, Pole
110. Lighting, Control System
111. Meter, Electric
112. Meter, Condensate
113. Meter, Flow, Chilled Water
114. Meter, Flow, Domestic
115. Meter, Flow, Steam
116. Meter, Heating Hot Water
117. Meter, Natural Gas
118. Motor
119. Motor Control Center
120. Phone, Emergency/Information
121. Pipeline, Natural Gas
122. Pump, Boiler Feed Water
123. Pump, Chemical Injection
124. Pump, Chilled Water
125. Pump, Condensate, Primary
126. Pump, Condensate, Secondary
127. Pump, Domestic High Rise
128. Pump, Domestic Hot Water
129. Pump, Fire
130. Pump, Glycol
131. Pump, Heating Hot Water
132. Pump, Sewer
133. Pump, Sump
134. Pump, Sump, Non-building
135. Pump, Tower Water
136. Pump, Vacuum, Building
137. Pump, Vacuum, Lab
138. Pump, Vacuum, Portable

139. Restroom Fixtures
140. Roof, Built-up
141. Roof, Green
142. Roof, Membrane
143. Roof, Metal
144. Roof, Shingle
145. Roof, Tile/Slate
146. Sensor, Differential Pressure
147. Separator, Air/Dirt
148. Separator, Oil/Water
149. Shower, Emergency
150. Sink, Custodial
151. Sink, Kitchen
152. Sink, Lab
153. Smoke Detector
154. Snorkels
155. Stormwater Detention System
156. Strainer, Chilled Water
157. Strainer, Cooling Tower
158. Switch, Automatic Transfer (ATS)
159. Switch, Busway
160. Switch, Disconnect
161. Switch, MV, Air
162. Switch, MV, Gas Filled
163. Switch, MV, Oil Filled
164. Switchboard / Main Distribution Panel (MDP)
165. Switchgear, MV System
166. Tank, Chilled Water Holding
167. Tank, Compressed Air Storage
168. Tank, Domestic Hot Water Storage
169. Tank, Expansion
170. Tank, Fuel Storage
171. Tank, Gasoline Storage
172. Transformer, MV, Dry
173. Transformer, MV, Oil Filled
174. Transformer, Secondary, Dry
175. Trap, Grease/Sediment
176. Valve, Gas Line Break
177. Valve, Pressure Reducing, Air
178. Valve, Pressure Reducing, Gas
179. Valve, Pressure Reducing, Steam
180. Valve, Safety Relief, Air
181. Valve, Safety Relief, Gas
182. Valve, Safety Relief, Steam
183. Valve, Safety Relief, Water
184. Variable Frequency Drive
185. Walk In Cooler
186. Walk In Freezer
187. Water Fountain
188. Water Fountain w/ Bottle Filler
189. Water Heater, Domestic, Electric
190. Water Heater, Domestic, Gas
191. Water Heater, Domestic, Steam
192. Water System, Deionized
193. Water System, Reverse Osmosis

J. Provide the following data for each specific asset and record the information on the Operations and Maintenance Data Integration document.

1. Acid Neutralization System

a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes

(1) Location of Tag
(2) Other Identifying Information

2. ADA Access Door Opener
   a. Barcode Number
      (1) 1 Tag/Floor/Type of Asset
   b. Asset ID/Label
   c. Asset Floor Location
   d. Warranty Start Date
   e. Warranty End Date
   f. General Notes
      (1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
      (2) Total number of that Asset on that floor with location for each (Ex. Typical of 4 Exterior Doors on 1st Floor list each location. Lobby 100, Corridor 128, Main Lobby 140, Corridor 182)
3. Air Compressor, Building
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information
4. Air Compressor, Lab
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information
5. Air Compressor, Plant
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information
6. Air Compressor, Portable
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes

(1) Location of Tag
(2) Other Identifying Information

7. Air Dryer, Building
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information
8. Air Dyer, Plant
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information
9. Appliance, Dishwasher, Commercial
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Other Identifying Information
10. Appliance, Dishwasher, Residential
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Other Identifying Information
11. Appliance, Ice Machine (Human Consumption Only)
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date

j. General Notes
   (1) Location of Tag
   (2) Other Identifying Information

12. Appliance, Refrigerator
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Other Identifying Information
13. Automated External Defibrillator
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Other Identifying Information
14. Backflow Preventer
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Asset Type and Service
       (3) Other Identifying Information
15. Backflow Preventer Test Gauge
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Asset Type and Service
       (3) Other Identifying Information
16. Blow Down Drain, Fire Sprinkler
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number

f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

17. Boiler, Domestic Hot Water
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Boiler Type
(3) Filter Type, Size and Quantity (if applicable)

18. Boiler, Heating Water
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Boiler Type
(3) Filter Type, Size and Quantity (if applicable)

19. Boiler, Steam
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Boiler Type
(3) Filter Type, Size and Quantity (if applicable)

20. Chemical Feeder
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

21. Chemical Pot

a. Barcode Number
   (1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag
   (2) Other Identifying Information

22. Chemical Treatment System
    a. Barcode Number
       (1) 1 Tag/System
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Other Identifying Information
23. Chemical Water Softener System
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Other Identifying Information
24. Condenser, Air Cooled
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Associated Indoor Unit(s) and Barcode Number(s)
25. Condenser, Water Cooled
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes

(1) Location of Tag
(2) Associated Indoor Unit(s) and Barcode Number(s)

26. Cooler, Evaporative
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
27. Cooler, Oil
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
28. Cooling Tower System
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Number of Cooling Tower Fan Motors
29. Curtain, Fire, Sliding
    a. Barcode Number
       (1) 1 Tag / Building
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Total number of assets within building with location of each documented
       (3) Other Identifying Information
30. Deaerator, Boiler Feed Water
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date

i. Warranty End Date
j. General Notes
(1) Other Identifying Information

31. Disposal, Garbage
a. Barcode Number
(1) 1 Tag/Building
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Total number of assets within building with location of each documented
(3) Other Identifying Information

32. Door, Emergency Egress
a. Barcode Number
(1) 1 Tag/Building
b. Asset ID/Label
c. Asset Floor Location
d. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Total number of assets within building with location of each documented
(3) Other Identifying Information

33. Door, Exterior
a. Barcode Number
(1) 1 Tag/Floor/Type of Asset
b. Asset ID/Label
c. Asset Floor Location
d. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Total number of assets within building per floor
(3) Other Identifying Information

34. Door, Fire, Rollup
a. Barcode Number
(1) 1 Tag/Building
b. Asset ID/Label
c. Asset Floor Location
d. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Total number of assets within building with location of each documented
(3) Other Identifying Information

35. Door, Fire, Sliding
a. Barcode Number
(1) 1 Tag/Building
b. Asset ID/Label
c. Asset Floor Location
d. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Total number of assets within building with location of each documented
(3) Other Identifying Information

36. Door, Fire, Swinging
a. Barcode Number
(1) 1 Tag/Building
b. Asset ID/Label
c. Asset Floor Location
d. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Total number of assets within building with location of each documented
(3) Other Identifying Information

37. Door, Interior
a. Barcode Number

(1) 1 Tag/Floor/Type of Asset
b. Asset ID/Label
c. Asset Floor Location
d. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Total number of assets within building per floor
(3) Other Identifying Information

38. Door, Overhead, Electric
a. Barcode Number
(1) 1 Tag/Building
b. Asset ID/Label
c. Asset Floor Location
d. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Total number of assets within building
(3) Other Identifying Information

39. Door, Overhead, Manual
a. Barcode Number
(1) 1 Tag/Building
b. Asset ID/Label
c. Asset Floor Location
d. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Total number of assets within building with location for each door
(3) Other Identifying Information

40. Elevator
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

41. Environmental Chamber
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

42. Eyewash Station, Emergency
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Floor Location
d. General Notes
(1) Location of Tag
(2) Emergency Eye Wash Station Type
(3) Other Identifying Information

43. Eyewash / Facewash Station, Emergency
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label

c. Asset Floor Location
d. General Notes
   (1) Location of Tag
   (2) Emergency Eye Wash Station Type
   (3) Other Identifying Information

44. Eyewash / Facewash / Shower Combo, Emergency
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Floor Location
    d. General Notes
       (1) Location of Tag
       (2) Emergency Eye Wash Station Type
       (3) Other Identifying Information
45. Eyewash / Shower Combo, Emergency
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Floor Location
    d. General Notes
       (1) Location of Tag
       (2) Emergency Eye Wash Station Type
       (3) Other Identifying Information
46. Fan, Ceiling
    a. Barcode Number
       (1) 1 Tag/Asset/Floor
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Total number of assets within building per floor
       (3) Other Identifying Information
47. Fan, Exhaust, Fume Hood
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag (pop rivet to housing if outside)
       (2) Exhaust Fan Type
       (3) Area of Service and/or Equipment (associate to equipment asset tag)
       (4) Belt Size and Number of Belts (if applicable) or note as Direct Drive
       (5) Filter Size and Quantity
48. Fan, Exhaust, Kitchen
    a. Barcode Number
       (1) 1 Tag / Asset within Space / Room
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes

(1) Location of Tag (pop rivet to housing if outside)
(2) Exhaust Fan Type
(3) Area of Service and/or Equipment (associate to equipment asset tag)
(4) Belt Size and Number of Belts (if applicable) or note as Direct Drive
(5) Filter Size and Quantity

49. Fan, Exhaust, Plant
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag (pop rivet to housing if outside)
        (2) Exhaust Fan Type
        (3) Area of Service and/or Equipment (associate to equipment asset tag)
        (4) Belt Size and Number of Belts (if applicable) or note as Direct Drive
        (5) Filter Size and Quantity
50. Fan, Exhaust, Smoke
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag (pop rivet to housing if outside)
        (2) Exhaust Fan Type
        (3) Area of Service and/or Equipment (associate to equipment asset tag)
        (4) Belt Size and Number of Belts (if applicable) or note as Direct Drive
        (5) Filter Size and Quantity
51. Fan, Exhaust, Space / Restroom
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag (pop rivet to housing if outside)
        (2) Exhaust Fan Type
        (3) Area of Service and/or Equipment (associate to equipment asset tag)
        (4) Belt Size and Number of Belts (if applicable) or note as Direct Drive
        (5) Filter Size and Quantity
52. Fan, Make-up Air
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date

j. General Notes
   (1) Location of Tag
   (2) Other Identifying Information

53. Fan, Portable
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information

54. Fan, Return Air
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Unit served
      (3) Other Identifying Information

55. Filter Heater Skid, Natural Gas
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information

56. Filter, HEPA
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Equipment/Space Served
      (3) Other Identifying Information

57. Fire Alarm System
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model

e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
    (1) Location of Tag
    (2) Other Identifying Information

58. Fire Extinguisher
    a. Barcode Number
        (1) 1 Tag/Building
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
        (2) Total number of assets within building
        (3) Other Identifying Information
59. Fire Hydrant
    a. Barcode Number
        (1) 1 Tag/Building
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Total number of assets within building
        (3) Other Identifying Information
60. Fire Suppression System, Chemical
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
61. Fire Suppression System, Dry Pipe
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
62. Fire Suppression System, Wet Pipe

a. Barcode Number
   (1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag
   (2) Other Identifying Information

63. Flag Pole
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Location
    d. Asset Floor Location
    e. General Notes
       (1) Lighting Type, Make, Model
       (2) Other Identifying Information

64. Fume Hood, Biological
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Associated Lab Exhaust Fan and Barcode Number
       (3) Other identifying information

65. Fume Hood, Chemical
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Associated Lab Exhaust Fan and Barcode Number
       (3) Other identifying information

66. Fume Hood, Radiological
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Associated Lab Exhaust Fan and Barcode Number
       (3) Other identifying information

67. Furnace, Electric
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Associated Outdoor Unit and Barcode Number
        (3) Other Identifying Information
68. Furnace, Natural Gas
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Associated Outdoor Unit and Barcode Number
        (3) Other Identifying Information
69. Gate
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
70. Generator, Gas Turbine
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
71. Generator, Installed (Emergency)
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location

h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

72. Generator, Portable
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

73. Heat Exchange, Domestic Hot Water
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

74. Heat Exchanger, Plate Frame
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

75. Heat Exchanger, Steam
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

76. HVAC Unit, Air Handling
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model

e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag
   (2) Belt Size and Number of Belts (if applicable) or note if motors are Direct Drive
   (3) Supply Fan Motor Size and Number of Supply Fan Motors
   (4) Return Fan Motor Size and Number of Return Fan Motors
   (5) Exhaust Fan Motor Size and Number of Exhaust Fan Motors
   (6) Energy Wheel Motor Size
   (7) Supply Pre-Filter Size and Quantity
      a) Ensure different size filters are listed (if applicable)
      b) Filter location if not located in unit
   (8) Supply Final-Filter Size and Quantity
      a) Ensure different size filters are listed (if applicable)
      b) Filter location if not located in unit
   (9) Exhaust/Return Filter Size and Quantity
      a) Ensure different size filters are listed (if applicable)
      b) Filter location if not located in unit
   (10) Any Specific Attribute Information
      a) Specific component warranty durations

77. HVAC Unit, Air Handling UV Sterilization
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Belt Size and Number of Belts (if applicable) or note if motors are Direct Drive
      (3) Model and Quantity of UV lights
      (4) Supply Fan Motor Size and Number of Supply Fan Motors
      (5) Return Fan Motor Size and Number of Return Fan Motors
      (6) Exhaust Fan Motor Size and Number of Exhaust Fan Motors
      (7) Energy Wheel Motor Size
      (8) Supply Pre-Filter Size and Quantity
         a) Ensure different size filters are listed (if applicable)
         b) Filter location if not located in unit
      (9) Supply Final-Filter Size and Quantity
         a) Ensure different size filters are listed (if applicable)
         b) Filter location if not located in unit
      (10) Exhaust/Return Filter Size and Quantity
         a) Ensure different size filters are listed (if applicable)
         b) Filter location if not located in unit
      (11) Any Specific Attribute Information
         a) Specific component warranty durations

78. HVAC Unit, CRAC
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date

j. General Notes
   (1) Location of Tag
   (2) Associated Outdoor Unit and Barcode Number
   (3) Belt Size and Number of Belts (if applicable) or note if motors are direct drive
   (4) Filter Size and Quantity
      a) Ensure different size filters are listed (if applicable)
      b) Filter location if not located in unit
   (5) Any Specific Attribute Information
      a) Specific component warranty durations

79. HVAC Unit, Fan Coil
   a. Barcode Number
      (1) 1 Tag/Floor/Asset Type
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
      (2) Total number of that Asset on that floor with locations (Ex. Typical of 30 Fan-Powered Variable Air Volume Units on 1st Floor, list each location)
      (3) Filter Size and Quantity of Filters (ensure different sizes are listed)
      (4) Motor Size (ensure different sizes are listed)
      (5) Other identifying information

80. HVAC Unit, Heater, Electric
   a. Barcode Number
      (1) 1 Tag/Floor/Asset Type
   b. Asset ID/Label01
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
      (2) Unit Heater Type
      (3) Total number and location of that Asset on that floor
      (4) Other identifying information

81. HVAC Unit, Heater, Hydronic
   a. Barcode Number
      (1) 1 Tag/Floor/Asset Type
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
      (2) Unit Heater Type
      (3) Total number and location of that Asset on that floor
      (4) Other identifying information

82. HVAC Unit, Heater, Natural Gas
   a. Barcode Number
      (1) 1 Tag/Floor/Asset Type
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number

f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
    (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
    (2) Unit Heater Type
    (3) Total number and location of that Asset on that floor
    (4) Other identifying information

83. HVAC Unit, Make-up Air
    a. Barcode Number
        (1) 1 Tag/Asset with filter/belt sizes
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Belt Size and Number of Belts (if applicable) or note if motors are Direct Drive
        (3) Supply Fan Motor Size and Number of Supply Fan Motors
        (4) Filter Size and Quantity
            a) Ensure different size filters are listed (if applicable)
            b) Filter location if not located in unit
        (5) Any Specific Attribute Information
            a) Specific component warranty durations

84. HVAC Unit, Package
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Belt Size and Number of Belts (if applicable) or note if motors are Direct Drive
        (3) Supply Fan Motor Size and Number of Supply Fan Motors
        (4) Return Fan Motor Size and Number of Return Fan Motors
        (5) Exhaust Fan Motor Size and Number of Exhaust Fan Motors
        (6) Energy Wheel Motor Size
        (7) Supply Pre-Filter Size and Quantity
            a) Ensure different size filters are listed (if applicable)
            b) Filter location if not located in unit
        (8) Supply Final-Filter Size and Quantity
            a) Ensure different size filters are listed (if applicable)
            b) Filter location if not located in unit
        (9) Exhaust/Return Filter Size and Quantity
            a) Ensure different size filters are listed (if applicable)
            b) Filter location if not located in unit
        (10) Any Specific Attribute Information
            a) Specific component warranty durations

85. HVAC Unit, Rooftop
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number

f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Belt Size and Number of Belts (if applicable) or note if motors are Direct Drive
(3) Supply Fan Motor Size and Number of Supply Fan Motors
(4) Return Fan Motor Size and Number of Return Fan Motors
(5) Exhaust Fan Motor Size and Number of Exhaust Fan Motors
(6) Energy Wheel Motor Size
(7) Supply Pre-Filter Size and Quantity
a) Ensure different size filters are listed (if applicable)
b) Filter location if not located in unit
(8) Supply Final-Filter Size and Quantity
a) Ensure different size filters are listed (if applicable)
b) Filter location if not located in unit
(9) Exhaust/Return Filter Size and Quantity
a) Ensure different size filters are listed (if applicable)
b) Filter location if not located in unit
(10) Any Specific Attribute Information
a) Specific component warranty durations

86. HVAC Unit Split Air Conditioner
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Belt Size and Number of Belts (if applicable) or note if motors are Direct Drive
(3) Supply Fan Motor Size and Number of Supply Fan Motors
(4) Energy Wheel Motor Size
(5) Filter Size and Quantity
a) Ensure different size filters are listed (if applicable)
b) Filter location if not located in unit
(6) Any Specific Attribute Information
a) Specific component warranty durations

87. HVAC Unit, Window Air Conditioner
a. Barcode Number
(1) 1 Tag/Floor
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Total number of that Asset on that floor with locations (Ex. Typical of 30 Fan-Powered Variable Air Volume Units on 1st Floor, list each location)
(3) Filter Size and Quantity
a) Ensure different size filters are listed (if applicable)

88. HVAC Unit, Air Compressor
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label

c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag
   (2) Belt Size and Number of Belts (if applicable) or note if motors are Direct Drive
   (3) Any Specific Attribute Information

89. HVAC Unit, Chilled Beam
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Any Specific Attribute Information
90. HVAC, Chiller
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Type of Chiller
91. HVAC, Chiller System, Departmental
    a. Barcode Number
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Type of Chiller
92. HVAC Unit, Dehumidifier, Installed
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Unit served and barcode of unit
       (3) Any Specific Attribute Information
93. HVAC Unit, Dehumidifier, Portable

a. Barcode Number
   (1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag
   (2) Unit or space served and barcode of unit
   (3) Any Specific Attribute Information

94. HVAC Unit, Heat Pump
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Belt Size and Number of Belts (if applicable) or note if motors are Direct Drive
       (3) Supply Fan Motor Size and Number of Supply Fan Motors
       (4) Supply Pre-Filter Size and Quantity
           a) Ensure different size filters are listed (if applicable)
           b) Filter location if not located in unit
       (5) Supply Final-Filter Size and Quantity
           a) Ensure different size filters are listed (if applicable)
           b) Filter location if not located in unit
       (6) Any Specific Attribute Information
           a) Specific component warranty durations

95. HVAC Unit, Humidifier, Installed
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Unit served and barcode of unit
       (3) Any Specific Attribute Information

96. HVAC Unit, Humidifier, Portable
    a. Barcode Number
       (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
       (1) Location of Tag
       (2) Unit served and barcode of unit

(3) Any Specific Attribute Information

97. HVAC Unit, VAV Terminal Unit Non-Fan Powered
    a. Barcode Number
        (1) 1 Tag/Floor
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Total number of that Asset on that floor with locations (Ex. Typical of 30 Fan-Powered Variable Air Volume Units on 1st Floor, list each location)
        (3) Filter Size and Quantity
            a) Ensure different size filters are listed (if applicable)
98. HVAC Unit, VAV Terminal Unit Fan-Powered
    a. Barcode Number
        (1) 1 Tag / Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag (visible area next to manufacturers information plate)
        (2) Belt Size and Number of Belts (if applicable) or note if motors are Direct Drive
        (3) Filter Sizes and Filter Quantity
            a) Ensure different size filters are listed (if applicable)
        (4) Any Specific Attribute Information
99. Inverter
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Other Identifying Information
100. Landscape Feature (fountain, statue, etc.)
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
101. Lift, Materials
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label

c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag
   (2) Other Identifying Information

102. Lift, Stage
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information

103. Lift, Wheelchair
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information

104. Light, Emergency Egress
   a. Barcode Number
      (1) 1 Tag/Floor/Asset Type
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Room Location
   f. Asset Floor Location
   g. Warranty Start Date
   h. Warranty End Date
   i. General Notes
      (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
      (2) Total number of that Asset on that floor with locations (Ex. Typical of 10 Exit Lights on 1st Floor, list each location with battery size or hard wired notes)
      (3) Other identifying information

105. Light, Emergency Exit Lights
   a. Barcode Number
      (1) 1 Tag/Floor/Asset Type
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Room Location
   f. Asset Floor Location
   g. Warranty Start Date
   h. Warranty End Date
   i. General Notes
      (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
      (2) Total number of that Asset on that floor with locations (Ex. Typical of 10 Exit Lights on 1st Floor, list each location with battery size or hard wired notes)

(3) Other identifying information

106. Light, Exterior, Building Mounted
    a. Barcode Number
        (1) 1 Tag/Floor/Asset Type
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
        (2) Total number of that Asset on that floor with locations (Ex. Typical of 10 Exit Lights on 1st Floor, list each location with battery size or hard wired notes)
        (3) Other identifying information
107. Light, Exterior, Crosswalk
    a. Barcode Number
        (1) 1 Tag/Asset Type
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
        (2) Total number of that Asset
        (3) Other identifying information
108. Light, Exterior, Ground
    a. Barcode Number
        (1) 1 Tag/Asset Type
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
        (2) Total number of that Asset
        (3) Other identifying information
109. Light, Exterior, Pole
    a. Barcode Number
        (1) 1 Tag/Asset Type
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag (Ex. Tag Location on side of unit in L100 Corridor)
        (2) Total number of that Asset
        (3) Other identifying information
110. Lighting, Control System
    a. Barcode Number
        (1) 1 Tag/Asset/System
    b. Asset ID/Label
    c. Asset Make

d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

111. Meter, Electric
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

112. Meter, Condensate
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

113. Meter, Flow, Chilled Water
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

114. Meter, Flow, Domestic
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

115. Meter, Flow, Steam
a. Barcode Number

(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

116. Meter, Heating Hot Water
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

117. Meter, Natural Gas
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

118. Motor
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Other Identifying Information

119. Motor Control Center
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

120. Phone, Emergency / Information
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Other Identifying Information
121. Pipeline, Natural Gas
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Other Identifying Information
122. Pump, Boiler Feed Water
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
        (2) Pump Type
        (3) Frame Size
        (4) Strainer Size and Type
123. Pump, Chemical Injection
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
        (2) Pump Type
        (3) Frame Size
        (4) Strainer Size and Type
124. Pump, Chilled Water
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location

h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
   (2) Pump Type
   (3) Frame Size
   (4) Strainer Size and Type

125. Pump, Condensate, Primary
   a. Barcode Number
      (1) 1 Tag/Asset per system
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
      (2) Pump Type
      (3) Frame Size
      (4) Strainer Size and Type

126. Pump, Condensate, Secondary
   a. Barcode Number
      (1) 1 Tag/Asset per system
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
      (2) Pump Type
      (3) Frame Size
      (4) Strainer Size and Type

127. Pump, Domestic High Rise
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
      (2) Pump Type
      (3) Frame Size
      (4) Strainer Size and Type

128. Pump, Domestic Hot Water
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes

(1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
(2) Pump Type
(3) Frame Size
(4) Strainer Size and Type

129. Pump, Fire
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
        (2) Pump Type
        (3) Frame Size
        (4) Strainer Size and Type
130. Pump, Glycol
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
        (2) Pump Type
        (3) Frame Size
        (4) Strainer Size and Type
131. Pump, Domestic Hot Water
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
132. Pump, Sewer
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
        (2) Pump Type
        (3) Frame Size
        (4) Strainer Size and Type
133. Pump, Sump

a. Barcode Number
   (1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
   (2) Pump Type
   (3) Frame Size
   (4) Strainer Size and Type

134. Pump, Sump, Non-building
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
      (2) Pump Type
      (3) Frame Size
      (4) Strainer Size and Type

135. Pump, Tower Water
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
      (2) Pump Type
      (3) Frame Size
      (4) Strainer Size and Type

136. Pump, Vacuum, Building
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
      (2) Pump Type
      (3) Frame Size
      (4) Strainer Size and Type

137. Pump, Vacuum, Lab
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label

c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
    (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
    (2) Pump Type
    (3) Frame Size
    (4) Strainer Size and Type

138. Pump, Vacuum, Portable
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag on frame if possible (wire/rivet if in a wet environment)
        (2) Pump Type
        (3) Frame Size
        (4) Strainer Size and Type
139. Restroom Fixtures
    a. Barcode Number
        (1) 1 Tag/Floor
    b. Asset ID/Label
    c. Asset Room Number
    d. Asset Floor Location
    e. General Notes
        (1) Locations of each restroom on the floor with quantities of the following per restroom:
            a) Quantity of Water Closets
            b) Quantity of Urinals
            c) Quantity of Lavatories
            d) Quantity of Showers/Tubs
            e) Quantity of Partitions/Dividers
140. Roof, Built-up
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
141. Roof, Green
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes

(1) Location of Tag
(2) Other Identifying Information

142. Roof, Membrane
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
143. Roof, Metal
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
144. Roof, Shingle
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
145. Roof, Tile/Slate
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
146. Sensor, Differential Pressure
    a. Barcode Number
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date

i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

147. Separator, Air / Dirt
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag

148. Separator, Water / Oil
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag

149. Shower, Emergency
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

150. Sink, Custodial
a. Barcode Number
(1) 1 Tag/Floor/Type of Asset
b. Asset ID/Label
c. Asset Room Number
d. Asset Floor Location
e. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Asset Type
(3) Total number of that Asset on that floor with location for each

151. Sink, Kitchen
a. Barcode Number
(1) 1 Tag/Floor/Type of Asset
b. Asset ID/Label
c. Asset Room Number
d. Asset Floor Location
e. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Asset Type
(3) Total number of that Asset on that floor with location for each

152. Sink, Lab
a. Barcode Number

(1) 1 Tag/Lab
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) List all contents inside lab with associated asset numbers

Descriptions	Floor	Room	Asset	Qty
LAB 1208				
Lab Sink Single Compartment Stainless	1	1208	028232	2
Eye Wash/Shower Combo - BRADLEY			015310	1
Chemical Fume Hood -LABCONCO			016766	1
984050110814 / 061265049B				
Biological Fume Hood -LABCONCO			028299	1
36213043726 / 061163352AL				
Snorkel Hood			028287	1

(3) Other Identifying Information

153. Smoke Detector
a. Barcode Number
(1) 1 Tag/Floor/Asset Type
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag (Ex. Tag Location on side of door in L100 Corridor)
(2) Asset Type
(3) Total number of that Asset on that floor with location for each

154. Snorkels
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag (location in visible area)
(2) Associated Lab Exhaust Fan
k. Other identifying information

155. Stormwater Detention System
a. Barcode Number
(1) 1 Tag/System
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location

g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

156. Strainer, Chilled Water
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Size of Strainer
(3) Other Identifying Information

157. Strainer, Cooling Tower
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Size of Strainer
(3) Other Identifying Information

158. Switch, Automatic Transfer (ATS)
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

159. Switch, Busway
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Other Identifying Information

160. Switch, Disconnect
a. Barcode Number
(1) 1 Tag/Asset

b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
    (1) Location of Tag
    (2) Other Identifying Information

161. Switch, MV, Air
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information

162. Switch, MV, Gas Filled
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information

163. Switch, MV, Oil Filled
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information

164. Switchboard / Main Distribution Panel (MDP)
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information

165. Switchgear, MV System
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Other Identifying Information
166. Tank, Chilled Water Holding
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Storage Tank Type
167. Tank, Compressed Air Storage
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Storage Tank Type
168. Tank, Domestic Hot Water Storage
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Storage Tank Type
169. Tank, Expansion
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date

j. General Notes
(1) Location of Tag

170. Tank, Fuel Storage
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Storage Tank Type

171. Tank, Gasoline Storage
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Storage Tank Type

172. Transformer, MV, Dry
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Any Other Identifying Information

173. Transformer, MV, Oil Filled
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Any Other Identifying Information

174. Transformer, Secondary, Dry
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location

h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag
   (2) Any Other Identifying Information

175. Trap, Grease / Sediment
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Interceptor Type
      (3) Other Identifying Information

176. Valve, Gas Line Break
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Any Other Identifying Information

177. Valve, Pressure Reducing, Air
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Any Other Identifying Information

178. Valve, Pressure Reducing, Gas
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Any Other Identifying Information

179. Valve, Pressure Reducing, Steam
   a. Barcode Number
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model

e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Other Identifying Information

180. Valve, Safety Relief, Air
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Any Other Identifying Information

181. Valve, Safety Relief, Gas
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Any Other Identifying Information

182. Valve, Safety Relief, Steam
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Any Other Identifying Information

183. Valve, Safety Relief, Water
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label
c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
(1) Location of Tag
(2) Any Other Identifying Information

184. Variable Frequency Drive
a. Barcode Number
(1) 1 Tag/Asset
b. Asset ID/Label

c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
    (1) Location of Tag
    (2) Asset Served by VFD
    (3) Other Identifying Information

185. Walk In Cooler
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Associated Condensing Unit and Location
        (3) Other Identifying Information

186. Walk in Freezer
    a. Barcode Number
        (1) 1 Tag/Asset
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Associated Condensing Unit and Location
        (3) Other Identifying Information

187. Water Fountain
    a. Barcode Number
        (1) 1 Tag/Asset Type
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date
    j. General Notes
        (1) Location of Tag
        (2) Filter sizes if applicable
        (3) Other Identifying Information

188. Water Fountain with Bottle Filler
    a. Barcode Number
        (1) 1 Tag/Asset Type
    b. Asset ID/Label
    c. Asset Make
    d. Asset Model
    e. Asset Serial Number
    f. Asset Room Location
    g. Asset Floor Location
    h. Warranty Start Date
    i. Warranty End Date

j. General Notes
   (1) Location of Tag
   (2) Filter sizes if applicable
   (3) Other Identifying Information

189. Water Heater, Domestic, Electric
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Asset Type and Service
      (3) Other Identifying Information

190. Water Heater, Domestic, Gas
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Asset Type and Service
      (3) Other Identifying Information

191. Water Heater, Domestic, Steam
   a. Barcode Number
      (1) 1 Tag/Asset
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Asset Type and Service
      (3) Other Identifying Information

192. Water System, Deionized
   a. Barcode Number
      (1) 1 Tag/System
   b. Asset ID/Label
   c. Asset Make
   d. Asset Model
   e. Asset Serial Number
   f. Asset Room Location
   g. Asset Floor Location
   h. Warranty Start Date
   i. Warranty End Date
   j. General Notes
      (1) Location of Tag
      (2) Other Identifying Information

193. Water System, Reverse Osmosis
   a. Barcode Number
      (1) 1 Tag/System
   b. Asset ID/Label

c. Asset Make
d. Asset Model
e. Asset Serial Number
f. Asset Room Location
g. Asset Floor Location
h. Warranty Start Date
i. Warranty End Date
j. General Notes
   (1) Location of Tag
   (2) Other Identifying Information

PART 2 - PRODUCTS

A. EQUIPMENT

1. Barcodes shall be provided by the CMMS Administrator with the University of Arkansas.
2. The Operations and Maintenance Data Integration Document shall be provided by the CMMS Administrator with the University of Arkansas.
3. All equipment required to install barcodes and document data into the Operations and Maintenance Data Integration Document shall be provided by the GC/CM or Subs.

PART 3 - EXECUTION

A. OVERVIEW OF THE OPERATION AND MAINTENANCE DATA INTEGRATION PROCESS

1. The following narrative provides a brief overview of the typical Operations and Maintenance Data Integration tasks during construction and the general order in which they occur.
   a. The process begins with a meeting conducted by the GC/CM where the process is reviewed with the Operations and Maintenance Data Integration team members. This meeting shall be held during a scheduled monthly/biweekly contractors' meeting and all Operations and Maintenance Data Integration team members should attend. This meeting will occur prior to the installation of any of the assets outlined in this specification, and the general meeting agenda shall be as follows:
      (1) Review roles and responsibilities of the Operations and Maintenance Data Integration Team.
      (2) Determine responsibility and timing of when FAMA barcodes will be provided.
      (3) Confirm project specific assets and review barcoding requirements for each asset.
      (4) Review current asset list provided by FAMA for the project to determine which assets may be removed and the process for documenting information of the removed assets.
      (5) Review Operations and Maintenance Data Integration documentation requirements.
      (6) Establish electronic documentation access.
      (7) Confirm Operations and Maintenance Data Integration documentation review process and procedures.
      (8) Review construction schedule to establish estimated completion date of Operations and Maintenance Data Integration documentation and installation of the barcodes.
   b. Depending on the duration and complexity of the project, additional meetings maybe required throughout construction, scheduled by the GC/CM with the Operations and Maintenance Data Integration team to plan, coordinate, and schedule future activities, as well as resolve issues or answer questions.
   c. The CMMS Administrator or Construction Coordinator with the University of Arkansas FAMA provides the necessary type and quantity of barcodes to the GC/CM to be installed on the assets.
   d. The CMMS Administrator or Construction Coordinator with the University of Arkansas FAMA provides the Operations and Maintenance Data Integration document to the GC/CM. This will be provided in a cloud-based collaborative spreadsheet or sent directly to the GC/CM by the CMMS Administrator or Construction Coordinator.
   e. The GC/CM and Subs install the barcodes for the project specific assets. The location of the barcode in relation to the asset is dependent on the type of asset receiving the barcode. Refer to other sections of this specification for the requirements of installing the barcodes.
   f. The GC/CM and Subs document the required data for each asset in the Operations and Maintenance Data Integration document and provide all the necessary information as required by FAMA. Refer to other sections of this specification for direction on properly documenting asset data.
   g. If the GC/CM and Subs are removing asset equipment from the project that includes existing barcodes, the GC/CM shall document that information on the Operations and Maintenance Data Integration document in the Removed Asset worksheet. Specifically, the following information of removed assets must be documented:
      (1) Asset Barcode (if multiple tags are present, all barcode numbers must be documented)
      (2) Asset Make
      (3) Asset Model Number
   h. Once the GC/CM completes the installation of all the barcodes for all of the required assets and completes documentation for each asset in the Operation and Maintenance Data Integration document for all the required assets, the GC/CM shall submit the Operations and Maintenance Data Integration documentation to the CxA for review and verification. The CxA will then recommend approval, and submit the documentation to the Asset Coordinator for final approval.
   i. The GC/CM must provide unused barcodes to the CMMS Administrator or Construction Coordinator prior to Substantial Completion.
   j. The GC/CM must compete the installation of all barcodes for all the required assets associated with the project prior to Substantial Completion.

k. The GC/CM must complete and submit documentation for each asset in the Operation and Maintenance Data Integration document for all the required assets associated with the project prior to Substantial Completion.

END OF SECTION 01 75 00

SECTION 01 77 00 – CLOSEOUT PROCEDURES

PART 1 - FINAL CLEANING:

1.01 PRIOR TO OWNER OCCUPANCY, clean all surfaces including fixtures and equipment, for use by the Owner. Employ experienced workers or professional cleaners for final cleaning. Leave all metal surfaces, hardware, fixtures and equipment in a bright, clean and polished conditions. Comply with the manufacturer's instructions for operations.

1.02 CLEAN TRANSPARENT MATERIALS, including mirrors and glass in doors and windows, to a polished condition. Remove putty and other substances which are noticeable as vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.

1.03 PROVIDE AND MAINTAIN PROTECTIVE MATS on finished floors to provide a path of travel through the project for inspection by the AHJ and for observation by the Architect and Owner. Provide non-staining reinforced Kraft paper or cardboard mats throughout the spaces, with adhesive surfaced walk-off “tack” mats at entrances from the exterior.

1.04 CLEAN EXPOSED EXTERIOR and interior hard-surfaced finishes to a dust-free condition, free of dust, stains, films and similar noticeable distracting substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors and pavement broom clean. Vacuum carpeted surfaces.

1.05 MECHANICAL AND ELECTRICAL EQUIPMENT must be wiped clean. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.

1.06 CLEAN THE PROJECT SITE, including landscape development areas, of rubbish, litter and other foreign substances. Sweep paved areas to a broom clean condition; remove stains, spills and other foreign deposits. Rake grounds that are neither paved nor planted, to a smooth even-textured surface.

PART 2 - SUBSTANTIAL COMPLETION PROCEDURES:

2.01 SET ALL TIME CLOCKS, thermostats and similar devices to the current local time. Provide a printed list of names, addresses and phone numbers of all sub-contractors and material suppliers used.

2.02 AFTER FINAL CLEANING is completed, and when the Project is ready for Owner occupancy, obtain an occupancy permit on behalf of the Owner, and arrange for inspections by other required AHJ representatives - including but not limited to health-department officials, when applicable (Contractor is not responsible for AHJ acceptance or approval of Work performed by Owner’s separate contractors).

2.03 SUBMIT WRITTEN REQUEST FOR INSPECTION per requirements of the General Conditions, certifying that the Work is Substantially Complete and is therefore ready for the Owner's beneficial use and occupancy. Accompany that request with the “comprehensive list” required by the General Conditions, of items yet to be completed or corrected before final completion (the initial “punch list”).

2.04 ARCHITECT’S ACTION: Following inspection of the Work, the Architect will either prepare a certificate of Substantial Completion, or will advise the Contractor of additional Work which must be completed before the certificate will be issued. Results of the Architect’s Substantial Completion inspection, together with the Contractor’s comprehensive list of items to be completed or corrected, will form the final “punch-list” for final completion.

PART 3 - PREREQUISITES TO FINAL COMPLETION:

3.01 COMPLETE ALL “PUNCH-LIST” WORK ITEMS as expeditiously as possible, providing labor at times when the facility is not in operation, if necessary. Coordinate with the Owner's representative and perform the Work so that it will not interfere with the Owner's operations.

3.02 COMPLETE FINAL TESTING of systems, and instruct Owner's personnel in the operation, adjustment, maintenance of all mechanical, plumbing, fire protection, monitoring and electrical systems.

3.03 REMOVE TEMPORARY FACILITIES and controls, and temporary utility services from the project site, along with construction tools, field office, mock-ups and similar elements.

3.04 TOUCH-UP AND REPAIR or restore marred exposed finishes. Deliver spare parts, tools, extra stock of materials and similar physical items.

3.05 SUBMIT FINAL CLOSEOUT SUBMITTALS before instruction of Owner’s personnel, and use the Operations & Owner’s Manuals as the basis for instruction.

3.06 INSTRUCTION OF OWNER'S PERSONNEL: Arrange for each installer of operating equipment and other work that requires regular or continuing maintenance, to meet at the site with the Owner's personnel to provide necessary basic instructions in the proper operation and maintenance of the entire Work. Where installers are not experienced in the required procedures, include instruction by the manufacturer's representatives.

3.07 SUBMIT WRITTEN CERTIFICATION that: (1) the Contract Documents have been reviewed, (2) the Work has been inspected for compliance with the Contract Documents, (3) the Work has been completed in accordance with the Contract Documents, (4) equipment and systems have been tested in the presence of the Owner's representative and are operational, and (5) the Work is completed and ready for final inspection.

3.08 ARCHITECT’S ACTION: Following final inspection, the Architect will either prepare the certificate of final acceptance, or will advise the Contractor of additional Work which must be performed before the certificate will be issued.

3.09 RE-INSPECTION FEES: Should the Architect perform re-inspections (for either Substantial Completion or for Final Completion) due to the failure of the Work to comply with the claims of status of completion made by the Contractor, the Owner will compensate the Architect for such additional services and will deduct the amount of such compensation and the Owner’s direct costs from the final payment to the Contractor.

END OF SECTION 01 77 00

SECTION 01 78 00 – CLOSEOUT SUBMITTALS

PART 1 - PREPARE AND SUBMIT final Closeout Submittals as required within this Section.

1.01 ORGANIZE CLOSEOUT SUBMITTAL INFORMATION into suitable sets of manageable content and size, and identified within the file structure with the title of the subject matter (such as "OPERATION AND MAINTENANCE MANUAL" or "RECORD DRAWINGS" or "WARRANTIES", as applicable), and include the Project name, Project address, the name of the Contractor, and the date prepared/submitted.

1.02 FORMAT OF SUBMITTAL (USB FLASH-DRIVES): Submit two (2) sets of Electronic Media Formatted (EMF) closeout documents before Final Completion, with document contents prepared typically in PDF format. Provide each set of Closeout Documents on a single, USB type flash-drive of sufficient capacity to contain all files on a single EMF device. Attach a concise, clearly printed label or tag to the drive to identify its contents.

1.03 CLOSEOUT SUBMITTALS

A. CONTRACT CLOSEOUT DOCUMENTS: Submit the following:

(1) FINAL OCCUPANCY PERMIT, and other legal releases necessary for the Owner' complete and unrestricted use.
(2) FINAL LISTING of all sub-contractors and material suppliers, with their products as used on the project.
(3) UPDATED FINAL STATEMENT accounting for additional changes (additions and deductions) to the Contract Sum. Identify amounts for change orders, liquidated damages (addition or deduction), deductions for uncorrected work, deductions for re-inspection payments, and previous payments.
(4) THE FINAL PAYMENT REQUEST with final unconditional lien releases from all sub-contractors and material suppliers, and other supporting documentation not previously submitted or accepted.
(5) LIEN WAIVERS indicating that lien rights are "unconditionally released" for all amounts previously paid by the Owner to the contractor, and "conditionally released" or contingent only upon receipt and bank clearance of the final payment amount yet due to the Contractor.

(a) PROVIDE LIEN WAIVERS FROM the Contractor, all subcontractors, sub-subcontractors, suppliers and any other entities lawfully entitled to file a lien more than One Thousand Dollars ($1,000.00) arising out of the Work of the Construction Contract. The Owner reserves the right to designate which entities involved in the Work must submit waivers.
(b) FORM OF WAIVER: Submit lien waivers on the 1990 Edition of the "Waiver and Release of Lien" form by the Construction Industry Affairs Council of Greater Kansas City Inc (CIAC) or other form provided or approved by the Owner, fully executed in a manner acceptable to Owner.

(6) FINAL, COMPLETED PUNCH-LIST(s) with the Contractor's signed statement indicating that all items have been completed or otherwise resolved for acceptance.
(7) EVIDENCE OF CONTINUING INSURANCE COVERAGE complying with requirement of the Contract Documents, including certificates of on-going insurance for products and completed operations coverage.
(8) RECORD DRAWINGS: Maintain and submit one (1) set of blue- or black-line white "prints" of the Contract Drawings and Shop Drawings.

(a) IDENTIFY AND DATE each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
(b) DO NOT USE PROJECT RECORD DRAWINGS for construction purposes. Protect Project Record Drawings from deterioration and loss. Provide access to Project Record Drawings for Architect's reference during normal working hours.
(c) MARK RECORD DRAWINGS to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Drawings. Give particular attention to information on concealed elements that cannot be readily identified and recorded later. Accurately record information in an understandable drawing technique. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Record Drawings.

(i) MARK WITH ERASABLE, RED-COLORED PENCIL. Use other colors to distinguish between changes for different categories of the Work at the same location.
(ii) MARK IMPORTANT ADDITIONAL INFORMATION that was either shown schematically or omitted from original Drawings.
(iii) NOTE CONTRACT MODIFICATION REFERENCES, including Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.

(d) RECORD SPECIFICATIONS: Submit one (1) copy of the Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

(i) MARK COPY with the proprietary name and model number of products, materials, and equipment actually furnished, including substitutions and product options selected.
(ii) NOTE related Change Orders, Record Drawings, and Product Data, where applicable.

(9) RECORD PRODUCT DATA:

(a) SUBMIT ONE (1) COPY of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.

(b) INCLUDE SIGNIFICANT CHANGES in the product delivered to Project site and changes in manufacturer's written instructions for installation.
(c) NOTE related Change Orders, Record Drawings, and Record Specifications, where applicable.

(10) MISCELLANEOUS RECORD SUBMITTALS:

(a) ASSEMBLE MISCELLANEOUS RECORDS required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
(b) SUBMIT OTHER MARKED-UP RECORD DOCUMENTS (whether prepared by the GC or by the Owner's direct suppliers), Operations and Maintenance manuals, damage or settlement survey, extra copies of drawings and specifications, and similar final record information. Provide one-set of half-size drawings at the Project Site for the Owner's use.

(11) ELECTRONIC PROJECT RECORD DOCUMENTS: Immediately before the Architect's inspection for Substantial Completion, review the marked-up Record Documents with the Architect. When authorized, scan paper originals of the reviewed Record Drawings, Record Specifications, Record Product Data and miscellaneous Record Submittals to PDF files for the Owner's record and future use.

1.04 OPERATION AND MAINTENANCE (O&M) MANUALS

A. ASSEMBLE A COMPLETE SET of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:

(1) OPERATION DATA:

(a) Emergency instructions and procedures.
(b) System, subsystem, and equipment descriptions, including operating standards.
(c) Operating procedures, including startup, shutdown, seasonal, and weekend operations.
(d) Description of controls and sequence of operations.
(e) Piping diagrams.

(2) MAINTENANCE DATA:

(a) Manufacturer's information, including list of spare parts.
(b) Name, address, and telephone number of Installer or supplier.
(c) Maintenance procedures.
(d) Maintenance and service schedules for preventive and routine maintenance.
(e) Maintenance record forms.
(f) Sources of spare parts and maintenance materials.
(g) Copies of maintenance service agreements.
(h) Copies of warranties and bonds.

1.05 WARRANTIES

A. SUBMITTAL TIME: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
B. PARTIAL OCCUPANCY: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
C. ORGANIZE WARRANTY DOCUMENTS into an orderly sequence based on the Table of Contents of the Project Manual.
D. PROVIDE COPIES OF EACH WARRANTY within applicable sections of the Operation and Maintenance Manuals.

END OF SECTION 01 78 00

SECTION 01 79 00 – MINIMUM OWNER TRAINING REQUIREMENTS

PART 1 - GENERAL

A. SUMMARY

(1) This section is intended to clearly define the requirements for Owner Training. If other sections within the contract documents contain owner training requirements, the most stringent requirements shall supersede.
(2) The term “Owner Training” shall encompass both “demonstration” and “training” as outlined in this specification section and throughout the project.
(3) The Commissioning Agent will be responsible for reviewing and approving all Owner Training for commissioned systems. Non-commissioned systems will be reviewed and approved by the Architect/Engineer.

B. RELATED DOCUMENTS

(1) Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
(2) Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

C. GENERAL

(1) The GC/CM shall coordinate the Owner Training. Owner Training shall be completed according the requirements outlined within this and other specification sections within the contract documents.

D. APPLICABLE EQUIPMENT AND SYSTEMS

(1) At a minimum, Contractor shall provide training on all systems including, but not limited to, the following (as applicable to the Project):

(a) Architectural Finishes
(b) Heating, Ventilating and Air Conditioning equipment; including both air and water side equipment
(c) Building Automation System
(d) Electrical System; including Normal and Emergency Power service and distribution equipment as well as interior and exterior lighting and associated controls
(e) Pluming System; including Booster Pumps, Water Heaters, Circulation Pumps, Water Treatment, Natural Gas, Fuel Oil etc.
(f) Life Safety Systems; including Fire Alarm, Voice Annunciation, Fire Suppression, Smoke Control/Evacuation, Stairwell Pressurization, Controls Systems, etc.
(g) Low Voltage Systems; including Wired and Wireless Networks, Nurse Call, Public Address, Audio and Visual Equipment, etc.
(h) Security Systems; including access control, video monitoring, etc.
(i) Conveyance System; including elevators and escalators
(j) Refrigeration Systems
(k) Medical Systems; including Med Gasses, Vacuum, etc.
(l) Laboratory Systems
(m) Other Systems as Directed by the Owner

E. SUBMITTALS

(1) Training Plan: At least 30 days prior to the start of Owner Training, the GC/CM shall provide the training plan to the Architect, Owner and Commissioning Agent for review and approval. The GC/CM shall revise and resubmit until acceptable. The Training Plan shall include the following at a minimum:

(a) Overall schedule showing all Owner Training sessions.
(b) Include at least the following for each training session:
(c) Identification, date, time, and duration.
(d) Description of products and/or systems to be covered.
(e) List of all subjects to be covered. See training session requirements located in section 3.2.
(f) Name of firm and person conducting training; include qualifications.
(g) Intended audience, such as job description.
(h) Objectives of training and suggested methods of ensuring adequate training.
(i) Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
(j) Media to be used, such as slides, hand-outs, etc.
(k) Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
(l) Sample attendance record.
(m) Sample Owner Training Evaluation Forms. Custom forms shall be created for each equipment system to ensure key learning objectives have been achieved.

(2) Training Manuals: The GC/CM shall provide a training manual for each attendee; allow for minimum of two (2) attendees per training session.

(a) Include applicable portion of O&M manuals.
(b) Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
(c) Provide one (1) extra copy of each training manual to be included with operation and maintenance data.

(3) Scheduling – The GC/CM shall coordinate with the Architect, Engineer, Owner and Commissioning Agent on the date(s) of Owner Training and shall provide at least 14 days’ notice prior to training.

(4) Training Reports:

(a) Identification of each training session, date, time, and duration.
(b) Sign-in sheet showing names and job titles of attendees.
(c) List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.
(d) Completed Owner Training Evaluation Forms.

(5) Video Recordings: Submit digital video recording of all Owner Training for Owner's subsequent use.

(a) Format: DVD Disc and Electronic Format.
(b) Label each disc and container with session identification and date.
(c) Training video shall be broken up, edited, and labeled for each piece of equipment and/or training session.
(d) Electronic Copies shall be included in the Close-Out documentation.

F. QUALITY ASSURANCE

(1) Instructor Qualifications: Factory authorized and trained individual who is familiar with the design, operation, maintenance and troubleshooting of the relevant products and systems.

(a) Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
(b) Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 - PRODUCTS – NOT USED

2.01

PART 3 - EXECUTION

A. DEMONSTRATION - GENERAL

(1) Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner and Commissioning Agent and satisfy all other requirements of this specification.
(2) Demonstrations conducted during Functional Performance Testing need not be repeated unless Owner personnel require additional information.
(3) Demonstration may be combined with training sessions if applicable.
(4) Dynamic Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.

(a) Perform demonstrations not less than two (2) weeks prior to Substantial Completion.
(b) For equipment or systems requiring seasonal operation, perform demonstration for other season within six (6) months.

(5) Static Equipment or Systems: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.

(a) Perform demonstrations not less than two (2) weeks prior to Substantial Completion.

B. TRAINING - GENERAL

(1) GC/CM will prepare the Training Plan based on draft plans submitted.
(2) Conduct Owner Training on-site unless otherwise indicated.
(3) Owner will provide classroom and seating at no cost to Contractor.
(4) Where applicable, do not start Owner Training until Functional Performance Testing is complete, unless otherwise specified or approved by the Commissioning Authority.
(5) Each training session shall cover the following topics at a minimum:

(a) Basis of Design and Operational Requirements including but not limited to:
(b) General systems and equipment description and function
(c) Performance and design criteria
(d) Operational parameters including setpoints, schedules, etc.
(e) Limiting conditions including safeties, interlocks, alarms, etc.
(f) Location of all control devices including sensors, actuators, controllers, etc.
(g) Review of project documents including but not limited to:
(h) Location of turnover documents within the facility
(i) Location of equipment and systems within facility
(j) As-Built project record drawings
(k) O&M Manuals
(l) Recommended maintenance forms and checklists
(m) Troubleshooting guides and decision trees
(n) Warranty information and maintenance agreements
(o) Normal Operation
(p) Startup process and procedures
(q) Normal shutdown process and procedures
(r) Normal operating instructions
(s) As-built control sequences for all modes of operation
(t) As-built setpoints and schedules

(u) Safety procedures
(v) Seasonal, weekend and holiday operating instructions
(w) Emergency Operation
(x) Explanation of warnings, alarms, trouble indicators and error messages
(y) Emergency shutdown process and procedures
(z) Non-normal operation instructions for operating outside normal limits, including failure of components, sensors or subsystems
(aa) Safety procedures
(bb) Maintenance and Adjustments
(cc) Alignments and adjustments
(dd) Noise and vibration
(ee) Routine cleaning and inspections, including frequency, materials and tools required
(ff) Preventative maintenance activities and frequency, including checklists, materials and tools required
(gg) Troubleshooting and Repairs
(hh) Identification and diagnostic instructions
(ii) Test and inspection procedures
(jj) Disassembly instructions, including removal and replacement
(kk) Repair instructions
(ll) Identification of parts and components
(mm) Review of attic stock and recommended spare parts

C. MINIMUM TRAINING HOURS

(1) The total minimum owner training hours required for each system/equipment are identified below. If the contractor believes hours are insufficient, additional time shall be included in the project to ensure sufficient understanding of all operation and maintenance requirements of equipment and systems. Reference all specifications and minimum training hours is whatever is the most stringent in the specifications.

EQUIPMENT/SYSTEM TYPE	SPECIFICATION SECTION	MINIMUM TRAINING HOURS
GENERAL SYSTEMS		
Membrane Roofing System	07 5000	1
Sheet Metal Roofing	07 6100	1
Coiling Doors	08 3300	1
Accordian Folding Fire Doors	08 3513.23	2
Ceiling Assemblies	09 5100, 09 5400, 09 5426, 09 5453	2
EQUIPMENT		
Commercial Laundry Equipment	11 1100	2
Commercial Equipment	11 2000	2
Suspended Maintenance and Fall Protection Equipment	11 2400	1
Laboratory Equipment	11 5300	4
Laboratory Fume Hoods	11 5313	4
Biological Safety Cabinets	11 6531	4
SPECIAL CONSTRUCTION		
Environmental Rooms	13 0380	2
MRI Radiofrequency Enclosure	13 0950	2
CONVEYING SYSTEMS		
Traction Service Elevators	14 2113	1
Traction Passenger Elevators	14 2123	1
MECHANICAL		
Motors	20 0513	2
Variable Frequency Drive (VFD) System	20 0514	2
FIRE SUPPRESSION		
Standpipe System	21 1200	2
Automatic Fire Sprinkler System	21 1314	2

PLUMBING		
Domestic Water System Balance	22 0594	1
Water Distribution System	22 1118	2
Sanitary Waste and Storm Drainage Systems	22 1314	2
Plumbing Specialties	22 2114	3
Water Heating Equipment	22 3314	4
Plumbing Fixtures and Controls	22 4000	4
Laboratory Compressed Air System	22 6114	4
Laboratory Vacuum Piping System	22 6214	4
Nitrogen, Carbon Dioxide and Special Gas Piping Systems	22 6314	3
HVAC		
Controls System Integration	23 0901	20
Control Instrumentation	23 0903	10
Direct Digital Controllers and Networks	23 0923	10
Pumps	23 2123	3
Chemical Treatment Systems	23 2514	2
Fans	23 3400	2
Air Terminal Devices	23 3600	8
Laboratory Temperature and Airflow Control System	23 3614	8
Filters	23 4114	4
Primary Cooling Equipment	23 6000	8
Heat Recovery Equipment	23 7114	6
Factory Fabricated Custom Air Handling Units	23 7328	10
Heating and Cooling Terminal Units	23 7328	6
Coils	23 8216	2
Humidification Equipment	23 8413	6
ELECTRICAL		
Power Distribution Acceptance Tests and Test Tables	260812 26 0813	2
Network Lighting Controls	26 0943	6
Pad Mounted, Liquid-Filled, Medium-Voltage Transformers	26 1219	4
Low-Voltage Transformers	26 2200	4
Low-Voltage Switchgear	26 2200	4
Switchboards	26 2300	4
Lighting and Appliance Panelboards	26 2416.13	2
Distribution Panelboards	26 2416.16	2
Electrical Metering	26 2713	4
Photovoltaic Electrical Generating System	26 3110	4
Engine Generators	26 3213	6
Uninterruptible Power Supply With Battery Storage	26 3353	4
Automatic Transfer Switches	26 3623	2
Lightning Protection For Structures	26 4113	1
Surge Protective Devices	26 4300	1
Lighting	26 5000	4
COMMUNICATIONS		
Two-Way Communication System	27 5129	1
Audio Visual System	27 4100	2

Emergency Responder Radio Reinforcement System	27 5319	1
ELECTRONIC SAFETY AND SECURITY		
Electronic Access Control	28 1000	4
Video Surveillance	28 2000	4
Fire Dection and Alarm Systems	28 3113	8
LANDSCAPE		
Landscape Irrigation	TBD	2
Plants	32 9300	1
UTILITIES		
Distribution, Service, and Isolation	33 0000	4

D. SCHEDULING

(1) Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
(2) No single training session may last more than 90 minutes without a minimum of a 15-minute break between sessions.
(3) No more than seven (7) hours of training may be completed in a single day.
(4) Total training hours identified above are intended to be utilized throughout the one-year warranty period as outlined below. Contractor shall plan training time according to enable onsite support at a minimum of each point:

(a) Initial owner training at turnover.
(b) Three to six (3-6) months after turnover or at first major preventative maintenance cycle to answer questions and re-train on specific items as necessary.
(c) Participate at the 10-month warranty review or prior to completion of the 1-year warranty to answer any remaining questions and ensure sufficient knowledge on operation of equipment.

E. VIDEO RECORDING

(1) Video recording of all Owner Training shall comply with the following requirements:

(a) Video recording shall be done on a device specifically intended for this purpose. Tripods or other stabilizing devices shall be used to ensure a stable, high quality video.
(b) Remote microphones shall be utilized to ensure high quality audio and understanding of trainer.
(c) Ensure sufficient lighting is provided to observe instructor and all components being trained on.

(2) Any of the following will result in rejection of the training video and require re-training at no additional cost to the owner or count against the minimum hours listed above:

(a) Use of cellular phones or tablets for recording device.
(b) Use of video cameras without tripods or other stabilizing devices.
(c) Poor audio quality due to not using remote microphones or excessive ambient noise.
(d) Poor lighting resulting in inability to clearly see equipment or components.

F. TRAINING ACCEPTANCE

(1) The Commissioning Agent and/or Architect will review all Owner Training with the Owner’s operating personnel and determine if training provided was satisfactory. If training is determined to be insufficient to ensure proper operation and maintenance, additional training will be provided by the contractor a no cost to the owner.
(2) Training will not be deemed acceptable until the following have been completed:

(a) Training plan has been approved.
(b) All required turnover documents have been received (O&M Manuals, As-Builts, etc.)
(c) Training manuals have been approved.
(d) Training reports have been approved.
(e) Video Recordings have been approved.
(f) Owner competence has been confirmed.

END OF SECTION 01 79 00

SECTION 01 81 13 – LEED CERTIFICATION REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. ENVIRONMENTAL CONSIDERATIONS: This project is designed and constructed with practices and procedures to meet the project's environmental considerations and goals. These considerations and goals are to establish a facility which is environmentally responsible, profitable, and a healthy place to live and work. To guide this process, this project is pursuing LEED certification per the v4 USGBC Green Building Design and Construction Reference Guide for New Construction. Compliance with all credits and prerequisites shown in the checklist attached to section 01 81 81 is required. All team members will be required to perform some amount of associated documentation. Refer to Sections listed below for environmental considerations and goals, and applicable paragraphs of this specification section. The Contractor shall ensure that the requirements related to these considerations and goals, as defined in the Contract Documents, are implemented to the fullest extent.

B. The Design Professionals have selected materials and utilized integrated design processes that achieve the Owners objectives. Contractor is responsible to maintain and support these objectives in developing means and methods for performing work and in proposing product substitutions or changes to specified processes. By submitting a change or substitution of materials or processes, contractor must demonstrate its diligence in performing the level of investigation and comparison required to achieve required credits under the USGBC LEED Rating system.

C. This project is pursuing certification through a Third-Party Certification program. Provide construction related sustainability documentation to verify achievement of LEED V4 Certification. Provide documentation for the following LEED Credits and as detailed and required throughout the specifications. Contractor is responsible for all costs associated with constructing and demonstrating that project complies with approved Third-Party Certification requirements, including but not limited to:

(1) TPC coordination with client and other consultants, Third Party Certification website requirements, and management for construction related documentation.

(2) It is the intent of the project that this project achieves LEED certification. Entegrity Consulting has been contracted to work with the contractor on coordinating the LEED certification documentation during construction.

(3) Commissioning scope as required for Construction Phase Fundamental and Enhanced Commissioning. Entegrity Consulting has been contracted to provide this service. Contractor will be required to coordinate with Entegrity consulting for Commissioning related items.

(4) Construction work required to incorporate TPC credits and documentation requirements required for the following credits.

(a) Sustainable Sites: Heat Island Reduction
(b) Sustainable Sites: Construction Activity Pollution Prevention
(c) Water Efficiency: Indoor Water Use Reduction prerequisite and credit
(d) Energy and Atmosphere: Fundamental and Enhanced Commissioning
(e) Materials and Resources: Building Product Disclosure and Optimization – Environmental Product Declarations
(f) Materials and Resources: Building Product Disclosure and Optimization - Sourcing of Raw Materials
(g) Materials and Resources: Building Product Disclosure and Optimization – Material Ingredients
(h) Materials and Resources: Construction and Demolition Waste Management Planning and 75% Reduction
(i) Indoor Environmental Quality: Construction Indoor Air Quality Management Plan
(j) Indoor Environmental Quality: Low-Emitting Materials
(k) Indoor Environmental Quality: Indoor Air Quality Assessment (IAQ Testing)

1.02 RELATED WORK

A. Section 01 50 00 TEMPORARY FACILITIES AND CONTROLS
B. Section 01 74 19 CONSTRUCTION WASTE MANANGEMENT
C. Section 01 81 19 INDOOR AIR QUALITY MANAGEMENT
D. Section 01 81 81 SUSTAINABLE CHECKLIST REQUIREMENTS
E. Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS

1.03 DEFINITIONS

A. Total Materials Cost: A tally of actual material cost from specification divisions 03 through 10, 31 (applicable to foundations) and 32 (applicable to paving, site improvements, and planting). Alternatively, 45 percent of total construction hard costs in those specification divisions.

B. Recycled Content: Recycled content of materials is defined according to Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260). Recycled content value of a material assembly is determined by weight. Recycled fraction of assembly is multiplied by cost of assembly to determine recycled content value.

(1) "Post-Consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.

(2) "Pre-Consumer" material is defined as material diverted from waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

C. Low Pollutant-Emitting Materials: Materials and products which are minimally odorous, irritating, or harmful to comfort and well-being of installers and occupants.
D. Permanently Installed Products: an item that arrives on the project site either as a finished element ready for installation or as a component to another item assembled on–site.
E. Volatile Organic Compounds (VOC): Chemicals that are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects.
F. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates must include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body. The status of chain of custody certification can be verified at http://info.fsc.org/certificate.php.
G. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of project site. If only a fraction of a product or material is extracted or harvested or recovered and manufactured locally, then only that percentage (by weight) must contribute to regional value.
H. Biobased Material: Products which meet the Sustainable Agriculture Network's Sustainable Agriculture Standard. Biobased raw materials other than wood must be tested using ASTM Test Method D6866 and be legally harvested, as defined by the exporting and receiving country. Exclude hide products, such as leather and other animal skin material.
I. Salvaged or reused materials: Construction materials recovered from existing buildings or construction sites and reused. Common salvaged materials include structural beams and post, flooring, doors, cabinetry, brick, and decorative items.
J. Refurbished materials: Products that could have been disposed of as solid waste. These products have completed their life cycle as consumer items and are then refurbished for reuse without substantial alteration of their form. Refurbishing includes renovating, repairing, restoring, or generally improving appearance, performance, quality, functionality, or value of a product.
K. Environmental Product Declaration (EPD): A compliant EPD is a third-party declaration with external verification; is product-specific (not industry-wide); conforms to ISO 14025 and EN 15804 or ISO 21930; and has at least a cradle-to-gate scope.
L. Health Product Declaration (HPD): A compliant HPD provides full disclosure of known hazards and demonstrates chemical inventory of the product to at least 0.1 percent (1000 ppm).
M. Extended producer responsibility (EPR): An environmental policy approach in which a producer's responsibility for a product is extended to the postconsumer stage of the product's lifecycle. An extended producer responsibility policy shifts responsibility (physically and/or economically, fully, or partially) upstream toward the producer and away from municipalities; and creates incentives for producers to consider environmental considerations when designing their products. EPR should help in shifting cost of disposal to the manufacturer, the programs must demonstrate that the manufacturer is responsible for the cost. If EPR involves shipping and handling cost that is acceptable, but EPR cannot enforce project team to purchase more products.
N. Green power: A subset of renewable energy comprised of grid-based electricity produced from renewable energy sources.
O. Carbon offset: A unit of carbon dioxide equivalent that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere.
P. Renewable energy certificates (RECs):
Q. Scope 1 emissions: Direct greenhouse gas emissions from sources owned or controlled by the entity, such as emissions from fossil fuels burned on site.
R. Scope 2 emissions: Indirect greenhouse gas emissions associated with the generation of purchased electricity, heating/cooling, or steam off site, through a utility provider for the entity's consumptions.

1.04 REFERENCE STANDARDS

A. LEED v4 Certification for New Construction
B. Carpet and Rug Institute Green Label Plus program.
C. U.S. Department of Agriculture BioPreferred program (USDA BioPreferred).
D. U.S. Environmental Protection Agency Comprehensive Procurement Guidelines (CPG).
E. U.S. Environmental Protection Agency WaterSense Program (WaterSense).
F. U.S. Environmental Protection Agency ENERGY STAR Program (ENERGY STAR).
G. Forest Stewardship Council Principles and Criteria for Forest Stewardship (FSC STD-01-001).
H. Sustainable Agriculture Network's Sustainable Agriculture Standard.
I. 2012 EPA Construction General Permit.
J. California Department of Public Health Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, version 1.1 or v1.2, Emission Testing method for California Specification 01350 (CDPH Standard Method v1.1-2010* or CDPH Standard Method v1.2-2017).
K. California Air Resources Board (CARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings.
L. ANSI/BIFMA Standard Method M7.1-2011(R2016).
M. ANSI/BIFMA e3-2014e Furniture Sustainability Standard, Sections 7.6.1, 7.6.2, and 7.6.3.
N. South Coast Air Quality Management District (SCAQMD) Rule 1168 October 6, 2017, and SCAQMD Rule 1113 February 5, 2016.
O. Global Reporting Initiative (GRI) Sustainability Report.
P. Organization for Economic Co-operation and Development (OECD) Guidelines for Multinational Enterprises.
Q. Chemical Abstract Service Registration Number (CASRN).
R. Health Product Declaration Open Standard.
S. Cradle to Cradle Certified.

T. REACH Optimization.
U. EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air".
V. Green-e Energy Certified
W. Green-e Climate Certified

1.05 SUBMITTALS

A. All submittals to be provided by contractor to Architect(s) and to include the Product Data Reporting Form attached to section 01 81 13.
B. Sustainability Action Plan:
   (1) Submit documentation as required by this section; provide additional copies of typical submittals required under technical sections when sustainable construction requires copies of record submittals.
   (2) Within 30 days after Preconstruction Meeting provide a narrative plan for complying with requirements stipulated within this section.
   (3) Sustainability Action Plan must:
      (a) Make reference to sustainable construction submittals defined by this section.
      (b) Address all items listed under PERFORMANCE CRITERIA.
      (c) Indicate individual(s) responsible for implementing the plan.
   (4) Provide monthly progress reports of plan criteria.
C. Project Materials Cost Data Spreadsheet: Within 30 days after the Preconstruction Meeting provide a preliminary Project Materials Cost Data Spreadsheet. The Project Materials Cost Data Spreadsheet must be an electronic file and indicate all materials in Divisions 3 through 10, 31, and 32 used for Project (excluding labor costs and excluding all mechanical, electrical, and plumbing system components), and be organized by specification section. Additional materials may be added from mechanical and plumbing specifications sections depending on material qualities. The spreadsheet must include the following:
   (1) Identify each reused or salvaged material, its cost, and its replacement value.
   (2) Identify each recycled-content material, its post-consumer and pre-consumer recycled content as a percentage the product's weight, its cost, its combined recycled content value, defined as the sum of post-consumer recycled content value plus one-half of pre-consumer recycled content value, and total combined recycled content value for all materials as a percentage of total materials costs.
   (3) Identify each biobased material, its source, its cost, and total value of biobased materials as a percentage of total materials costs.
   (4) Total cost for Project and total cost of building materials used for Project.
D. Low Pollutant-Emitting Materials Tracking Spreadsheet: Within 30 days after Preconstruction Meeting provide a preliminary Low Pollutant-Emitting Materials Tracking Spreadsheet. The Low Pollutant-Emitting Materials Tracking Spreadsheet must be an electronic file and include all materials on Project in categories described under Low Pollutant-Emitting Materials in 01 81 13 and additional product performance criteria for Low Pollutant-Emitting Materials as described in Section 01 81 81 SUSTAINABLE CHECKLIST REQUIREMENTS.
E. Construction Indoor Air Quality (IAQ) Management Plan:
   (1) Not more than 30 days after Preconstruction Meeting provide a Construction IAQ Management Plan as an electronic file including descriptions of the following:
      (a) Instruction procedures for meeting or exceeding minimum requirements of ANSI/SMACNA 008-2008, Chapter 3, including procedures for HVAC Protection, Source Control, Pathway Interruption, Housekeeping, and Scheduling.
      (b) Instruction procedures for protecting absorptive materials stored on-site or installed from moisture damage.
      (c) Schedule of submission of photographs of on-site construction IAQ management measures such as protection of ducts and on-site stored oil installed absorptive materials. Photos to be provided from entire construction timeframe.
      (d) Instruction procedures if air handlers must be used during construction, including a description of filtration media to be used at each return air grille.
      (e) Instruction procedure for replacing all air-filtration media immediately prior to occupancy after completion of construction, including a description of filtration media to be used at each air handling or air supply unit, date of start-up and date of filter replacement.
      (f) Instruction procedures and schedule for implementing building flush-out.
      (g) Additional information included in Section 01 81 19 Indoor Air Quality Management.
F. Sustainable Construction Progress Reports: Concurrent with each Application for Payment, submit a Sustainable Construction Progress Report to confirm adherence with Sustainability Action Plan.
   (1) Include narratives of revised strategies for bringing work progress into compliance with plan and product submittal data and calculations to demonstrate compliance with thresholds based on materials costs.
   (2) Include updated and current Project Materials Cost Data Spreadsheet.
   (3) Include updated and current Low Pollutant-Emitting Materials Tracking Spreadsheet.

4. Include construction waste tracking, in tons or cubic yards, including waste description, whether diverted or landfilled, hauler, and percent diverted for comingled quantities; and excluding land-clearing debris and soil. Provide haul receipts and documentation of diverted percentages for comingled wastes.

1.06 PRODUCT SUBMITTALS

A. Submittals must include LEED Tracking Form for all submittals within divisions 3-10, 31, 32 and Mechanical and Plumbing adhesives and sealants. Additional verification documentation described below must also be supplied.

B. Recycled Content: Submit product data from manufacturer indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content (excluding MEP systems equipment and components). Include submitting for plumbing piping, mechanical ductwork and insulation if recycled content exists.
C. Low Pollutant-Emitting Materials: Submit product data confirming compliance with relevant requirements for all materials showing compliance with performance criteria listed in Part 2 and as described below.
D. Additional Product Submittals to be provided with all manufacturer documentation:
   (1) Life-cycle assessment conforming to ISO 14044 with cradle to gate scope.
   (2) Environmental Product Declaration.
   (3) Evidence of manufacturer participation in an extended producer responsibility program.
   (4) Health Product Declaration.
   (5) Regional Materials: Indicate location and distance from project site of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and fraction by weight that is considered regional.
   (6) Biobased Materials: Include statement indicating cost of each relevant product and fraction by weight that is considered biobased material. Submittals for products to be installed or used included on the USDA BioPreferred program's product category lists. Data to include biobased content percentage and source of biobased material; indicating name of manufacturer and cost of each material as described above.
   (7) Provide chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each product with certified wood and fraction by weight that is certified wood.
   (8) For paints and coatings applied on site within the weatherproofing membrane provide documentation of compliance with low-emitting materials requirements:
      (a) Third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area.
      (b) Third-party certification in compliance with the California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017 must also state range of total VOCs after 14 days (336 hours), measured as specified in the CDPH Standard Manual v1.1 or v2.1: 0.5 mg/cubic meter or less; between 0.5 and 5.0 mg/cubic meter; or 5.0 mg/cubic meter or more. **Certificates must be dated less than 3 years of construction start date.**
      (c) VOC content for each product in grams per liter (g/L). VOC content from the manufacturer should demonstrate that the products has been tested following the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC).
   (9) For adhesives and sealants applied on site within the weatherproofing membrane provide documentation of compliance with low-emitting material requirements:
      (a) Third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area.
      (b) Third-party certification in compliance with the California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017 must also state the range of total VOCs after 14 days (336 hours), measured as specified in the CDPH Standard Manual v1.1 or v2.1: 0.5 mg/cubic meter or less; between 0.5 and 5.0 mg/cubic meter; or 5.0 mg/cubic meter or more. **Certificates must be dated less than 3 years of construction start date.**
      (c) VOC content for each product in grams per liter (g/L). VOC content from the manufacturer should demonstrate that the products has been tested following the SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264).
   (10) For flooring installed on site within the weatherproofing membrane provide documentation of compliance with low-emitting material requirements:
      (a) Third-party certification in compliance with the California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017 which states the exposure scenario used to determine compliance. **Certificates must be dated less than 3 years of construction start date.**
   (11) Composite wood products: Provide third-party certificate confirming products meet one of the following requirements: EPA TSCA Title VI for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins, California Air Resources Board (CARB) ATCM for formaldehyde requirements for ultra-low emitting formaldehyde (ULEF) resins, EPA TSCA Title VI formaldehyde requirements for no added formaldehyde resins (NAF), or CARB ATCM formaldehyde requirements for no added formaldehyde resin (NAF). Note manufacturer's claims for meeting above-mentioned requirements do not meet LEED standards.
   (12) Ceiling, wall, thermal and acoustic insulation products:
      (a) Third-party certification of compliance with the California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017 which states the exposure scenario used to determine compliance. **Certificates must be dated less than 3 years of construction start date.**

1.07 CLOSEOUT SUBMITTALS

A. Within 14 days after Substantial Completion provide the following:
   (1) Final version of Project Material Cost Data Spreadsheet.
   (2) Final version of Low Pollutant-Emitting Materials Tracking Spreadsheet.
   (3) Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for filtration media installed at return air grilles during construction if permanently installed air handling units are used during construction.

(4) Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for final filtration media in air handling units.
(5) Minimum 25 construction photographs including six photographs taken on five different occasions during construction of ANSI/SMACNA 008-2008, Chapter 3 approaches employed, along with a brief description of each approach, documenting implementation of IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.
(6) Provide the final completed documentation for the following prerequisites and credits:

(a) Construction activity pollution prevention.
(b) Construction and demolition waste management planning.
(c) Building product disclosure and optimization – environmental product declaration.
(d) Building product disclosure and optimization – sourcing of raw materials.
(e) Building product disclosure and optimization – material ingredients.
(f) Construction and demolition waste management.
(g) Low-emitting materials.
(h) Construction indoor air quality management plan.
(i) Indoor air quality assessment (see Section 01 81 19 – Indoor Air Quality Management)

(i) Flush out documentation meeting either the before occupancy or during occupancy LEED required thresholds.

OR

(ii) Indoor Air Quality testing report from third party qualified subcontractor that is compliant with LEED v4.1 requirements.

(7) Final submittals required to demonstrate compliance and provided to client;

(a) Approved LEED checklist
(b) One LEED Certification Certificate
(c) One LEED Certification Sticker.

1.08 QUALITY ASSURANCE

A. Preconstruction Meeting: After award of Contract and prior to commencement of Work, schedule and conduct meeting with Sustainability Consultant to discuss the Project Sustainable Action Plan content as it applies to submittals, project delivery, required Construction Indoor Air Quality (IAQ) Management Plan, and other Sustainable Construction Requirements. The purpose of this meeting is to develop a mutual understanding of the Sustainable Construction Requirements and coordination of contractor's management of these requirements with the Contracting Officer and the Construction Quality Manager.
B. Sub-Contractor Training Meeting: Prior to foundation work schedule a meeting with all applicable sub-contractors, site superintendent and Sustainability Consultant to review expectations of submittals and roles and responsibilities regarding implementation of the Project Sustainable Action Plan.
C. Construction Job Conferences: Status of compliance with Sustainable Construction Requirements of these specifications will be an agenda item at regular job meetings conducted during the course of work at the site.
D. Weekly jobsite meetings: Waste Management, IAQ and Erosion Control shall be included at weekly jobsite meetings with site superintendent and sub-contractors.
E. Third Party Certification

(1) Bear all costs associated with constructing and demonstrating that project complies with the LEED requirements, including but not limited to:

(a) Coordination with LEED consultant and associated documentation.
(b) Complying with Sustainable Checklist Requirements per 01 81 81.
(c) Construction work required to incorporate LEED requirements including but not limited to;

(i) Enhanced Commissioning Construction Services
(ii) Indoor Air Quality Testing or Building Flush Out

(d) Submittals required to demonstrate compliance with LEED checklists.

1.09 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
B. South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, February 5, 2016.
C. South Coast Air Quality Management District (SCAQMD) Rule 1168, October 6, 2017.
D. Sheet Metal and Air Conditioning National Contractors' Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition (ANSI/SMACNA 008-2008), Chapter 3.
E. California Department of Public Health Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, version 1.1 or v1.2, Emission Testing method for California Specification 01350 (CDPH Standard Method V1.1-2010 or CDPH Standard Method v1.2-2017).
F. Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260).
G. ASHRAE Standard 52-2010.

PART 2 - PRODUCTS

2.01 PERFORMANCE CRITERIA

A. Construction waste diversion from landfill disposal must comprise at least **50 percent** of total construction waste, excluding land clearing debris and soil. Alternative daily cover (ADC) does not qualify as material diverted from disposal.

B. Low Pollutant-Emitting Materials:
   1. Liquid Applied Products must be 75% percent by volume of interior paints and coatings and adhesives and sealants must be compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. 100% of liquid/wet applied product must meet the VOC content requirements. **Certificates must be dated less than 3 years of construction start date.**
   2. Adhesives, sealants, and sealant primers applied on site within the weatherproofing membrane must comply with VOC limits of SCAQMD Rule 1168:
      a. Adhesives for Architectural Applications:
         1) Building envelope membrane adhesive: 250 g/L.
         2) Carpet pad adhesives: 50 g/L
         3) Ceramic glass, porcelain, & stone tile adhesive: 65 g/L
         4) Cove base adhesives: 50 g/L
         5) Dry wall and panel adhesives: 50 g/L
         6) Multi-purpose construction adhesives: 70 g/L
         7) Roofing- sinlge ply roof membrane adhesive: 250 g/L
         8) Roofing- all other roof adhesives: 250 g/L
         9) Rubber floor adhesives: 60 g/L
         10) Structural glazing adhesives: 100 g/L
         11) Structural wood member adhesive: 140 g/L
         12) Subfloor adhesive: 50 g/L
         13) VCT and asphalt tile adhesives: 50 g/L
         14) Wood flooring adhesive: 100 g/L
         15) All other indoor floor covering adhesives: 50 g/L
         16) All other outdoor floor covering adhesives: 50 g/L
      b. Specialty Applications
         1) Computer diskette manufacturing adhesive: 350 g/L.
         2) Contact adhesive: 80 g/L
         3) Edge glue adhesive: 250 g/L
         4) ABS welding cement: 325 g/L
         5) ABS to PVC transition cement: 510 g/L
         6) CPVC welding cement: 490 g/L
         7) PVC welding cement: 510 g/L
         8) All other plastic cement welding cements: 100 g/L
         9) Rubber Vulcanization Adhesive: 250 g/L
         10) Special purpose contact adhesive: 250 g/L
         11) Thin metal laminating adhesive: 780 g/L
         12) Tire tread adhesive: 100 g/L
         13) Top and trim adhesive: 250 g/L
         14) Waterproof resorcinol glue: 170 g/L
         15) All other adhesives: 250 g/L
      c. Substrate Specific Applications
         1) Metal substrate-specific adhesives: 30 g/L
         2) Plastic foam substrate-specific adhesives: 50 g/L
         3) Porous material (except wood) substrate-specific adhesives: 50 g/L
         4) Wood substrate-specific adhesives: 30 g/L
         5) Fiberglass substrate-specific adhesives: 80 g/L
         6) Reinforced plastic composite substrate-specific adhesives: 200 g/L
      d. Sealants for Architectural Applications
         1) Clear, paintable, and immediately water-resistant sealant:250 g/L
         2) Foam insulation: 250 g/L
         3) Grout: 250 g/L
         4) Roadway sealant: 250 g/L
         5) Non-staining plumbing putty: 250 g/L
         6) Potable water sealant: 250 g/L
         7) Roofing - single ply roof membrane sealant: 450 g/L
         8) Roofing - all other roof sealants: 300 g/L
         9) All other architectural sealants: 50 g/L
         10) Marine deck sealant: 760 g/L
         11) All other sealants: 420 g/L
      e. Adhesive Primers
         1) Plastic adhesive primers: 550 g/L
         2) Pressure sensitive adhesive primers: 250 g/L
         3) Traffic marking tape adhesive primers: 150 g/L
         4) Vehicle glass adhesive primers: 250 g/L
         5) All other adhesive primers: 250 g/L
      f. Sealant Primers
         1) Architectural non-porous sealant primer: 250 g/L
         2) Architectural porous sealant primer: 775 g/L
         3) Modified bituminous sealant primer: 500 g/L
         4) Marine deck sealant primer: 760 g/L

5) All other sealant primers: 750 g/L

g. Other adhesives, adhesive bonding primers, adhesive primers, or any other primers: 250 g/L.

3. Aerosol adhesives must not be applied on site within the weatherproofing membrane.
4. Paints and coatings applied on site within the weatherproofing membrane must comply with the following criteria:
   a. Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs applied to interior elements must not exceed VOC content limits established in SCAQMD Rule 1113.
   b. Comply with the following VOC content limits:
      1) Bond breakers: 350 g/L.
      2) Colorant - Architectural coatings, excluding IM coatings: 50 g/L
      3) Colorant - Solvent-based IM: 600 g/L.
      4) Colorant - Waterborne IM: 50 g/L.
      5) Concrete - Curing compounds: 100 g/L
      6) Concrete - Curing compounds for roadways and bridges: 350 g/L
      7) Concrete surface retarder: 50 g/L
      8) Driveway sealer: 50 g/L
      9) Dry-fog coatings: 50 g/L
      10) Faux finishing coatings - Clear topcoat: 100 g/L
      11) Faux finishing coatings - Decorative coatings 350 g/L
      12) Faux finishing coatings – Glazes: 350 g/L
      13) Faux finishing coatings – Japan: 350 g/L
      14) Faux finishing coatings - Trowel applied coatings: 50 g/L
      15) Fire-proofing coatings: 150 g/L
      16) Flats: 50 g/L
      17) Floor coatings: 50 g/L
      18) Form release compound: 100 g/L
      19) Graphic arts (sign) coatings: 200 g/L
      20) Industrial maintenance coatings: 100 g/L
      21) Industrial maintenance coatings - color indicating safety coatings: 480 g/L
      22) Industrial maintenance coatings - High temperature IM coatings: 420 g/L
      23) Industrial maintenance coatings - Non-sacrificial anti-graffiti coatings: 100 g/L
      24) Industrial maintenance coatings - Zinc-rich IM primers: 100 g/L
      25) Magnesite cement coatings: 450 g/L
      26) Mastic coatings: 100 g/L
      27) Metallic pigmented coatings: 150 g/L
      28) Multi-Color coatings: 250 g/L
      29) Non-flat coatings: 50 g/L
      30) Pre-treatment wash primers: 420 g/L
      31) Primers, sealers, and undercoaters: 100 g/L
      32) Reactive penetrating sealers: 350 g/L
      33) Recycled coatings: 250 g/L
      34) Roof coatings: 50 g/L
      35) Roof coatings, aluminum: 100 g/L
      36) Roof primers, bituminous: 350 g/L
      37) Rust preventative coatings: 100 g/L
      38) Sacrificial anti-graffiti coatings: 50 g/L
      39) Shellac – Clear: 730 g/L
      40) Shellac – Pigmented: 550 g/L
      41) Specialty primers: 100 g/L
      42) Stains: 100 g/L
      43) Stains, interior: 250 g/L
      44) Stone consolidants: 450 g/L
      45) Swimming pool coatings – Repair: 340 g/L
      46) Swimming pool coatings – Other: 340 g/L
      47) Tile and stone sealers: 100 g/L
      48) Traffic coatings: 100 g/L
      49) Tub and tile refinish coatings: 420 g/L
      50) Waterproofing sealers: 100 g/L
      51) Waterproofing concrete/masonry sealers: 100 g/L
      52) Wood coatings – varnish: 275 g/L
      53) Wood coatings - sanding sealers: 275 g/L
      54) Wood coatings – lacquer: 275 g/L
      55) Wood conditioners: 100 g/L
      56) Wood preservatives: 350 g/L
      57) Low solids coatings: 120 g/L
5. Carpet installed in building interior must comply with one of the following:
   a. Meet testing and product requirements of the Carpet and Rug Institute Green Label Plus program.
   b. Maximum VOC concentrations specified in CDPH Standard Method V1.1-2010 or CDPH Standard Method v1.2-2017, using office scenario at the 14-day time point.

6. Each non-carpet flooring element installed in building interior which is not inherently non-emitting (stone, ceramic, powder-coated metals, plated or anodized metal, glass, concrete, clay brick, and unfinished or untreated solid wood flooring) must comply with one of the following:
   a. Meet requirements of the FloorScore standard as shown with testing by an independent third-party.
   b. Maximum VOC concentrations specified in CDPH Standard Method V1.1-2010 or CDPH Standard Method v1.2-2017, using office scenario at 14-day time point.
7. Composite wood products within the weatherproofing membrane must be documented to have low formaldehyde emissions, and a third-party certificate confirming products meet one of the following requirements: EPA TSCA Title VI for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins, California Air Resources Board (CARB) ATCM for formaldehyde requirements for ultra-low emitting formaldehyde (ULEF) resins, EPA TSCA Title VI formaldehyde requirements for no added formaldehyde resins (NAF), or CARB ATCM formaldehyde requirements for no added formaldehyde resin (NAF) must be provided.
8. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies must not contain added urea-formaldehyde.

C. Recycled and Regional Content:
1. Provide recycled content (post-consumer and pre-consumer content) and regional content (manufactured and extraction locations) for all products installed on the project and at minimum the following products and as listed elsewhere in the specifications.
   a. Building insulation.
   b. Cement and concrete.
   c. Masonry
   d. Consolidated and reprocessed latex paint.
   e. Flooring
   f. Flowable fill.
   g. Laminated paperboard.
   h. Nonpressure pipe.
   i. Hardscape pavers
   j. Roofing materials.
   k. Shower and restroom dividers/partitions.
   l. Structural fiberboard.
   m. Lawn and garden edging.
   n. Plastic lumber landscaping timbers and posts.
   o. Site furnishings
   p. Site Fencing
   q. Bike racks.
2. Provide building materials with recycled content such that post-consumer recycled content value plus half the pre-consumer recycled content value constitutes a minimum of 25 percent of cost of materials used for Project, exclusive of mechanical, electrical, and plumbing components, specialty items such as elevators, and labor and delivery costs.

D. Biobased Content:
1. Materials and equipment being installed or used that are listed on the USDA BioPreferred program product category list must provide documentation showing compliance with ASTM Test Method D6866 and be legally harvested.
   a. USDA BioPreferred program categories include:
      1) Adhesive and Mastic Removers.
      2) Carpets.
      3) Composite Panels.
      4) Erosion Control Materials.
      5) Floor Coverings (Non-Carpet).
      6) Mulch and Compost Materials.
      7) Multipurpose Cleaners.
      8) Multipurpose Lubricants.
      9) Packaging Films.
      10) Paint Removers.
      11) Batt and Roll Insulation.
      12) Pipe and Duct Insulation.
      13) Plastic Insulating Foam.
      14) Roof Coatings.
      15) Wood and Concrete Sealers.
      16) Wood and Concrete Stains.

E. Materials, products, and equipment being installed which fall into a category covered by the WaterSense program (toilets, urinals, lavatory faucets and showerheads) must be WaterSense-labeled, unless disallowed for infection control reasons.

F. At least 20 permanently installed products from at least 5 different manufacturers must have one of the following:
1. Publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that has at least a cradle to gate scope. For credit calculation purposes, this is valued at one whole of a product.
2. Environmental Product Declarations (EPD):
   a. Product-Specific Type III EPD – Internally Reviewed: Products with an internally critically reviewed LCA in accordance with ISO 14071. Products with product-specific internal EPDs which conform to ISO 14025, and EN 15804 or ISO 21930 and have at least a cradle to gate scope are valued as one whole product for the purposes of credit achievement calculation.
   b. Industry-wide (generic) EPD – Products with third-party certification (Type III), including external verification in which the manufacturer is explicitly recognized as a participant by the program operator. Products with industry-

wide EPDs, which conform to ISO 14025, and EN 15804 or ISO 21930 and have at least a cradle to gate scope are valued as one whole product for the purposes of credit achievement calculation.

c. Product-specific Type III EPD – EPD's which conform to ISO 14025 and EN 15804 or ISO 21930 and have at least a cradle to gate scope. Products with such EPD's having third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as the participant by the program operator are valued as 1.5 products for the purposes of credit achievement calculation. [OR]

G. Products that comply with one of the criteria below contributes for Embodied Carbon/LCA Optimization:
   1. Third party certified products that demonstrate impact reduction below industry average in at least three of the following categories:
      - Embodied Carbon/LCA Optimization.
      - Reductions in Embodied Carbon: less than 10% reduction in Global Warming Potential (GWP) relative to baseline.
      - Reductions in Embodied Carbon: 10%+ reduction in GWP relative to baseline
      - Reductions in Embodied Carbon: 20% + reduction in GWP and 5% + reduction in tow additional impact categories, relative to baseline.

H. For Credit achievement calculation, these products are valued at 100 percent of their cost for credit achievement calculations. Products sourced (extracted, manufactured, purchased) within 100 miles (160 km) of project site are valued at 200 percent of their base contributing cost.

I. Products that meet at least one of the responsible extraction criteria below account for at least 15 percent by cost of total value of permanently installed products:
   1. Responsible extraction criteria:
      a. Extended producer responsibility. Products purchased from a manufacturer (producer) that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility. Products meeting extended producer responsibility criteria are valued at 50 percent of their cost for the purposes of credit achievement calculation.
      b. Biobased materials. Biobased products must meet the Sustainable Agriculture Network's Sustainable Agriculture Standard. Biobased raw materials must be tested using ASTM Test Method D6866 and be legally harvested, as defined by the exporting and receiving country. Exclude hide products, such as leather and other animal skin material. Products meeting biobased materials criteria are valued at 100 percent of their cost for the purposes of credit achievement calculation.
      c. Wood products. Wood products must be certified by the Forest Stewardship Council or USGBC-approved equivalent. Products meeting wood products criteria are valued at 100 percent of their cost for the purposes of credit achievement calculation.
      d. Materials reuse. Reuse includes salvaged, refurbished, or reused products. Products meeting materials reuse criteria are valued at 100 percent of their cost for the purposes of credit achievement calculation.
      e. Recycled content. Recycled content is the sum of post-consumer recycled content plus one-half the pre-consumer recycled content, based on cost. Products meeting recycled content criteria are valued at 100 percent of their cost for the purposes of credit achievement calculation.
      f. USGBC approved program. Other USGBC approved programs meeting leadership extraction criteria.
   2. For credit achievement calculation, products sourced (extracted, manufactured, and purchased) within 100 miles (160 km) of project site are valued at 200 percent of their base contributing cost. For credit achievement calculation, the base contributing cost of individual products compliant with multiple responsible extraction criteria is not permitted to exceed 100 percent its total actual cost (before regional multipliers) and double counting of single product components compliant with multiple responsible extraction criteria is not permitted and in no case is a product permitted to contribute more than 200 percent of its total actual cost.

J. At least 20 different permanently installed products from at least five different manufacturers that use any of the following programs to demonstrate the chemical inventory of the product to at least 0.1% (1000 ppm).
   a. ANSI ANSI/BIFMA e3 Furniture Sustainability Standard. The documentation from the assessor or scorecard from BIFMA must demonstrate the product earned at least 3 points under 7.5.1.3 Advanced Level in e3-2014 or 3 points under 7.4.1.3 Advanced Level in e3-2012.
   b. Cradle to Cradle. Product has Material Health Certificate or is Cradle to Cradle Certified™ under standard version 3 or later with a Material Health achievement level at the bronze level or higher.
   c. Declare. The Declare product label must meet the following requirements:
   - Declare labels designated as Red List Free, LBC Red List Free, or Declared.
   - Declare labels designated as LBC Red List Approved or LBC Compliant that demonstrate content inventory to 0.1% (1000 ppm).
   d. Facts – NSF/ANSI 336: Sustainability Assessment for Commercial Furnishings Fabric at any certification level.
   e. Global Green TAG PHD labels issued after January 1, 2020.
   f. Health Product Declaration: The end use product has a published, complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration open Standard.
   g. Living Product Challenge. The included Declare product label must demonstrate content inventory to 0.1% (1000 ppm).
   h. Manufacturer Inventory: The manufacturer has published complete content inventory for the product following these guidelines:
   - A publicly available inventory of all ingredients identified by name and Chemical Abstract Service Registration Number (CASRN) and/or European Community Number (EC Number).
   - Materials defined as trade secret or intellectual property may withhold the name and/or CASRN/EC Number but must disclose ingredient/chemical role, amount and hazard score/class using either:
     - Greenscreen List Translator (LT) score and/or Full GreenScreen Benchmark (BM).

- The Globally Harmonized System of Classification and Labeling of Chemicals rev.6 (2015) (GHS).

i. Product Lens Certification.

Any compliant reports above with third-party verification that includes the verification of content inventory are worth 1.5 products for credit achievement calculations.

K. Use at least 5 permanently installed products sourced from at least different manufacturers. Use the products that have at least one of the following compliant material ingredients optimization report or action plan:
   a. Material Ingredient Screening and Optimization Action Plan
   b. Advanced Inventory & Assessment
   c. Material Ingredient optimization.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Construction Indoor Air Quality Management:

(1) During construction, meet or exceed recommended control measures of ANSI/SMACNA 008-2008, Chapter 3.
(2) Protect stored on-site and installed absorptive materials from moisture damage.
(3) If permanently installed air handlers are used during construction, filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2-1999 (with errata but without addenda). Replace all filtration media immediately prior to occupancy.
(4) Provide construction dust control as needed and documentation of methods chosen for dust control.
(5) Provide Indoor Air Quality Testing as described in 01 81 91.

END OF SECTION 08 81 13

PRODUCT DATA REPORTING FORM for LEED v4 Projects

THIS FORM IS REQUIRED TO BE SUBMITTED *WITH Product Data Submittals*

You must include backup documentation such as *SPECIFIC* Product Data Sheets, Cut Sheets, Product Specific Letter from Manufacturer, etc. DO NOT INCLUDE GENERIC MARKETING MATERIAL

LEED PROJECT NAME: _____
SUBCONTRACTOR: _____
Specification Section: _____ Submittal Number: _____

Project Product Data				*Materials and Resources LEED Credits*										*Low-Emitting Materials LEED Credits*			
														Some Qualifying VOC Standards (More in Note 10): CDPH Standard Method v1.1 or v1.2; FloorScore: Hard Surfaces & Adhesives; Green Label Plus: Carpet, Adhesive, Cushion; UL Greengaurd Gold: When Meeting CDPH Std. v1.1 or v1.2			
	Product	Manufacturer	Product Costs[1] (only exclude install labor) ($)	Product Specific (PS) or Industry Wide (IW) Env. Product Declaration (EPD)[3]?	FSC Certified[7] Wood Products? (%)	Post-Consumer Recycled Content[8] (%)	Pre-Consumer Recycled Content[9] (%)	Extended Producer Responsibility[5] Program Name?	Delclare Label with ingredient disclosure greater than 1000 ppm?	Fully Declared HPD to 1000 ppm Declaration[4] included?	C2C version (2.1.1 or 3.0) Level of Certification	ONLY if product has FSC or recycled content, then fill Regional Data	Extracted, Manufactured, & Purchased within[2] 100 miles?	CDPH Emissions[10] testing compliant?	VOC Content[11] (g/L)	Wet-Applied Products Volume Used (L)	Wood Products are ULEF or NAF[12]?
Ex.	ABC Product	ABC. Inc.	$ XX,XXX	PS / IW	%	%	%	Yes / No	Yes / No	Yes / No	Yes / No		Yes / No	Yes / No	##	##	Yes / No
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	

NOTES / DEFINITIONS:

1. Furnish Costs include all expenses to deliver the material to the project site, including taxes, transport, fabrication and profit. Do not include site labor or installation.

2. Within 100 miles distance is defined as travel by air to the project site, not travel distance by road. http://www.distancefromto.net/

3. Environmental Product Declarations which conform to ISO 14025 and EN 15804 or ISO 21930 and have at least a cradle to gate scope. http://productguide.ulenvironment.com/QuickSearch.aspx

4. The end use product has a published, complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration open Standard. https://www.hpd-collaborative.org/

5. Extended producer responsibility. Products purchased from a manufacturer (producer) that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility. (e.g. Closed Loop or Take Back Program)

7. Wood products must be certified by the Forest Stewardship Council (FSC) and must be provide proof of vendor FSC Chain-of-Custody with this Product Data Submittal. As an alternative option they can also meet SFI Certification with a few additional critiera. Contact your LEED Consultant if you have SFI products. http://info.fsc.org/certificate.php

8. Post-Consumer Recycled Content: Sourced from recovered Consumer Waste and used as a raw material (e.g. plastic bottles, newspaper, etc).

9. Pre-Consumer Recycled Content: Recovered Industrial Materials diverted from municipal solid waste for use in a different mfg. process, prior to use by a consumer. Note: "home scrap" from the original mfg. process that are reused / reprocessed do not qualify.

10. TVOC Emissions for Building products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010 or or CDPH Standard Method v1.2-2017. http://www.usgbc.org/resources/low-emitting-materials-third-party-certification-table

11. All paints and coatings wet-applied on site must meet applicable VOC limits of the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for Architectural Coatings, or the South Coast Air Quality Management District (SCAQMD) Rule 1113, effective February 5, 2016. All adhesives and sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168.

12. Composite Wood Evaluation as defined by the California Air Resources Board (CARB), Airborne Toxic Measure to Reduce Formaldehyde Emissions from Composite Wood Products Regulation, must provide third-party certificate confirming products meet one of the following requirements: EPA TSCA Title VI for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins, California Air Resources Board (CARB) ATCM for formaldehyde requirements for ultra-low emitting formaldehyde (ULEF) resins, EPA TSCA Title VI formaldehyde requirements for no added formaldehyde resins (NAF), or CARB ATCM formaldehyde requirements for no added formaldehyde resin (NAF).

I, _____ a duly authorized representative of_____ hereby certify that the material information submitted here is an accurate representation of the material to be provided under our contract.

EMAIL CONTACT FOR AUTHORIZED REPRESENTATIVE: _____ Direct Phone: _____
SIGNATURE OF AUTHORIZED REPRESENTATIVE: _____ DATE: _____

SECTION 01 81 19 – INDOOR AIR QUALITY MANAGEMENT

PART 1 - PART 1 GENERAL

1.01 SECTION INCLUDES

A. Construction procedures to promote adequate indoor air quality during construction to achieve LEED Indoor Air Quality Management Plan – During Construction and LEED Indoor Air Quality Management Plan - Before Occupancy.

1.02 PROJECT GOALS

A. See Section 01 81 13 LEED Certification Requirements, for overall project goals relating to environment and energy.
B. Dust and Airborne Particulates: Prevent deposition of dust and other particulates in HVAC ducts and equipment.
   (1) Cleaning of ductwork is not contemplated under this Contract.
   (2) Contractor shall bear the cost of cleaning required due to failure to protect ducts and equipment from construction dust.
C. Airborne Contaminants: Procedures and products have been specified to minimize indoor air pollutants.
   (1) Furnish products meeting the specifications.
   (2) Avoid construction practices that could result in contamination of installed products leading to indoor air pollution.
   (3) Perform either a building flush-out or indoor air quality testing to assure indoor air pollutant levels are at a minimum.
   (4) Prohibit the use of tobacco products inside the building and within 25 feet of the building entrance during construction.

1.03 DEFINITIONS

A. Adsorptive Materials: Gypsum board, acoustical ceiling tile and panels, carpet and carpet tile, fabrics, fibrous insulation, and other similar products.
B. Contaminants: Gases, vapors, regulated pollutants, airborne mold and mildew, and the like, as specified.
C. Particulates: Dust, dirt, and other airborne solid matter.
D. Wet Work: Concrete, plaster, coatings, and other products that emit water vapor or volatile organic compounds during installation, drying, or curing.

1.04 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.
B. Indoor Air Quality Management Plan: Describe in detail measures to be taken to promote adequate indoor air quality upon completion; use SMACNA IAQ Guidelines for Occupied Buildings Under Construction as a guide.
   (1) Submit not less than 60 days before enclosure of building.
   (2) Identify potential sources of odor and dust.
   (3) Identify construction activities likely to produce odor or dust.
   (4) Identify areas of project potentially affected, especially occupied areas.
   (5) Evaluate potential problems by severity and describe methods of control.
   (6) Describe construction ventilation to be provided, including type and duration of ventilation, use of permanent HVAC systems, types of filters and schedule for replacement of filters.
   (7) Describe cleaning and dust control procedures.
   (8) Describe coordination with commissioning procedures.
C. Interior Finishes Installation Schedule: Identify each interior finish that either generates odors, moisture, or vapors or is susceptible to adsorption of odors and vapors, and indicate air handling zone, sequence of application, and curing times.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Low VOC Materials: See other sections for specific requirements for materials with low VOC content.
B. Auxiliary Air Filters: MERV of 8, minimum, when tested in accordance with ASHRAE 52.2.

PART 3 - PART 3 EXECUTION

3.01 CONSTRUCTION PROCEDURES

A. Prevent the absorption of moisture and humidity by adsorptive materials by:
   (1) Sequencing the delivery of such materials so that they are not present in the building until wet work is completed and dry.
   (2) Delivering and storing of such materials in fully sealed moisture-impermeable packaging.
   (3) Store such materials on pallets to avoid exposure to moisture on the ground.
   (4) Provide sufficient ventilation for drying within reasonable time frame.
   (5) Discard and replace such materials damaged by moisture.
B. Begin construction ventilation when building is substantially enclosed.
C. HVAC equipment and supply air ductwork may be used for ventilation during construction:
   (1) Ensure that air filters are correctly installed prior to starting use; replace filters when they lose efficiency.
D. Do not store construction materials or waste in mechanical or electrical rooms.

E. Prior to use of return air ductwork without intake filters clean up and remove dust and debris generated by construction activities.
   (1) Inspect duct intakes, return air grilles, and terminal units for dust.
   (2) Clean plenum spaces, including top sides of lay-in ceilings, outsides of ducts, tops of pipes and conduit.
   (3) Clean tops of doors and frames.
   (4) Clean mechanical and electrical rooms, including tops of pipes, ducts, and conduit, equipment, and supports.
   (5) Clean return plenums of air handling units.
   (6) Remove intake filters last, after cleaning is complete.

F. Do not perform dusty or dirty work after starting use of return air ducts without intake filters.

G. Use other relevant recommendations of SMACNA IAQ Guideline for Occupied Buildings Under Construction for avoiding unnecessary contamination due to construction procedures.

H. Contractor is responsible for contracting and managing Indoor Air Quality testing to obtain 1 point under IEQ Credit 4 – Indoor Air Quality Assessment.
   (1) LEED v4.1: Air Testing – 2 points.
      (a) Conduct baseline IAQ testing after construction ends and prior to occupancy, using testing protocols consistent with EPA Compendium of Methods for the Determination of Air Pollutants in Indoor Air.
         (i) The contractor shall contract with a qualified sub-contractor to provide IAQ testing.
         (ii) The contractor is to coordinate construction activities to prepare for the IAQ testing, which will take place after all construction activities are complete and prior to owner furniture move in.
         (iii) The building is to be cleaned with Green Seal or equivalent cleaning chemicals.
         (iv) Vacuum cleaners with HEPA filters to be used.
         (v) Outside air to be used flush out the building as much as practical.
         (vi) Filtration media to be replaced prior to testing.
   (2) If initial Indoor Air Quality test fails, contractor shall flush the building, limiting humidity to a maximum of 60 percent and temperature to a minimum of 60 degrees, and retest the building. Contractor shall incur all costs for flush and retesting.

END OF SECTION 01 81 19

SECTION 01 81 81 – SUSTAINABILITY CHECKLIST REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. All credits/prerequisites in the attached checklist must be achieved and are necessary to contribute to sustainability certification under the LEED v4 for New Construction and Major Renovations rating system (LEED NC v4). This section is compatible with 01 81 13 LEED CERTIFICATION REQUIREMENTS.

(1) A copy of the LEED NC v4 Project Checklist is attached at the end of this section.

1.02 RELATED WORK

A. Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT
B. Section 01 81 13 LEED CERTIFICATION REQUIREMENTS
C. Section 01 81 19 INDOOR AIR QUALITY MANAGEMENT

PART 2 - PRODUCTS

2.01 NOT USED

PART 3 - EXECUTION

3.01 NOT USED

3.02 ATTACHMENTS

A. LEED NC v4 Project Checklist

END OF SECTION 01 81 81

LEED v4 for BD+C: New Construction and Major Renovation

Project Checklist

Project Name: UA I3R
Date: 9.8.22

Y	?	N				
1			Credit	v4.1	Integrative Process	1

8	1	7	Location and Transportation			16
		16	Credit	v4	LEED for Neighborhood Development Location	16
1			Credit	v4.1	Sensitive Land Protection	1
1		1	Credit	v4	High Priority Site	2
4		1	Credit	v4	Surrounding Density and Diverse Uses	5
		5	Credit	v4.1	Access to Quality Transit	5
1			Credit	v4	Bicycle Facilities	1
1			Credit	v4.1	Reduced Parking Footprint	1
	1		Credit	v4.1	Green Vehicles	1

2	0	8	Sustainable Sites			10
Y			Prereq	v4	Construction Activity Pollution Prevention	Required
1			Credit	v4.1	Site Assessment	1
		2	Credit	v4.1	Site Development - Protect or Restore Habitat	2
1			Credit	v4	Open Space	1
		3	Credit	v4.1	Rainwater Management	3
		2	Credit	v4	Heat Island Reduction	2
		1	Credit	v4	Light Pollution Reduction	1

4	2	5	Water Efficiency			11
Y			Prereq	v4	Outdoor Water Use Reduction	Required
Y			Prereq	v4	Indoor Water Use Reduction	Required
Y			Prereq	v4	Building-Level Water Metering	Required
1		1	Credit	v4	Outdoor Water Use Reduction	2
2	2	2	Credit	v4.1	Indoor Water Use Reduction	6
		2	Credit	v4	Cooling Tower Water Use	2
1			Credit	v4	Water Metering	1

15	3	15	Energy and Atmosphere			33
Y			Prereq	v4	Fundamental Commissioning and Verification	Required
Y			Prereq	v4	Minimum Energy Performance	Required
Y			Prereq	v4	Building-Level Energy Metering	Required
Y			Prereq	v4	Fundamental Refrigerant Management	Required
5		1	Credit	v4	Enhanced Commissioning	6
9	3	6	Credit	v4	Optimize Energy Performance	18
1			Credit	v4	Advanced Energy Metering	1
		2	Credit	v4	Demand Response	2
		3	Credit	v4.1	Renewable Energy Production	3
		1	Credit	v4	Enhanced Refrigerant Management	1
		2	Credit	v4	Green Power and Carbon Offsets	2

3	6	4	Materials and Resources			13
Y			Prereq	v4	Storage and Collection of Recyclables	Required
Y			Prereq	v4.1	Construction and Demolition Waste Management Planning	Required
	3	2	Credit	v4.1	Building Life-Cycle Impact Reduction	5
1	1		Credit	v4.1	Building Product Disclosure and Optimization - Environmental Product Declarations	2
		2	Credit	v4.1	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
1	1		Credit	v4.1	Building Product Disclosure and Optimization - Material Ingredients	2
1	1		Credit	v4.1	Construction and Demolition Waste Management	2

9	2	5	Indoor Environmental Quality			16
Y			Prereq	v4	Minimum Indoor Air Quality Performance	Required
Y			Prereq	v4	Environmental Tobacco Smoke Control	Required
2			Credit	v4	Enhanced Indoor Air Quality Strategies	2
2	1		Credit	v4.1	Low-Emitting Materials	3
1			Credit	v4	Construction Indoor Air Quality Management Plan	1
2			Credit	v4.1	Indoor Air Quality Assessment	2
1			Credit	v4	Thermal Comfort	1
1		1	Credit	v4	Interior Lighting	2
		3	Credit	v4.1	Daylight	3
		1	Credit	v4	Quality Views	1
	1		Credit	v4.1	Acoustic Performance	1

4	2	0	Innovation			6
1			Credit	v4	Innovation: Green Education	1
1			Credit	v4	Innovation: Reduced mercury in lighting	1
	1		Credit	v4	Innovation: WELL Features	1
1			Credit	v4	Pilot Credit: Designing with Nature	1
	1		Credit	v4	Exemplary: EPDs	1
1			Credit	v4	LEED Accredited Professional	1

4	0	0	Regional Priority			4
1			Credit		Regional Priority: Optimize energy Performance (TH= 1 pts)	1
1			Credit		Regional Priority: Outdoor Water Use Reduction (TH = 1 pts)	1
1			Credit		Regional Priority: Open Space (TH = 1 pts)	1
1			Credit		Regional Priority: High Priority Site (TH=1 pt)	1

50	16	44	TOTALS	Possible Points:	110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

SECTION 01 91 00 – COMMISSIONING

PART 1 - GENERAL

1.01 WORK INCLUDED: Commission various, completed building systems to verify that they are installed in accordance with the Contract Documents, and to verify and demonstrate proper operation and control in accordance with the requirements indicated. Provide all labor, equipment, materials and physical activities necessary to perform building system commissioning indicated herein.

1.02 COMMISSIONING AGENT (CA): The Owner will engage the CA independently.

1.03 COMMISSIONING AGENT (CA): The Contractor is to engage the CA as part of the Work of this Section.

1.04 DEFINITIONS

A. COMMISSIONING AGENT (CA): An entity who must plan, manage and coordinate the overall energy-system commissioning process. The CA is also to provide an unbiased and objective opinion of energy related systems installation, operation, and performance to the Owner and to the Contractor. Activities and duties of the CA do do not affect the Contractor's responsibility to provide a finished and complete project, installed and fully functional in accordance with requirements of the Contract Documents.

(1) The CA will prepare appropriate energy-system "pre-functional checklists" before commissioning operations begin.

B. COMMISSIONING TEAM: Members include representatives of the General Contractor and appropriate trade subcontractors, including but not limited to the Building Automation System (BAS) controls subcontractor, as well as the Testing, Adjusting and Balancing (TAB) subcontracted entity. During the commissioning process, The Contractor and appropriate representatives of each trade subcontractor must be present on-site when commissioning activities involve their Work or equipment.

1.05 SYSTEMS REQUIRED TO BE COMMISSIONED

A. MECHANICAL - ENERGY RELATED SYSTEM COMMISSIONING: Inspect, test and certify that the building's energy related mechanical systems are complete and operational as intended by the system design, and then operate in the presence of the CA. Commission the following energy related elements:
B. DUCTS AND AIR HANDLING SYSTEMS: Perform installation and verification checks of ductwork insulation and seals, and confirm completion of flow balancing operations, and duct-system leak testing.
C. SUPPLY, RETURN, RELIEF, & EXHAUST FANS: Perform installation and verification checks of rotation, sound levels, motor current draw, airflows, and pressures, as applicable.
D. AIR HANDLING UNITS: Perform installation and verification checks of units, including performance of checkout and start-up procedures by the manufacturer's representative; complete with documented capacity tests for heating, cooling, air flow, and static pressures; operation of all controls; and sound levels.
E. ENERGY RECOVERY UNITS: Work includes installation inspections and checks, checkout and start-up by manufacturer's representative as specified; documented capacity tests for heating, cooling, air flow, and static pressures; operation of all controls; and sound levels.
F. BUILDING AUTOMATION SYSTEMS (BAS): Perform installation and verification checks and operation of all controlled devices; point-to-point verification of control units; calibration of all control sensors and devices, providing graphical trend logs of all HVAC systems, complete operation of all control sequences; in coordination with commissioning of all controlled systems.

1.06 PROVIDE TREND LOGS prepared by the "Controls" subcontractor after all equipment has passed its functional testing. Prepare in graphical format, including all control points requested by the CA. Trending must occur over seven (7) consecutive days at 15 minute intervals. Print trend logs in color, and provided copies to the CA and include in the O&M Manual.

1.07 THE CA WILL INDICATE which equipment is to be trended. The Controls Contractor will include in the project scope, trending of each piece of equipment installed, however the CA may only select a sampling of certain types of equipment.

1.08 MONITOR CONTROL POINTS continuously and maintain on the BAS hard drive for a minimum of thirty (30) consecutive days. The Owner must be able to obtain trend logs of any control point.

PART 2 - TEAM MEMBER RESPONSIBILITIES:

2.01 COMMISSIONING AGENT (CA) RESPONSIBILITIES:

A. Plan, organize, and implement the commissioning process for energy-related systems.
B. Prepare commissioning plan and pre-functional checklists, and ensure distribution for review and comment,
C. Revise commissioning plan as required during construction
D. In conjunction with activities of the General Contractor, coordinate commissioning activities among all sub-contractors, sub-trades, and suppliers.
E. Monitor execution of pre-functional checklists and ensure that results are documented.
F. Monitor controls point-to-point checks done by control subcontractor and ensure that results are documented.
G. Observe sampling of start-up and initial system operational tests and checks.
H. Direct the Contractor to operate equipment and systems as required to ensure that all functional tests required are carried out for verification purposes.
I. Witness all functional tests and document results.
J. Review and comment on all trend logs prepared and submitted by the controls subcontractor.
K. Document all deficiencies for the Contractor to correct.

L. Re-evaluate all corrected deficiencies as tested and trended by the controls subcontractor.
M. Prepare and submit a Commissioning Report which documents all checks and tests done throughout the commissioning process and the results from each.

2.02 GENERAL CONTRACTOR RESPONSIBILITIES: The General Contractor is responsible for the overall completion of the Project, and must:

A. Participate in the Commissioning process.
B. Ensure that the appropriate subcontractors perform assigned commissioning responsibilities as specified herein.
C. Ensure the cooperation and participation in the commissioning process of other sub-contractors as applicable.
D. The General Contractor will submit the name of the person assigned as their representative to the CA, the Architect, the Mechanical Contractor and to the Owner within one month after executing the construction Contract. This person will have the authority to make decisions on behalf of the General Contractor regarding details and the scheduling of the commissioning process.
E. In the event that any scheduled equipment of system start-up or functional tests are terminated because the CA or the Mechanical Engineer discover deficient or incomplete Work, or because of non-attendance of required personnel at required activities, the Contractor will be responsible for paying the reasonable, additional costs for time and travel by the CA (if engaged by the Owner), the Mechanical Engineer, and the Architect if they were physically present to witness the start-up or functional testing.

2.03 TESTING AND BALANCING (TAB) AGENCY RESPONSIBILITIES:

A. Attend commissioning meetings scheduled by CA prior to and during on-site TAB work being done.
B. Submit proposed TAB procedures to the CA and to the Mechanical Engineer for review and acceptance.
C. Provide the Owner and the Mechanical Engineer a TAB progress reports listing deficiencies discovered during the TAB process that need to be corrected before completing final TAB report.
D. At the completion of the TAB Work, submit the final TAB report to the Owner with copies to the CA and to the Mechanical Engineer.
E. Participate in verification of the TAB report for diagnostic purposes and in solving field problems.

2.04 MECHANICAL SYSTEMS SUBCONTRACTOR

A. The Mechanical Subcontractor and all mechanical sub-subcontractors or suppliers within the Mechanical Division must cooperate with the CA to facilitate successful completion of the commissioning process.
B. The Mechanical Subcontractor must submit the name of the person assigned as their representative to the CA, the Architect, the Mechanical Engineer and the Owner within one month after signing the construction contract. This person will attend all commissioning meetings and have the authority to make decisions on behalf of the mechanical subcontractor regarding details and the scheduling of the commissioning process.
C. Each subcontractor or sub-subcontractor will include in their quotes the cost of participating in the commissioning process as specified.
D. Ensure that the automatic temperature control subcontractor performs the commissioning responsibilities as indicated.
E. Ensure participation of major equipment suppliers in appropriate start-up, testing, and training activities.
F. Notify the CA two weeks in advance of scheduled equipment and system start-up so that the CA may witness functional testing and equipment and system start-ups.
G. Provide sufficient personnel to assist the CA as required during functional testing.
H. Prior to start-up of equipment and/or systems requiring CA verification, inspect, check and confirm that the installation is correct and complete. Document the results of all inspections, complete the check lists provided in the commissioning plan, and sign them.
I. Provide equipment and systems start-up resources as specified or required.
J. Carry out performance checks to ensure that all equipment and systems are fully functional and ready for the CA to witness the formal Functional Tests (FT).
K. Operate equipment and systems for FT's in accordance with the commissioning plan and as directed by the CA. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FT will be suspended by the CA. Those responsible for the deficient or incomplete work will be responsible for the costs in accordance with this Section. Correct all deficiencies, retest the systems to confirm correct operation and notify the CA to schedule another FT.

2.05 CONTROLS SUBCONTRACTOR:

A. Include the cost of commissioning requirements in the quoted price.
B. Review design for controllability with respect to equipment selected for the project;
C. Review and confirm in writing that a proper hardware specification exists to permit functional testing as required by the specifications and sequence of operation.
D. Review and confirm in writing that proper safeties and interlocks are included in design.
E. Ensure the proper sizing of control valves and actuators based on design pressure drop and flow. Ensure that the control valve authority will result in capacity control as specified. Include valve sizing and authority information in submittals.
F. Ensure the proper sizing of control dampers. Ensure control damper authority to control air flows as specified. Review and confirm in writing proper damper positions for mixing and to prevent stratification. Ensure correct actuator vs. damper movement for smooth operation. Include damper sizing, control authority and actuator selection in submittals.
G. Ensure the proper selection of sensor ranges and include data with submittals.
H. Clarify all questions concerning sequences of operation with the mechanical engineer.
I. Attend all commissioning meetings.

J. Inspect, check, and confirm the proper installation and performance of controls/BAS hardware, and software provided by others.
K. Integrate installation and programming scheduling with construction and commissioning schedules.
L. Inspect, check and confirm the correct installation and operation of input and output field point and devices through documented and signed off point-to-point checkouts.
M. In conjunction with the mechanical subcontractor, demonstrate system performance to the CA including all modes of system operation (i.e. occupied, unoccupied, and emergency) during the functional tests (FTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with this Section.
N. Provide trend logs of all equipment as requested by the CA.
O. Provide control system technician to assist during system verification and functional testing.
P. Provide support and coordination with TAB subcontractor on all interfaces between controls and TAB scope of work. Provide, at no additional cost to the TAB and commissioning agent, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB procedures.

2.06 ELECTRICAL SUBCONTRACTOR:

A. Include the cost of commissioning requirements in the quoted price.
B. Review design with respect to providing power to the equipment.
C. Verify that proper hardware specifications exist for functional performance and sequence of operation required by the specifications
D. Verify that proper safeties and interlocks are included in the design of electrical connections to the equipment.
E. Attend commissioning meetings scheduled by the CA.
F. Schedule work so that required electrical installations are completed and performance of all electrical service provided.
G. Provide electrical system technicians to assist during system verification and functional performance testing.

END OF SECTION 01 91 00

SECTION 01 91 19 – EXTERIOR ENCLOSURE COMMISSIONING

PART 1 - WORK INCLUDED: Provide labor, equipment, temporary materials and procedures necessary to pressure test the exterior enclosure of the building (without occupants), and to substantiate compliance with the International Energy Conservation Code (IECC), as follows:

1.01 MAXIMUM ALLOWABLE LEAKAGE RATE: 0.40 CFM/SF (Cubic Feet per Minute per Square Foot) at a pressure differential of 0.3 inches water gauge (WG) per ASTM E 779, or an equivalent AHJ approved method.

1.02 PROVIDE THE SERVICES OF a “Certified Professional” in air-barrier testing methods and procedures by the National Environmental Balancing Bureau (NEBB - www.NEBB.org), who will determine the testing means and methods and who will supervise the on-site testing operations.

1.03 IF TEST RESULTS exceed the maximum allowable air-leakage rate indicated, evaluate the installed enclosure system, and provide immediate corrective improvements and re-testing until satisfactory compliance is achieved, at no additional cost to the Owner.

PART 2 - CALCULATION METHODS:

2.01 APPLICABLE BUILDING AREAS: Add the “footprint” area in square feet (SF) of the bottom floor, plus the area of the top floor’s ceiling or roof membrane (depending on where the air-barrier is located), and add overhanging soffits of conditioned spaces that are enclosed by the air-barrier system, plus the area of exterior wall surfaces between the top and bottom layers (including below-grade walls and fenestrations consisting of storefront, doors, or windows).

2.02 CALCULATE A BASE-LINE VALUE representing the maximum air-leakage rate permitted.

2.03 THE LEAKAGE RATE is the quantity of air-leakage in CFM divided by the sum of the above SF areas.

PART 3 - EXECUTION

3.01 PREPARE THE BUILDING as required by the referenced standards, installing tightly sealed blower units at exterior doors typically on the leeward side of the building. Isolate and close-off any areas not applicable to testing, such as adjacent tenant spaces or other existing areas that are not a part of this Project, as applicable. Seal-off fans with back-draft or motorized dampers and exhausts for equipment requiring combustion air, including kitchen equipment. Seal-off floor drains and plumbing traps, and elevator pressure relief openings.

3.02 TEST AIR-LEAKAGE in accordance with the required, referenced standard, and document the average, actual leakage rate per the above requirements. Take not less than ten (10) leakage readings at setpoint pressures averaged over a ten (10) second period, or as otherwise required by the referenced standard.

3.03 PROVIDE CERTIFIED, SATISFACTORY TEST RESULTS copied electronically to the Architect, MEP Engineer and to the Owner, within 48 hours of testing.

END OF SECTION 01 91 19

SECTION 01 91 23 – FIRE-RATED DOOR COMMISSIONING

PART 1 - GENERAL

1.01 WORK INCLUDED: Prior to the request for inspection at Substantial Completion, inspect and test fire-rated doors and openings throughout the Project

1.02 PERFORM TESTING by the building hardware supplier's certified Architectural Hardware Consultant (AHC) or other entity knowledgeable with their operation who is approved in advance by the Architect.

1.03 COMPLY WITH requirements of NFPA 80 "Standard for Fire Doors and Other Opening Protectives", including but not limited to its "Paragraph 5.2.3 – Acceptance Testing." Include physical closing of each unit by all means of activation. Record results of the inspections and submit to the Owner for potential future review by the AHJ.

1.04 PREPARE AND SUBMIT A REPORT of testing, including modifications made and recommendations for continuing maintenance and management of fire-rated doors and openings by the Owner. Submit report to the Architect and Owner before making request for inspection at Substantial Completion, and maintain a printed copy at the site at occupancy inspection, for use by the AHJ, if requested.

PART 2 - REQUIREMENTS

2.01 FOR SWINGING FIRE-DOORS, Verify each of the following, as applicable:

A. Labels are clearly visible and legible.
B. No open holes or breaks exist in surfaces of either the door or the frame
C. Glazing, vision light frames, and glazing beads are intact and securely fastened in place, if so equipped,
D. The door, frame, hinges, hardware, and noncombustible thresholds are secured, aligned and in working order with no visible signs of damage.
E. No parts are missing or broken
F. Door clearances do not exceed clearances as listed in NFPA 4.8.4 and 6.3.1.7.
G. The self-closing device is operational; that is the active door completely closes when operated from the full open position.
H. If a coordinator is installed, the inactive leaf closes before the active leaf.
I. Latching hardware operates and secures the door when it is in the closed position.
J. Auxiliary hardware items that interfere or prohibit operation are not installed on the door or frame.
K. No field modifications to the door assembly have been performed that void the label.
L. Meeting edge protection, gasketing and edge seals, where required, are inspected to verify their presence and integrity.
M. Signage affixed to a door meets the requirements listed in NFPA 80 – Paragraph 4.1.4.

2.02 FOR HORIZONTALLY SLIDING, VERTICALLY SLIDING OR ROLLING FIRE DOORS, verify the following:

A. Labels are clearly visible and legible.
B. No open holes or breaks exist in surface of either the door or the frame.
C. Slats, end locks, bottom boar, guide assembly, curtain entry, hood and flame baffle are correctly installed and intact for rolling steel fire doors.
D. Glazing, vision light frames, and glazing beads are intact and securely fastened in place, if so equipped.
E. Curtain, barrel, and guides are aligned, leveled, plumbed and true for rolling steel fire doors.
F. Expansion clearance is maintained in accordance with the manufacturer's listing.
G. Drop release arms and weights are not blocked or wedged.
H. Mounting and assembly bolts are intact and secured.
I. Attachments to jambs are with bolts, expansion anchors, or as otherwise required by the listing.
J. Smoke detectors, if equipped, are installed and operational.
K. No parts are missing or broken
L. Fusible links, if equipped, are in the location; chain/cable, S-hooks, eyes and so forth are in good conditions; the cable or chain is not kinked, pinched, twisted or inflexible; and links are not painted or coated with duct or grease.
M. Auxiliary hardware items that interfere or prohibit operation are not installed on the door or frame.
N. No field modifications to the door assembly have been performed that void the label.
O. Doors must have an average closing speed of not less than 6 inches/second or more than 24 inches/second.

2.03 FOR CLOSING DEVICES, all fire doors, fire shutters, and fire window assemblies must be inspected and tested to check for proper operation and full closure. Resetting of the automatic-closing devices must be done in accordance with the manufacturer's instructions.

END OF SECTION 01 91 23

END OF DIVISION 1

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 22 00 – EXISTING CONDITIONS ASSESSMENT

PART 1 - PRIOR TO COMMENCEMENT OF WORK, verify existing conditions, control points, principal lines and elevations, the presence of underground utilities, at or related to the site and the existing building, and also examine adjacent facilities upon which the work is in any way dependent.

PART 2 - SURVEY THE EXISTING BUILDING prior to the start of construction, to document any existing defects. This record shall serve as a basis for determination of subsequent damage resulting from the Contractor's operations at the site.

PART 3 - IN THE EVENT OF ANY INCONSISTENCY or conflict, between existing conditions and the Construction Documents, immediate notify the Architect of the inconsistency or conflict. Do not undertake any phase of the Work affected by such inconsistency or conflict, pending the issuance of Supplemental Instructions by the Architect.

PART 4 - ELEVATIONS OF EXISTING GRADES, floors, tops of walls, parapets, beams and locations of existing columns, walls and similar elements are based on drawings of the existing building and limited verification by the Architect. However, the Architect or Owner assumes no responsibility for the accuracy of that information. It is the intent of the Contract Drawings to integrate new Work with the existing work and the Contractor must verify and confirm the actual building conditions.

PART 5 - REVIEW EXISTING FLOOR SUBSTRATE elevations and conditions to verify if any of the following exist, and notify the Architect if they do:

5.01 Variation of over 1/2 inch or more over entire floor area

5.02 Slopes of over 1/8th inch in 10 feet in any area

5.03 Rough or un-stable flooring substrates requiring extensive repair

PART 6 - REVIEW CONDITIONS of other existing construction elements to be reused in the new construction, and verify that they will provide an acceptable substrate for new materials and finishes indicated.

PART 7 - REPORT all un-acceptable substrate or existing materials to the Architect in writing.

END OF SECTION 02 22 00

SECTION 02 26 00 – HAZARDOUS MATERIALS ASSESSMENT

PART 1 - GENERAL

1.01 THE PRESENCE OF HAZARDOUS MATERIALS is not anticipated by the Owner.

1.02 THIS SECTION INCLUDES REQUIREMENTS to provide a Phase II Environmental Site/Building Assessment (ESA) of hazardous materials.

1.03 IF HAZARDOUS MATERIALS ARE DISCOVERED, PROVIDE PROPOSED WORK PLANS for the removal, abatement or remediation of materials discovered, for review and approval by the Owner, as a change in scope to the Construction Contract. Include in the Work Plan, a description of the proposed means and methods to be used, and an assessment of alternative methods, costs and logistics, including recommended steps to perform site cleanup and follow-up monitoring for residual contaminates, as applicable.

1.04 PROVIDE an ENVIRONMENTAL SITE ASSESSMENT & RECOMMENDATIONS REPORT of the site and existing building, in accordance with ASTM E 1903 to include testing for petroleum hydrocarbons, heavy metals (including lead and mercury), pesticides, solvents, asbestos and mold, including priority pollutants and other hazardous or regulated materials, and in accordance with requirements of this Section.

1.05 HAZARDOUS MATERIALS INSPECTION AGENCY: Engage the Professional Services of a company legally qualified and certified to provide EPA Phase II and III site and building inspections, to take samples of existing site and building materials for testing and analysis, and to make recommendations to the Owner regarding the recommended scope of hazardous materials removal or remediation Work. Provide an inspection agency, or multiple agencies, employing the following individuals:

1.06 FOR ASBESTOS INSPECTIONS, provide an individual who has EPA Model Accreditation Plan (MAP) "Building Inspector" training; accreditation as required by 40 CFR 763 - Subpart E, Appendix C, and who possesses an EPA/State certification or license as a “Building Inspector".

1.07 FOR HEAVY METALS INSPECTIONS, including Lead-Based Paints and Paints Containing Leads (LBPs) inspections, employ a Certified Industrial Hygienist (CIH) who has been certified for comprehensive practice by the American Board of Industrial Hygiene, or a Certified Safety Professional (CSP) certified by the Board of Certified Safety Professionals.

A. This facility was constructed prior to 1978, and is therefore likely to have painted surfaces containing lead-based paints.

1.08 FOR POLYCHLORINATED BIPHENYLS (PCBs) inspection, provide a person who is a Certified Industrial Hygienist (CIH) certified for comprehensive practice by the American Board of Industrial Hygiene, and with demonstrable experience in removal of PCBs.

1.09 FOR MICROBIAL (MOLD) INSPECTIONS, the Inspection Agency (IA) must employ an individual who is an Industrial Hygienist (IH) that is qualified by education, training, and experience to anticipate, recognize, evaluate, and develop controls for occupational and indoor air quality hazards. Education must include a minimum 12 semester hours or quarter hour equivalent of chemistry and 18 additional semester hours or quarter hour equivalent of courses in any combination of chemistry, physics, engineering, health physics, environmental health, biostatistics, biology, physiology, toxicology, epidemiology, or industrial hygiene. An IH for mold inspections must be supervised by a CIH, who is also trained and experienced in mold hazards in accordance with current federal, State, and local regulations.

1.10 ENGAGE A TESTING LABORATORY (TL) or multiple laboratories (if necessary) to perform testing and analysis of building materials taken for Hazardous Materials Assessments.

A. For testing ACMs, use an OSHA approved and accredited laboratory by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA).
B. For testing lead materials, use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis. Laboratories selected to perform blood lead analysis shall be OSHA approved.

1.11 THE OWNER RESERVES THE RIGHT to engage a separate Hazardous Inspector and Testing Laboratory to review and consult with the Owner in regards to the assessments and recommendations specified herein.

END of SECTION 02 26 00

SECTION 02 4113 - SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

A. Selective demolition work, complete, as indicated, specified, and required for new work, including removal and disposal of demolished materials.

B. Removal, protection, and storage of items designated to be reused.

C. Removal, protection, and delivery of items designated as Owner's salvage to location as directed by Owner.

1.02 RELATED WORK

A. Not in this Phase

1.03 SUBMITTALS:

A. Before commencing selective demolition work, submit for review and approval of the Engineer, a schedule showing the commencement, order, and completion dates for the various parts of this work. Include coordination for shut-off, capping, and continuation of utility services as required, together with details for dust and noise protection.

B. Before starting any work relating to existing utilities that will temporarily discontinue service to adjacent buildings, notify the Engineer / Owner 72 hours in advance and obtain approval before proceeding with work. Do not disconnect or disrupt service without Engineer's prior approval.

1.04 PROJECT CONDITIONS:

A. Condition of Structure: Owner assumes no responsibility for actual condition of items or portions of structures to be demolished.

B. Salvageable Items:

C. Salvage items indicated. Store at location as directed by Owner.

D. Items indicated to be removed, and not designated for Owner's salvage or for reuse, may be salvaged by the Contractor. Transport salvaged items from site as they are removed. Storage or sale of removed items on site will not be permitted.

E. Protections:

F. Provide protective measures as required to protect personnel and general public from injury due to selective demolition work.

G. Provide adequate fire protection in accordance with local Fire Department requirements.

H. Damages: Promptly repair, to the satisfaction of the Engineer, damages caused to contents by demolition work or due to insufficiency of protection provided, at no cost to Owner. Replace damaged work, as directed by the Engineer, if not satisfactory.

I. Traffic: Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

J. Explosives: Use of explosives will not be permitted.

K. Environmental Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practicable level. Comply with governing regulations pertaining to environmental protection.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 DEMOLITION

A. Refer to drawings and provide selective demolition as indicated and as required for new work.

B. Proceed in a systematic manner. Use such methods as required to complete work in accordance with demolition schedule and governing regulations.

C. Demolish concrete in small sections. Cut concrete at junctures with construction to remain using power-driven masonry saw or hand tools: do not use power driven impact tools.

3.02 DISPOSAL OF DEMOLISHED MATERIAL

A. Remove debris, rubbish, and other materials resulting from demolition operations as the work progresses. Transport and legally dispose of materials off site. Burning of debris will not be permitted on site.

3.03 CLEAN UP AND REPAIR

A. Upon completion of selective demolition work, remove tools, equipment and demolished materials from site. Remove protections.

B. Repair demolition performed in excess of that required. Return structures and surfaces to remain to condition existing prior to commencement of selective demolition work. Repair construction or surfaces soiled or damaged by selective demolition work.

END OF SECTION 02 41 13

SECTION 02 4114 - UTILITY LINE BORES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Providing encasement pipe jacked through bored tunnel for crossing of utility pipelines under roadways and railroad tracks where noted on Drawings.

B. Providing sand packing of encasement pipe around pressure lines.

C. Pulling or jacking carrier pipe through encasement pipe.

D. Providing brick closures at ends of encasement pipe.

1.02 RELATED WORK

A. Section 33 3100 – Sanitary Sewer Gravity Line.

B. Utility crossings under existing streets where boring is noted.

1.03 REFERENCE

A. American Society for Testing and Materials (ASTM):

1. ASTM A 139: Specification for Electric-Fusion (ARC) – Welded Steel Pipe (sizes 4 inch and over).
2. ASTM D41.1 Specification for Spiral-Welded Steel or Iron Pipe.

B. American Welding Society (AWS):

1. AWS D1.1 Structural Welding Code.

1.04 SUBMITTALS

A. See Related Work

PART 2 PRODUCTS

2.01 MATERAILS

A. Encasement pipe: Smooth wall steel pipe conforming to ASTM A139 (Grade B), ASTM A211, or AWWA C202 (Grade B) with ends prepared for welded joints.

B. Welding materials: Type required materials being welded and conforming to applicable AWS Specifications.

C. Sand: Clean industrial sand, concrete sand, masonry sand, or other type approved by Engineer.

D. Skids or chocks: Pressure-treated wood shaped to fit underside of carrier pipe and bottom of encasement pipe. Size skids to allow carrier pipe to be installed at designated grade.

E. Furnish stainless steel bands to secure skids or chocks to carrier pipe.

F. Brick: New or used day brick; or concrete brick.

G. Mortar: Type “M”.

PART 3 EXECUTION

3.01 SUBSURFACE INVESTIGATION

A. Do not set up equipment or begin excavating pit on state highway without permission of Arkansas State Highway and Transportation Department District Engineer or his authorized representative. Refer to Section 01 1000.

B. Do not begin boring and jacking operation for railroad crossings without permission of railroad company’s Area Road master or his designated representative.

3.02 INSTALLATION, ENCASEMENT PIPE

A. General: Install encasement pipe at grade and alignment shown on Drawing. Allow for height of skids or chocks when establishing grade for gravity line encasement pipe.

B. Bores:

1. Excavate pits and trenches required at each side of crossing to minimum width and length necessary for boring and jacking operation and carrier pipe installation.
2. Carefully set timer or steel guide rails in pit to attain specified grade and alignment.
3. Keep pit pumped free of standing water. Maintain pit bottom to provide stable base for rails and equipment and firm footing for workmen. Granular material used in bottom of pit will not be paid for as “Extra gravel in trench”.
4. Provide temporary sheeting and bracing as necessary to prevent earth-slides. Leave in place until it can be safely removed.
5. Bore tunnel and simultaneously jack encasement pipe forward one section at a time. Connect sections by full penetration butt welding performed in accordance with AWS D1.1.
6. Remove excavated soil from boring operation as it enters pit and dispose of it offsite.

C. Open Cut:

1. Trenches shall be constructed as described in Section 33 3100.
2. Provide temporary sheeting and bracing as necessary to prevent earth-slides. Leave in place until it can be safely removed.
3. Connect encasement pipe sections by full penetration butt welding performed in accordance with AWS D1.1.

3.03 INSTALLATION, CARRIER PIPE

A. General: Joint pipe as specified in Sections 33 1100, 33 1219, and 33 3100, as applicable. Pull or jack carrier pipe through encasement pipe. Do not allow cables or jacks to be in direct contact with carrier pipe while pulling or jacking pipe. Use timber or padded steel member.

B. Pressure lines: Install in encasement pipe with weight of pipe resting on pipe barrels and sliding directly on bottom of encasement pipe.

C. Gravity lines: Strap skids or chocks to carrier pipe, two per pipe length near ends. Refer to Detail Drawings bound in Project Manual.

3.04 INSTALLATION, SAND

A. Pressure lines: Fill void between encasement pipe and carrier pipe with sand. Install vertical single wythe mortared brick wall in ends of encasement pipe, sealing around carrier pipe.

3.05 BACKFILL

A. Use material excavated from pit.

B. Backfill against ends of encasement pipe.

C. Backfill pit and around carrier pipe in same manner as specified in Sections 33 3100 and 33 1219.

3.06 CLEANUP

A. Cleanup ground surface around work area in same manner as specified for line work in Sections 33 1219 and 33 3100.

END OF SECTION 02 41 14

SECTION 02 41 16 – STRUCTURE DEMOLITION

PART 1 - GENERAL

1.01 WORK INCLUDED: Demolish and remove the existing building structure and site improvements, as indicated on the Drawings, as required to facilitate the new construction, and as specified herein. Backfill excavations, when applicable.

1.02 MATERIALS OWNERSHIP: The Owner reserves the right to claim any existing product or material from the project site for reuse, at their discretion. Except for items or materials so claimed, demolished materials will become the Contractor's property and must be removed from the site with further disposition at the Contractor's option.

1.03 PROMPTLY REPAIR DAMAGE to existing conditions and facilities caused by demolition operations and restore to original operational conditions.

1.04 PROTECTION:

A. PROVIDE TEMPORARY BARRICADES and other forms of protection as required to protect adjacent Work, the Owner's personnel or the public from injury due to demolition work.
B. EXISTING TO REMAIN: Protect construction indicated or intended to remain against damage and soiling during selective demolition. Items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.

1.05 QUALITY ASSURANCES:

A. TRAFFIC: Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with other adjacent occupied or used facilities.
B. REGULATORY REQUIREMENTS: Comply with governing EPA notification regulations before starting selective demolition. Comply with hauling and disposal regulations of applicable AHJ representatives.

1.06 PROJECT CONDITIONS

A. EXISTING CONDITIONS: The Owner and the Architect do not accept or assume any responsibility for the condition of items or building elements intended to be demolished.
B. HAZARDOUS MATERIALS: It is not expected that asbestos, PCB's, lead-based paints or other hazardous materials will be encountered. If any material is uncovered that is suspected to contain a hazardous material, do not disturb the material – and notify the Architect immediately.
C. CONDITIONS EXISTING at time of inspection for bidding purpose will be maintained by the Owner to the greatest extent practical.
D. STORAGE OR SALE OF REMOVED ITEMS or materials on-site will not be permitted.

1.07 EXAMINATION

A. EXAMINE areas and conditions under which the Work of this Section will be performed. Do not proceed if conditions exist that are detrimental to proper and timely completion. Commencement of this Work will be construed as acceptance of existing conditions, and assumption of responsibility for satisfactory completion.

1.08 UTILITY SERVICES

A. MAINTAIN EXISTING UTILITIES in service and protect them against damage during demolition operations.
B. DO NOT INTERRUPT EXISTING UTILITIES serving any occupied or operating facilities, except when authorized in writing by the Owner.
C. UTILITY REQUIREMENTS: Locate, identify, disconnect, and seal or cap off indicated utility services serving structures to be demolished. Arrange to shut off indicated utilities with utility companies.
D. VERIFY THAT UTILITIES have been disconnected and capped before start of demolition operations.

PART 2 - PREPARATION - GENERAL:

2.01 CONDUCT DEMOLITION OPERATIONS and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities

2.02 CONDUCT DEMOLITION OPERATIONS TO PREVENT INJURY to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways.

2.03 PROVIDE AND MAINTAIN SHORING, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of buildings or elements to be demolished and to adjacent buildings or elements intended to remain. Strengthen or add new supports when required during progress of demolition.

PART 3 - PREPARATION FOR BUILDING DEMOLITION:

3.01 DO NOT CLOSE OR OBSTRUCT STREETS, walks, or other adjacent occupied or used facilities without permission from the Owner.

3.02 PROVIDE ALTERNATE ROUTES around closed or obstructed roads if necessary.

3.03 PROTECT EXISTING SITE IMPROVEMENTS, appurtenances, and landscaping to remain.

3.04 ERECT A FENCE around drip line of individual trees or around perimeter drip line of groups of trees to remain.

3.05 BELOW-GRADE DEMOLITION WORK: Demolish foundation walls and other below-grade construction, as follows:

A. REMOVE BELOW GRADE CONSTRUCTION, including foundation walls, completely.
B. BELOW GRADE CONCRETE SLABS: break up and remove in entirety.

PART 4 - DISPOSAL OF DEMOLISHED MATERIALS

4.01 PROMPTLY DISPOSE of demolished materials. Do not allow demolished materials to accumulate on-site.

4.02 DO NOT BURN demolished materials on-site.

4.03 TRANSPORT DEMOLISHED MATERIALS off the property and legally dispose of.

END OF SECTION 02 41 16

SECTION 02 41 19 – SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 WORK INCLUDED: Demolish and remove existing site improvements and building components, as indicated on the Drawings, as required to facilitate the new construction Work, and as specified herein.

1.02 RELATED SECTIONS: Division-31 “Earthwork” Section for backfill of excavations, when applicable.

1.03 MATERIALS OWNERSHIP: The Owner reserves the right to claim any existing product or material for reuse, at their discretion. Except for items or materials so claimed, demolished materials will become the Contractor's property and must be removed from the site with further disposition at the Contractor's option.

1.04 PROMPTLY REPAIR DAMAGE to existing conditions and facilities caused by demolition operations and restore to original operational conditions.

1.05 QUALITY ASSURANCES:

A. TRAFFIC: Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with other adjacent occupied or used facilities.
B. REGULATORY REQUIREMENTS: Comply with governing EPA notification regulations before starting selective demolition. Comply with hauling and disposal regulations of applicable AHJ representatives.

1.06 PROJECT CONDITIONS

A. EXISTING CONDITIONS: The Owner and the Architect do not accept or assume any responsibility for the condition of items or building elements intended to be demolished.
B. HAZARDOUS MATERIALS: It is not expected that asbestos, PCB’s, lead-based paints or other hazardous materials will be encountered with this Project. If any material is uncovered that is suspected to contain a hazardous material, do not disturb the material – and notify the Architect immediately.
C. CONDITIONS EXISTING at the time of inspection for bidding will be maintained by the Owner to the greatest extent practical.

1.07 STORAGE OR SALE OF REMOVED ITEMS or materials on-site will not be permitted.

A. PROVIDE REPAIR MATERIALS identical to existing materials, whose installed performance equals or surpasses that of the exiting materials. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

PART 2 - EXECUTION

2.01 EXAMINATION

A. EXAMINE areas and conditions under which the Work of this Section will be performed. Do not proceed if conditions exist that are detrimental to proper and timely completion. Commencement of this Work will be construed as acceptance of existing conditions, and assumption of responsibility for satisfactory completion.
B. SURVEY EXISTING CONDITIONS and correlate with requirements indicated to determine extent of selective demolition required.
C. INVENTORY AND RECORD THE CONDITION of items to be removed and reinstalled and items to be removed and salvaged. Photograph existing damage to structural surfaces, equipment or to surrounding properties which could be misconstrued as damage resulting from selective demolition work; file with Architect prior to starting work.
D. IF UNANTICIPATED mechanical, electrical, or structural elements which conflict with the intended function of design are encountered, investigate and measure both nature and extent of the conflict. Submit report to the Architect in written, accurate detail. Pending receipt of directive from the Architect, rearrange selective demolition schedule as necessary to continue overall job progress without delay.
    (1) SURVEY THE CONDITION OF THE BUILDING to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

2.02 PROTECTION:

A. PROVIDE TEMPORARY BARRICADES and other forms of protection as required to protect adjacent Work, the Owner's personnel or the public from injury due to selective demolition work.
B. EXISTING TO REMAIN: Protect construction indicated or intended to remain against damage and soiling during selective demolition. Items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.

2.03 BUILDING SERVICES

A. MAINTAIN EXISTING SERVICES in operation and protect them against damage during demolition operations.
B. DO NOT INTERRUPT EXISTING SERVICES serving any other occupied or operating facilities, except when indicated in the Drawings or so authorized in writing by the Owner and with concurrence of AHJ representatives.
C. PROVIDE TEMPORARY SERVICES during interruptions of existing services, acceptable to the Owner and to AHJ’s.
D. LOCATE, IDENTIFY, DISCONNECT AND SEAL OR CAP OFF services associated with selective demolition operations, and verify that services have been disconnected and capped before start of selective demolition operations.

2.04 PREPARATION - GENERAL:

A. CONDUCT SELECTIVE DEMOLITION OPERATIONS and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities
B. CONDUCT OPERATIONS TO PREVENT INJURY to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways.
C. PROVIDE AND MAINTAIN SHORING, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of buildings or elements to be demolished and to adjacent buildings or elements intended to remain. Strengthen or add new supports when required during progress of demolition.
D. PROVIDE TEMPORARY WEATHER PROTECTION, during interval between demolition and removal of existing construction, on exterior surfaces to ensure that no water leakage or damage occurs to structure or interior areas.

2.05 PREPARATION FOR SELECTIVE SITE DEMOLITION:

A. DO NOT CLOSE OR OBSTRUCT STREETS, walks, or other adjacent occupied or used facilities without permission from the Owner, and if required, from AHJ's.
B. PROVIDE ALTERNATE ROUTES around closed or obstructed roads if required by AHJ's.
C. PROTECT EXISTING SITE IMPROVEMENTS, appurtenances, and landscaping to remain.
D. ERECT A FENCE around drip line of individual trees or around perimeter drip line of groups of trees to remain.
E. PREPARATION FOR INTERIOR SELECTIVE DEMOLITION:
F. PROTECT WALLS, CEILINGS, FLOORS, and other existing finishes that are to remain and are exposed during demolition operations.
G. COVER AND PROTECT furniture, furnishings, and equipment that have or will not be removed. Protect air-handling equipment from dust or debris.
H. ERECT AND MAINTAIN DUSTPROOF PARTITIONS and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise. Construct dustproof partitions of not less than nominal 4-inch studs, 5/8-inch gypsum wallboard with joints taped on occupied side, and 2-inch fire-retardant plywood on the demolition side. Insulate partition to provide noise protection to occupied areas. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.

2.06 POLLUTION CONTROLS:

A. UTILIZE water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations, as applicable.
B. DO NOT CREATE HAZARDOUS or objectionable conditions, such as ice, flooding, and pollution, when using water, and do not create objectionable odors from use of chemicals.
C. REMOVE AND TRANSPORT DEBRIS in a manner that will prevent spillage on adjacent surfaces and areas. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level.

PART 3 - SELECTIVE DEMOLITION OPERATIONS: Demolish and remove existing construction elements only to the extent required by new construction or as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:

3.01 NEATLY CUT OPENINGS AND HOLES plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain

3.02 CUT OR DRILL FROM THE EXPOSED OR FINISHED SIDE into concealed surfaces to avoid marring existing finished surfaces. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations. Maintain adequate ventilation when using cutting torches

3.03 REMOVE DECAYED, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

3.04 RETURN ELEMENTS OF CONSTRUCTION AND SURFACES TO REMAIN to condition existing before start of demolition operations.

3.05 DEMOLISH CONCRETE AND MASONRY in small sections. Cut concrete and masonry at junctures with construction to remain, using power-driven masonry saw or hand tools; do not use power-driven impact tools.

3.06 REMOVE RESILIENT FLOOR COVERINGS and adhesive according to recommendations of the Resilient Floor Covering Institute's (RFCI) "Recommended Work Practices for the Removal of Resilient Floor Coverings" and Addendum. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.

3.07 REMOVE AIR-CONDITIONING EQUIPMENT without releasing refrigerants.

3.08 BELOW-GRADE DEMOLITION WORK: Demolish foundation walls and other below-grade construction, as follows:

A. REMOVE BELOW GRADE CONSTRUCTION, including foundation walls completely.
B. BELOW GRADE CONCRETE SLABS: break up and remove unless otherwise indicated to remain..

3.09 PATCHING AND REPAIRS

A. PROMPTLY PATCH AND REPAIR holes and damaged surfaces caused to adjacent construction by selective demolition operations. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
B. RESTORE EXPOSED FINISHES of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.

C. PATCH AND REPAIR FLOOR AND WALL SURFACES in the new space where demolished walls or partitions extend one finished area into another. Provide a flush and even surface of uniform color and appearance. Closely match texture and finish of existing adjacent surface. Patch with durable seams that are as invisible as possible.
D. WHERE PATCHING SMOOTH PAINTED SURFACES, extend final paint coat over entire unbroken surface containing the patch after the surface has received primer and second coat
E. REMOVE EXISTING FLOOR AND WALL COVERINGS and replace with new materials, if necessary, to achieve uniform color and appearance.

3.10 DISPOSAL OF DEMOLISHED MATERIALS

A. PROMPTLY DISPOSE of demolished materials. Do not allow demolished materials to accumulate on-site.
B. DO NOT BURN demolished materials on-site.
C. TRANSPORT DEMOLISHED MATERIALS off the property and legally dispose of.

3.11 CLEANING

A. SWEEP THE SITE AND BUILDING broom clean on completion of selective demolition operation.
B. CHANGE FILTERS ON AIR-HANDLING EQUIPMENT on completion of selective demolition operations.

END OF SECTION 02 41 19

SECTION 02 82 00 – ASBESTOS REMEDIATION

PART 1 – GENERAL

1.01 THE SCOPE OF WORK of this Section will be authorized by the Owner after submittal and review of the Hazardous Materials Assessment and Work Plan proposed, as required in Division-02 Section “Hazardous Materials Assessment”. Based upon specific direction and authorization by the Owner, provide Asbestos Remediation, that may include the following.

A. REMOVE AND CONTROL existing Asbestos-Containing Materials (ACMs) discovered, by application of proper cleaning techniques, engineered controls and through application of best management practices. The Work may include containment and disposal of ACM’s, and includes handling, legal disposal, and procedures and equipment required to protect workers, the environment, building occupants, and the existing building, from contact with asbestos.

1.02 THIS SECTION INCLUDES various cleaning, removal and disposal protocols on existing building materials. The level of containment and requirements for cleaning and remediation of materials will depend on the existing conditions of the space and the materials being remediated. As so authorized by the Owner, provide labor, materials, services, and equipment necessary in accordance with applicable Federal, State, and local regulations, and as follows:

A. ENGAGE THE SERVICES OF A COMPETENT PERSON (CP) to prepare an Asbestos Control Work Plan (ACWP). Engage the CP to determine the specific needs for personnel protective equipment (PPE) to be used with the ACWP, and include an assessment of the risk for people to occupy areas adjoining the remediation areas while remediation work is occurring. The CP must be onsite whenever remediation activities are ongoing.

B. COORDINATE with Work being performed in adjacent areas. Detail coordination procedures in the ACWP and detail how asbestos exposure will be prevented to other Work, workers or other personnel performing Work unrelated to asbestos remediation activities.

1.03 THE OWNER RESERVES THE RIGHT to engage a separate CP to review and approve the ACM Assessment Survey, the ACWP, to monitor activities at the site at any time while Work is in progress, and to verify compliance with the ACWP, including verification of clearance testing. Remove Worker from the site if the Owner’s CP observes their non-compliance with the quality requirements specified herein.

1.04 LICENSES, PERMITS AND NOTIFICATIONS: Obtain necessary licenses, permits and notifications in conjunction with ACM abatement, transportation and disposal actions and provide timely notification of such actions as required by federal, state, regional, and local AHJ’s. Notify the Regional Office of the USEPA and/or the state's environmental protection agency responsible for asbestos air emissions in writing, at least ten (10) days prior to commencement of work, in accordance with 40 CFR 61, Subpart M, and state and local requirements to include the mandatory "Notification of Demolition and Renovation Record" form and other required notification documents. Notification must be by Certified Mail, Return Receipt Requested. Furnish copies of receipts to the Owner in writing, prior to the commencement of work.

1.05 DEFINITIONS:

A. ASBESTOS-CONTAINING MATERIAL (ACM): Any materials containing more than one percent (1%) asbestos.

B. CLASS I ASBESTOS WORK: Activities defined by OSHA involving the removal of thermal system insulation (TSI) and surfacing ACM’s.

C. CLASS II ASBESTOS WORK: Activities defined by OSHA involving removal of ACM which is not thermal system insulation or surfacing material., including but not limited to removal of asbestos-containing gypsum board, floor tile and floor sheeting, roofing and siding shingles, and construction mastic. Certain "incidental" roofing materials such as mastic, flashing and cements when they are still intact are excluded from Class II asbestos work. Removal of small amounts of these materials which would fit into a glovebag may be classified as a Class III job.

D. CLASS III ASBESTOS WORK: Activities defined by OSHA that involve repair and maintenance operations, where ACM, including TSI and surfacing ACM, is likely to be disturbed. Operations may include drilling, abrading, cutting a hole, cable pulling, crawling through tunnels or attics and spaces above the ceiling, where asbestos is actively disturbed or asbestos-containing debris is actively disturbed.

E. CLASS IV ASBESTOS WORK: Maintenance and custodial construction activities during which employees contact but do not disturb ACM and activities to clean-up dust, waste and debris resulting from Class I, II, and III activities. This may include dusting surfaces where ACM waste and debris and accompanying dust exists and cleaning up loose ACM debris from TSI or surfacing ACM following construction.

F. COMPETENT PERSON (CP): As used in this section, refers to a person employed by the Contractor who is legally qualified to inspects buildings for asbestos and who has EPA Model Accreditation Plan (MAP) "Building Inspector" training; accreditation as required by 40 CFR 763 - Subpart E, Appendix C, and who possesses an EPA/State certification or license as a “Building Inspector".

G. DISPOSAL BAG: A 6 mil thick, leak-tight plastic bag, pre-labeled in accordance with 29 CFR 1926.1101, used for transporting asbestos waste from containment to disposal site.

H. DISTURBANCE: Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount which can be contained in 1 standard sized glove-bag or waste-bag - size no larger than sixty (60) inches in length and width - in order to access a building component.

I. GLOVEBAG: Not more than a 60 by 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which material and tools may be handled.

J. HIGH-EFFICIENCY PARTICULATE AIR (HEPA) FILTER: A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter.

K. INDEPENDENT TESTING LABORATORY (for ACM work activities): An entity completely independent from the Contractor or Owner that is recognized by federal, state or local regulations, selected to perform the sample analyses and report the results.
L. NESHAP: National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at 40 CFR 61, Subpart M.
M. NONFRIABLE ACM: A NESHAP term defined in 40 CFR 61, Subpart M and EPA 340/1-90/018 meaning any material containing more than 1 percent asbestos that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure.
N. NONFRIABLE ACM (CATEGORY I): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90/018 meaning asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos.
O. NONFRIABLE ACM (CATEGORY II): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90/018 meaning any material, excluding Category I nonfriable ACM, containing more than 1 percent asbestos.
P. REGULATED AREA: An OSHA term defined in 29 CFR 1926.1101 meaning an area established to demarcate areas where Class I, II, and III asbestos work is conducted; including also any adjoining area where debris and waste from such asbestos work accumulate; and an area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed, the permissible exposure limit.
Q. REMOVAL: All operations where ACM is taken out or stripped from structures or substrates, and includes demolition operations.
R. REPAIR: Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM attached to structures or substrates.
S. SURFACING ACM: Asbestos-containing material which contains more than 1% asbestos and is sprayed-on, troweled-on, or otherwise applied to surfaces, such as acoustical plaster on ceilings and fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, or other purposes.
T. THERMAL SYSTEM INSULATION (TSI) ACM: ACM which contains more than 1% asbestos and is applied to pipes, fittings, boilers, breeching, tanks, ducts, or other interior structural components to prevent heat loss or gain or water condensation.

1.06 REFERENCED STANDARDS AND REGULATIONS: comply with applicable regulatory requirements, including the latest editions and most recent addenda, revisions and supplements of regulatory agencies, codes, and similar requirements, including but not limited to:

A. Occupational Safety and Health Administration (OSHA):
(1) Title 29 Code of Federal Regulations, Section 1910.134(d) - air Quality.
(2) Title 29 Code of Federal Regulations, Section 1926.1101- Construction Industry, including:
(a) Appendix A - OSHA Reference Method.
(b) Appendix B - Detailed Procedures for Asbestos Sampling and Analysis.
(c) Appendix C - Qualitative and Quantitative Fit Testing Procedures.
(d) Appendix D - Medical Questionnaires.
(e) Appendix E - Interpretation and Classification of Chest Roentgenograms.
(f) Appendix F - Work Practices and Engineering Controls for Major Demolition Operations.
(g) Appendix G - Work Practices and Controls for Small Scale, Short Duration Renovation Activities.
(3) Title 29 Code of Federal Regulations, Section 1926.59 - Hazard Communication Standard.

B. Environmental Protection Agency (EPA):
(1) Title 40 CFR Part 763 Subpart G - Asbestos Abatement Projects; worker Protection
(2) Title 40 CFR Part 61 - National Emission Standards for Hazardous Air Pollutants

1.07 SUBMITTALS

A. SUBMIT PRODUCT DATA for Vacuum Filters and Respirators
B. SUBMIT TEST REPORTS for sampling results, and the Occupational and Environmental Assessment Data Report.
C. SUBMIT CERTIFICATES including Qualifications of CP, Testing Laboratory qualifications, Occupant Notification, Training Certification of Workers and Supervisors, Notification of the Commencement of ACM Hazard Abatement.
D. QUALITY CONTROL SUBMITTALS, Submit the ACWP with CP approval (including signature, date, and certification number), Rental equipment notification, Respiratory Protection Program, Hazard Communication Program, EPA or State approved hazardous waste treatment, storage, or disposal facility for lead disposal, Lead Waste Management Plan, and Vacuum filter certifications.
E. CLOSEOUT SUBMITTALS: Clearance Certifications, Completed and signed hazardous waste manifest from treatment or disposal facility, Certification of Medical Examinations, Employee Training Certification, and Waste turn-in documents or weight tickets for non-hazardous wastes that are disposed of at sanitary or construction and demolition landfills.

1.08 QUALITY ASSURANCES

A. QUALIFICATIONS OF CP: Submit name, address, and telephone number of the Contractor’s CP. Provide previous experience of the CP, and include proper documentation that the CP is trained, licensed or otherwise certified in accordance with Federal, State, and local laws and the requirements of this Section.
B. TRAINING CERTIFICATION: Submit a certificate for each employee and supervisor, signed and dated by an authorized training provider, stating that the employee or supervisor has received the required training in ACM remediation procedures, and is certified to perform such activities. Submit proof the work will be performed by a certified firm.

C. TESTING LABORATORY (TL): Submit the name, address, and telephone number of the entity selected to perform the air and wipe sampling, testing, and reporting. Use an OSHA approved and accredited laboratory for testing ACMs by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA).

D. COMPETENT PERSON (CP) RESPONSIBILITIES

(1) Verify that training meets all federal, State, and local requirements.
(2) Review and approve the ACP for conformance with applicable standards. Ensure that work is performed in strict accordance with specifications at all times.
(3) Continuously inspect removal/control work for conformance with the approved plan.
(4) Perform air and wipe sampling.
(5) Control work to prevent hazardous exposure to human beings and to the environment at all times.
(6) Certify the conditions of the work as called for elsewhere in this specification.

E. ASBESTOS CONTROL PLAN (ACP): Submit a detailed job-specific plan of the work procedures to be performed. Include drawings indicating the location, size, and details of control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include a description of equipment and materials, controls and job responsibilities for each activity from which ACM will be removed. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of ACM related work, collected waste water and debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that ACMs are not released outside the control area. Include site preparation, cleanup and clearance procedures. Include occupational and environmental sampling, training, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan. Include a description of arrangements made among contractors on multi-contractor worksites to inform affected employees and to clarify responsibilities to control exposures.

F. PRE-ABATEMENT MEETING: Schedule and manage a meeting with the CP, the Architect, Owner representative, and other entities involved in abatement activities, before execution of the Work of this Section. Discuss and document the following:

(1) Preparation of regulated areas.
(2) Personal protective equipment to be used, including respiratory protection and protective clothing.
(3) Experience, training, certification, and assigned responsibilities of all individuals involved in the Work
(4) Decontamination procedures for personnel, regulated area and equipment.
(5) Abatement methods and procedures to be utilized.
(6) Required air monitoring procedures.
(7) Procedures for handling and disposing of waste materials.
(8) Procedures for final decontamination and cleanup.
(9) Work sequence and performance schedule.
(10) Procedures for dealing with heat stress, and other emergency procedures
(11) Methods of adhering plastic sheeting to the surfaces to be covered.

G. PROVIDE MATERIALS AND EQUIPMENT, including but not limited to respirators, protective wear, protective sheeting and other items as approved for use by the applicable regulatory agency and suitable for the intended purposes involved in the required abatement Work.

H. REGULATED AREAS: Conduct all Class I, II, and III Asbestos Work within regulated areas, which are demarcated to minimize the number of persons within the area and to protect persons outside the area from exposure to airborne asbestos. Access to regulated areas will be limited to authorized persons.

I. CONTROL MEASURES: Utilize one or any combination of the following control methods to achieve compliance with the "Permissible Exposure Limits":

(1) Local exhaust ventilation equipped with HEPA filter dust collection systems.
(2) General dilution ventilation equipped with HEPA filtration systems on both exhaust and return air.
(3) Vacuum cleaners equipped with HEPA filters.
(4) Enclosure or isolation of processes producing airborne asbestos fibers and dust.
(5) Use of wet methods, wetting agents or removal encapsulants
(6) Dry removal methods when wet methods would result in equipment damage or a safety hazard
(7) Prompt disposal of wastes contaminated with asbestos in leak-tight containers.

J. SUPPLEMENTAL CONTROL MEASURES: If above measures are not sufficient to reduce exposures, continue use to maintain exposure to lowest levels attainable and supplement with use of appropriate respiratory protection and protective clothing.

1.09 PREPARATION OF REGULATED AREAS

A. POST WARNING SIGNS at all approaches to a regulated area. Post signs at a distance sufficiently far enough away from the regulated area to permit any person to read the sign and take the necessary measures to avoid exposure.

B. SHUTDOWN AND LOCK OUT all heating, cooling and air conditioning system (HVAC) components that are in, supply or pass through regulated areas. Appropriate equipment and control measures must be utilized to prevent contamination of adjacent building spaces. Seal all intake and exhaust vents in the regulated areas with tape and two layers of poly sheeting. Seal any seams in system components that pass through the regulated areas.

C. DISCONNECT all electrical circuits to regulated areas. Provide temporary electrical service to regulated areas and other uncontaminated areas that are dependent on disconnected electrical circuits. Equip temporary electrical circuits with combination ground fault interrupter and circuit breakers meeting requirements of UL Class A, Group 1 devices, per requirements of the NEC. The ground fault interrupter portion must be solid state type, insulated and

isolated from the breaker mechanism. A test mechanism must provide overload and short circuit protection and must be operated by a toggle switch with over-center switching mechanism so that contact cannot be held closed.

D. PRE-CLEAN OBJECTS within regulated areas using a HEPA filtered vacuum or wet cleaning methods as appropriate. Clean machinery and behind grills or gratings where access may be difficult but contamination significant, and clean wall, floor and ceiling penetrations behind fixed items. After cleaning, enclose fixed objects in polyethylene sheeting and seal securely in place with tape. Remove movable cleaned objects from regulated areas to an uncontaminated location and store temporarily.

E. PRE-CLEAN SURFACES in regulated areas using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Do not use any methods that would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not disturb asbestos containing materials during the pre-cleaning phase.

F. SEAL OFF windows, doorways, elevator openings, corridors, entrances, drains, ducts, grills, grates, diffusers, skylights and any other openings between the regulated areas and uncontaminated areas outside the regulated areas (including the outside of the building, attics and crawl spaces) with poly sheeting and tape.

G. WALL PROTECTION: Cover with two (2) layers of poly sheeting, starting at top of wall and extending down and across the floor area until it meets in the center of the floor – and tape together to form a monolithic covering which completely encases the regulated area. Size poly sheets to minimize seams. Stagger seams and separate by a distance of at least six (6) feet. Secure wall protection to prevent it from falling away from the walls – providing additional support and attachment methods when negative pressure ventilation systems are utilized.

H. FLOOR PROTECTION: Cover the floor area previously covered with poly sheeting extended from the walls with one additional layer of minimum 6 mil poly sheeting. Provide additional protection such as plywood, canvas, or extra plastic sheeting for floors requiring special protection such as carpeting, hardwood flooring and tile floors which may be damaged by water leakage, ladder feet or scaffold wheels. Additional layers of sheeting may be utilized as drop cloths to aid in cleanup of bulk materials. Size sheeting to minimize seams. Locate necessary seams on successive layers of sheeting staggered a minimum of six (6) feet to reduce potential for water penetration into the flooring material. Do not locate any parallel seams at wall/floor joints. Extend floor protection at least 24" up the side walls of the work area.

I. WORKER DECONTAMINATION ENCLOSURE SYSTEM: Provide at each location where workers will enter or exit a regulated area. Portable, prefabricated units may be used, or construct of six (6) mil opaque black or white poly sheeting or equivalent materials for privacy. Provide a clean room, shower room, and an equipment room, each separated from each other and from the regulated area by air locks, and as follows:

J. AIRLOCKS: Access between any two rooms in the decontamination enclosure system and entry and exit from the decontamination enclosures must be through airlocks with at least three (3) feet separating each curtained doorway. Pathways into (from clean to contaminated) and out from (contaminated to clean) the regulated area must be clearly designated. Fabricate curtained doorways of two sheets of overlapping six (6) mil polyethylene sheeting, secured at the top and one side opposite each other. Provide curtains with weights attached to the bottom to insure that they hang straight and maintain a seal over the doorway when not in use.

K. CLEAN ROOM: Size to adequately accommodate work crews. Provide clean, disposable clothing, replacement filters for respirators, disposable towels and other necessary items in adequate supply, and a location for postings within each clean room.

L. SHOWER ROOM: Provide one or more shower heads as required to adequately accommodate workers. Supply each shower head with hot and cold water adjustable by a tap. Construct to insure against leakage of any kind. Provide an adequate supply of soap and disposable towels available at all times. Drain shower water, collect and filter as required by applicable regulations.

M. EQUIPMENT ROOM: Provide for storage of equipment and tools at the end of a shift after workers have been decontaminated. Store replacement filters (in sealed containers until used) for HEPA vacuums and negative pressure ventilation equipment, extra tools, containers or surfactant and other materials and equipment that may be required during the abatement operations. Provide a water-filled walk-off pan located in the regulated area just outside the equipment room for workers to clean off foot coverings after leaving the regulated area and prevent excessive contamination of the worker decontamination enclosure system. Provide a drum lined with a labeled six (6) mil polyethylene bag for collection of disposable clothing located in this room. Store contaminated rubber boots or other reusable footwear in this area for reuse the following workday.

N. WASTE CONTAINER PASS-OUT AIRLOCK SYSTEM: Construct away from Worker Decontamination Enclosure System, located where there is direct access from the regulated area to the outside of the building. The airlock system consists of an airlock, a container staging area, and another airlock with access to outside the regulated area. Construct similar to the Worker Decontamination Enclosure System using similar materials with airlock and curtain doorway designs. Do not use this airlock system to enter or exit the regulated area, and tightly seal when not in use.

O. EMERGENCY EXITS: Establish and clearly mark to permit easy location from anywhere within the regulated area – secured to prevent access from uncontaminated areas, but still permit emergency exiting. Properly seal these exits with sheeting which can be cut to permit egress if needed. Emergency exits may pass through the decontamination enclosure, the waste pass-out airlock, other alternative exits satisfactory to AHJ representatives.

P. TEMPORARY ISOLATION PARTITIONS: Provide within large rooms or open areas that require temporary air tight barriers to separate a contaminated regulated area from an uncontaminated area, constructed as follows:

(1) WALLS: Construct of wood or metal framing to support barriers in all openings larger than 4' x 8'.
(2) APPLY SHEATHING MATERIAL (plywood, drywall) of at least 3/8" thickness to work side of barrier.
(3) COVER work side of partition with double layer of four (4) mil poly sheeting with staggered joints and seal in place.
(4) WINDOW: One (1) each min. 12 x 12 inch heavy gage plastic sealed unit to view regulated area

Q. ENCLOSURE SYSTEM MAINTENANCE: After installation of system enclosures, initiate negative pressure system and allow overnight settling to insure that barriers will remain intact and secured to walls and fixtures before beginning actual abatement activities. Inspect all poly barriers and decontamination system enclosures at least twice daily prior to start of each day's abatement activities and after completion. Document inspections and observations in the daily project log.

(1) IMMEDIATELY REPAIR damage and defects in the enclosure system upon discovery.
(2) TEST EFFECTIVENESS of barrier system using smoke tubes
(3) STOP ALL WORK ACTIVITIES of abatement when visible abatement related dust or debris is observed outside of the regulated area or if damage occurs to barriers. Repair barriers as required and clean debris/residue using appropriate HEPA vacuuming and wet mopping procedures.

R. MAKE NEGATIVE AIR-PRESSURE OPENINGS in the Enclosure system airtight using tape and sealant. When multiple openings are provided, test individually, checking the integrity of barriers for secure attachment and provide additional reinforcement if required. Insure that adequate power supply is available to satisfy the requirements of the ventilating and exhaust units. Exhaust negative pressure units to the outside of the building – not into occupied areas of the building. Provide careful installation and daily inspections to insure that the ducting does not release fibers into uncontaminated building areas.

S. DO NOT USE enclosure systems until the following are completed:

(1) Enclosure systems are constructed, inspected, and tested.
(2) Negative pressure systems are functioning adequately.
(3) Pre-abatement submissions, notifications, postings and permits have been provided and approved
(4) All equipment for abatement, cleanup and disposal are placed at the Project Site.
(5) All worker training is completed.
(6) Written Notice-To-Proceed is received from applicable regulatory authorities

PART 2 - WORKPLACE ENTRY AND EXIT PROCEDURES

2.01 ENTRY TO REGULATED AREAS by workers and other authorized personnel must be made only through a Decontamination Enclosure System. Post required procedures in both the clean room and the equipment room. All persons must sign the registration log located in the clean room, both upon entry and exiting the area. All persons must proceed first to the clean room, remove all street clothes, and appropriately install respiratory protection, disposable coveralls, head covering and foot covering in addition to hard hats, eye protection and gloves required for operations. Provide clean respirators and protective clothing for use by each person for each separate entry into the regulated area. Personnel wearing designated personal protective equipment must then proceed from the clean room through the decontamination enclosure system to the regulated area.

2.02 UPON LEAVING THE REGULATED AREAS, all persons must remove gross contamination from the outside of respirators and protective clothing by brushing or wet wiping procedures, using small HEPA vacuums with brush attachments or equivalent equipment. Bottoms of protective footwear must be cleaned in the walk-off pan just prior to entering the equipment room. Persons are then to proceed to the equipment room where they remove all protective equipment except respirators. Deposit disposable clothing into appropriately labeled containers for disposal. Store reusable, contaminated footwear in the equipment room when not in use in the regulated area – and dispose as asbestos contaminated waste upon completion. Decontaminate rubber boots at completion of the abatement for reuse. Still wearing respirators, all persons must proceed to the shower area, clean the outside of the respirators and the exposed face area under running water prior to removal of respirator, and shower and shampoo to remove residual asbestos contamination. After showering and drying off, persons are to proceed to the clean room and apply their street clothing.

2.03 NO EATING, DRINKING, SMOKING gum chewing or tobacco chewing is permitted within regulated areas.

2.04 WASTE CONTAINER PASS-OUT PROCEDURES

A. TRANSPORT CONTAINERIZED CONTAMINATED WASTE out of regulated areas through the waste container pass-out airlock (or through the decontamination enclosure if a separate airlock has not been constructed).

B. CLEAN THE ENTIRE SURFACE, including bottoms of properly labeled bags, using HEPA vacuums and wet wiping techniques and transport them into the waste container pass-out airlock where they will be placed into another properly labeled bag by personnel inside the enclosure wearing protective clothing and respirators appropriate for the contaminated regulated area. No worker from the inside team may further exit the regulated area through this airlock. Workers outside the regulated area wearing appropriately assigned respirators, must enter the airlock from outside the regulated area. No worker from the outside team may further enter the regulated area through this airlock. Secure the exit from the airlock to prevent unauthorized entry.

C. WATER COLLECTION AND DISPOSAL: Collect all water waste resulting from pre-cleaning operation, excess from floor of regulated area and final cleaning operation into sealed containers for disposal as contaminated material. Collect water from the decontamination shower in a holding tank and filter to remove particles of 0.5 microns or larger size before draining water into sanitary sewer system.

2.05 WET ABATEMENT REMOVAL PROCEDURE

A. WET ALL ACM'S with an amended water solution, or removal encapsulant, using equipment capable of providing a fine spray mist, in order to reduce airborne fiber concentrations when the material is disturbed. Saturate the material to the substrate. Keep all removed material wet to prevent fiber release until it can be containerized for disposal. If regulated area temperatures are below 32 degrees F and amended water is subject to freezing, provide anti-freeze components. Maintain high humidity in the regulated area by misting or spraying to assist in fiber settling and reduce airborne concentrations.

B. REMOVE SATURATED ACM'S in manageable sections and place into containers before moving to a new location for continuance of work. Spray adjacent areas periodically to maintain in a wet condition until visible material is cleaned up.
C. REMOVE ACM's from building structures or components as intact sections or components whenever possible and carefully lower to the floor – do not drop or throw. For materials between 15 and 50 feet AFF, containerize at elevated levels or drop onto inclined chutes or scaffolding for subsequent collection and containerization.
D. FILL BAGS until half of their capacity is reached, and securely seal to prevent accidental opening and leakage by tying tops of bags in an overhand knot or by taping in gooseneck fashion – do not seal bags with wire or cord.
E. WRAP LARGE REMOVED COMPONENTS intact in two (2) layers of six (6) mil polyethylene sheeting secured with tape for transport to the approved disposal site.
F. PLACE ACM MATERIALS WITH SHARP-EDGED COMPONENTS (nails, screws, metal lath, metal sheeting) into drums for disposal in lieu of polyethylene bags. Mark such drums to differentiate contents from those drums containing bagged material.
G. WET BRUSH AND SPONGE substrate surfaces from which ACM's have been removed after completion of stripping work to remove all visible residue.

2.06 CEILING SYSTEM REMOVAL

A. REMOVE, CLEAN AND ENCLOSE ceiling mounted objects including lights and other items that may interfere with the abatement process that were not previously cleaned and sealed off. Use localized spraying of amended water, or HEPA vacuums, to reduce fiber dispersal during the removal of these fixtures.
B. REMOVE CEILING PANELS OR TILES within the regulated area carefully. If panels are to be reused, vacuum them with a HEPA filtered vacuum cleaner and carefully damp sponge and wrap cleaned units in poly sheeting, seal with tape, and store outside the regulated area. If units are to be discarded it is not necessary to clean them, but wrap in a similar fashion and stage for disposal in the waste container pass-out airlock.
C. CEILING GRID: When suspended ceiling grid components must be removed, HEPA vacuum and wet sponge each piece after removal from hangers. Wrap clean grid pieces in poly sheeting, seal with tape and store outside the regulated area or in the waste staging area if designated for disposal. When removal is not required, leave system in place and clean properly following completion of abatement.
D. REMOVE ACM CONTAMINATED CEILINGS complete with lath, furring channels, wire mesh, ties, clips, screws, nails and other accessory items and dispose as asbestos contaminated waste material. Spray ceiling materials and debris with amended water to keep wet until containerized for disposal as Work progresses.

2.07 FLOOR FINISH REMOVAL: Use solvents to remove flooring adhesive completely so that the substrate has no adhesive residue or debris remaining upon completion. Wash substrate with soap and water to remove all solvent. Repair or replace substrate building components damaged by excessive use of solvents.

A. GLOVE-BAG ABATEMENT: Use for small-scale, short-duration removal only when permitted by AHJ representatives.
B. PREPARE AREAS around glove-bag abatement using poly sheeting drop-cloths on floor and wall in a twelve (12) foot perimeter of the removal area and providing a negative air machine exhausting air through a HEPA filter. Install glove-bags under negative pressure during removal operations. In rooms smaller than the above area, seal door, window and all other openings with poly sheeting, shut-down the HVAC system, and introduce negative air-pressure to the affected area before using glove-bags.
C. WORKERS USING GLOVE-BAGS must wear (as a minimum) half mask dual--cartridge HEPA--equipped respirator, and full protective clothing to protect against the possibility of accidental leakage.
D. PLACE TOOLS and materials that will be required during the removal procedure into the Glove-Bag tool pouch. Apply glove-bag so that it completely encompassed the surface where removal work will take place. Cut side seams of the glove-bag the appropriate length to accommodate a size that will fit over the removal area. Place glove-bag into position and fold bag edges together and seal with tape. Seal all openings in the bag with tape, and seal the bottom seam with tape to prevent leakage.
E. GLOVE-BAG ABATEMENT: Remove ACM's within the glove-bag by thoroughly wetting with a wetting agent or removal encapsulant, applied with an airless sprayer through the side port of the glove-bag. After ACM's are removed, the exposed base surface must be thoroughly cleaned and wet wiped until all traces of ACM's is removed. Create constant negative pressure by running a HEPA vacuum hose into bag. Encapsulate exposed edges of ACM's that will remain after bag is removed with a bridging encapsulant to seal the material from releasing fibers to the atmosphere.

2.08 MINI-ENCLOSURE METHOD:

A. USE MINI-ENCLOSURES WHEN Work is too large for glove-bag abatement but of small-scale and short duration that a large enclosure is not warranted. A mini-enclosure can be small enough to restrict the space to use by one worker. Provide a small Changing Room contiguous to the mini-enclosure, a minimum of three (3) feet square.
B. CONSTRUCT by affixing plastic sheeting to existing walls and covering the floor with poly sheeting extending up walls at least 24 inches and sealed with tape. If existing walls are not available, construct a 2 x 4 wood framework with two (2) layers of poly sheeting sealed with tape applied to the interior side to allow clean "take-down," upon completion. Provide double poly curtains at the exit and the entrance to the mini-work enclosure – secure both curtains in each opening at the top and one side opposite from the other. Extend a hose from a HEPA vacuum through the enclosure and seal tight with tape. Run the HEPA vacuum continuously while abatement operations are ongoing.
C. PERFORM ABATEMENT WORK in a mini-enclosure using the wet removal method. All debris from such work must be bagged and disposed of as contaminated material. Upon completion, clean the interior surfaces of the regulated area and spray with an encapsulant. The abatement worker must wear two (2) Tyvek R or equivalent disposable work suit with appropriate HEPA filtered dual cartridge respiratory protection. Upon completion of the Work and

before leaving the change area, the abatement worker is to remove the outer work suit and then proceed to a shower that is not contiguous with the work area. Collapse the entire Mini-Enclosure unit inwardly – including the regulated area and the change room – bag and dispose of as contaminated material.

2.09 ENCAPSULATION PROCEDURES: Clean and isolate the regulated areas as previously indicated in “Preparation of Regulated Areas”. Repair damaged and missing areas of existing materials with nonasbestos-containing substitutes. Material must adhere adequately to existing surfaces and provide an adequate base for application of encapsulating agents. Apply filler material applied in accordance with manufacturer's recommended specifications. Spray apply with airless equipment with low nozzle pressure to all surfaces where asbestos is removed or surfaces containing asbestos that are to remain in place. Spray material to completely encapsulate any remaining asbestos, permanently locking it in place. Apply a minimum of one (1) coat with coverage in strict accordance with manufacturer's recommendations. Surfaces must be dry and free of dirt, oil and dust.

2.10 ENCLOSURE PROCEDURE: Clean and isolate the regulated areas as previously indicated in “Preparation of Regulated Areas”. Spray areas that will be disturbed during the installation of hangers or other support/framing materials for the enclosure with water containing surfactant. Keep these areas damp to reduce airborne fiber concentrations. Remove loose or hanging ACM’s. After installation of hangers and other fixing devices and before installation of the enclosure, repair damaged areas of fireproofing/thermal insulation materials using non-asbestos-containing replacement materials. Prepare surfaces and apply replacement material in accordance with manufacturer's recommendations.

2.11 AIR SAMPLING & MONITORING: Take air-samples with a high volume pump with a capacity of 10 to 16 liters per minute (not including a breathing zone pump). Engage an independent entity to perform air-samples per requirements of the AHJ. As a minimum, conform with requirements of OSHA Standard 29 CFR 1926.1101 – Appendix A for sample collection procedures and evaluations in determining exposure levels. Provide both “base” tests and clearance testing. Analyze all air-samples collected by a laboratory accredited by the American Industrial Hygiene Association. Submit results of each analysis to the AHJ when required, and copy to the Owner and Architect. Include the following documentation, as a minimum:

2.12 AIR SAMPLING PROCEDURES: Sampling times; sampling locations (with appropriate diagrams); evidence of periodic inspection of sampling equipment; documentation of pre and post calibration of equipment; detailed description of work conditions; description of worker protective devices; and a description of any atypical environmental conditions.

2.13 AIR SAMPLING ANALYSIS: Sample identification; sample duration; sample flow rate; total air volume; total fibers counted; total fields counted; blank filter analysis; reticule field area; and fiber concentration in fibers per cubic centimeter. Determine the concentration of fibers by the membrane filter method at 400-450X (magnification) (4 millimeter objective) with phase contrast illumination (PCI).

2.14 BASELINE TEST: Provide prior to the commencement of work. Take a 1,200 liter ambient air-sample (AHERA PCM protocol) within each regulated area, within the confines of the building in close proximity to the regulated area, and also outside of the building area.

A. OSHA P.E.L. As required by 29CFR 1926.1101(c). Within the breathing zone of each worker category (i.e., wetter, receiver, bagger) 25% of the crew or one per job category.

2.15 DAILY PERSONAL AIR MONITORING (OSHA Compliance): Perform daily determination of employee exposure by collecting one or more breathing zone samples that are representative of a full-shift exposure for each employee within each regulated area; and one or more breathing zone air samples that are representative of 30-minute exposures associated with operations that are most likely to produce exposures above the excursion limit for employes in each regulated area. Do not perform daily testing when employees are equipped with supplied-air respirators operated in a positive-pressure mode while performing abatement work.

PART 3 - CLEANUP PROCEDURES

3.01 REMOVE AND CONTAINERIZE all visible accumulations of asbestos containing material and asbestos contaminated debris utilizing rubber dust pans and rubber squeegees to move material around. Do not use metal shovels to pick up or move accumulated waste. Special care must be taken to minimize damage to floor sheeting.

3.02 WET CLEAN all surfaces in the regulated area using rags, mops and sponges as appropriate. (Note: Some HEPA vacuums might not be wet-dry vacuums.)

3.03 SPRAY SHEETING with an encapsulant before removing the inner layer of plastic sheeting, so that any residue remaining will be adhered to the plastic sheeting. Remove the cleaned inner layer of plastic sheeting from walls and floors. Windows, doors, HVAC system vents and all other openings must remain sealed. The negative pressure ventilation units must remain in continuous operation. Decontamination enclosure systems must remain in place and be utilized.

3.04 REMOVE ALL CONTAINERIZED WASTE from the regulated area and waste container pass-out airlock.

3.05 AFTER CLEANING THE REGULATED AREA, either spray the remaining barrier material with encapsulant or, wait at least 24 hours to allow fibers to settle and HEPA vacuum and wet clean all objects and surfaces in the regulated area again. Decontaminate all tools and equipment and remove at the appropriate time in the cleaning sequence. Clean until the regulated areas are in compliance with clearance testing.

3.06 AFTER SATISFACTORY CLEARANCE TESTING of air-samples, remaining barriers and properly disposed of prior to other trades occupying the area. Uncover and thoroughly clean all fixed objects within the area, which were covered with poly prior to abatement work. A final visual inspection may be preformed by the AHJ to insure that no contamination remains in the regulated area. Provide additional cleaning and air-testing if unsatisfactory conditions exist until satisfactory clearance testing is obtained.

3.07 CLEARANCE TESTING BY PHASE CONTRAST MICROSCOPY (PCM):

A. PERFORM CLEARANCE SAMPLING and analysis only after completion of abatement work. Conduct air-sampling for final clearance using collection procedures in accordance with NIOSH Standard Analytical Method 7400. Provide sufficient air-volumes to provide reliable results down to a concentration of 0.01 fibers per cubic centimeter of air (f/cc) or lower. Minimum air volumes of 1,200 liters must be collected on a 25 mm filter. Perform sampling with portable fans circulating air in the Work area to simulate actual use conditions – negative pressure ventilation units are not to be used for this purpose.
B. PROVIDE a minimum of three (3) samples for each 1,000 square feet of enclosed area or as otherwise required by the AHJ.
C. ANALYZE AIR-SAMPLES by the Phase Contrast Microscopy (PCM) method except where Transmission Electron Microscopy (TEM) is required by the AHJ. All samples analyzed must indicate concentrations of airborne fibers less than 0.01 f/cc, or less than the average of the fiber count established by Base Testing for outside containment air, whichever is greater. Re-clean areas exceeding this level until satisfactory levels are obtained. Protective barriers can be removed only when tests meet the acceptable level.
D. PROVIDE INITIAL CLEARANCE TESTING in addition to all retesting required due to failure to meet requirements for clearance

3.08 CLEARANCE TESTING BY TRANSMISSION ELECTRON MICROSCOPY (TEM)

A. PERFORM CLEARANCE SAMPLING and analysis only after abatement work area is completely cleaned and visually inspected. Collect five (5) samples simultaneously within the enclosed work area and collect five (5) additional samples outside the enclosure area for the purpose of comparison. The volume of air drawn for each sample collected must be equal to or greater than 1200 liters of air using a 25 mm filter, or 2800 liters of air using a 37 mm filter. An additional three samples (referred to as field blanks) must be provided. Two (2) samples must be taken by removing the cap for 30 seconds and replacing it. These samples must be made at entrance to enclosure and at an ambient site. The third sample must remain sealed and kept with the other samples.
B. ANALYZE SAMPLES using the TEM method specified in EPA regulation 40 CFR Part 763, Appendix A to Subpart E. If the average concentration of asbestos in the five samples does not exceed the filter background level of 70 structures per square millimeter, then the area may be declared clear of asbestos. If the average concentration of asbestos in the five samples collected from the enclosed work area exceeds the filter background level of 70 structures per square millimeter, then a comparison of the ten samples must be made to determine if the average of the enclosure samples is significantly larger than the average of the outside samples and the three field blanks. A statistical comparison using the Z-test found in 40 CFR Part 763, Appendix A to Subpart E must be used to determine if the two averages are significantly different. Should the test indicate no significant difference, the area will be considered clear of asbestos. If a significant difference is noted, the cleaning procedure must be repeated and retesting must be required.

3.09 ABATEMENT CLOSEOUT & DISPOSAL PROCEDURES

A. REMOVE AND TRANSPORT sealed and labeled containers of ACM waste directly to the pre-arranged NESHAP authorized disposal location as the Work progresses to prevent exceeding the available storage capacity on site. Use of an intermediate storage location is not acceptable. Mark vehicles used to transport ACM containing waste materials in accordance with NR 447.12(4)(a)1 to 3.
B. PROVIDE CHAIN-OF-CUSTODY DOCUMENTATION in the form of a transportation and disposal manifest that will provide a chain-of-custody record of all ACM waste from the project site to the disposal site. All ACM waste generated must be accounted for by these records and copies of all such records must be delivered to the Owner.
C. PROVIDE A LOCKABLE WASTE CONTAINER consisting of a truck, trailer or dumpster, for storage and transportation of ACM waste. Lock unit while unattended and during transportation of waste. Load bags directly into the waste container for transportation upon removal from the regulated area. Unit must be free of debris and lined with poly sheeting to prevent contamination from leaking. Install floor sheeting first and extend up the side walls – and overlap wall sheeting and tape into place. Place drums on level surface in the waste container and pack tightly together to prevent shifting and tipping. Secure large components to prevent shifting and place bags on top. Do not throw ACM containers into the waste container. Protect personnel loading ACM containing waste containers with disposable clothing including head, body and foot protection and at a minimum, half-face-piece, air-purifying, dual cartridge respirators equipped with HEPA filters. Immediately clean any debris or residue observed on containers or surfaces outside of the regulated area resulting from cleanup or disposal activities using HEPA filtered vacuum equipment and/or wet methods.
D. DISPOSAL AT LANDFILL: Upon reaching the landfill, trucks are to approach the dump location as closely as possible for unloading of the asbestos containing waste. Inspect bags, drums and components as they are off-loaded at the disposal site. Carefully tape shut damaged containers and re-packed into drums or bags as required. Place waste containers on the ground at the disposal site, not pushed or thrown out of trucks. Personnel off-loading containers at the disposal site must wear protective equipment consisting of disposable head, body and foot protection and, at a minimum, half-facepiece, air-purifying, dual cartridge respirators equipped with HEPA filters. After removal of all containerized waste, de-contaminate the truck cargo area using HEPA vacuums and wet methods to meet the no visible residue criteria. Remove poly sheeting and discarded with contaminated cleaning materials and protective clothing, in bags or drums at the disposal site.

3.10 REESTABLISHMENT OF REGULATED ABATEMENT AREAS can occur only after completion of cleanup procedures and after clearance air monitoring has been performed and documented. Re-secure objects removed from their original locations during area preparation activities. Re-secure and relocate objects removed to temporary locations back to their original positions. Reestablish HVAC, mechanical and electrical systems in proper working order as originally existed. Remove potentially contaminated HVAC system filters and dispose of as asbestos contaminated waste. Decontaminate filter assembly using HEPA vacuums and wet cleaning techniques.

END OF SECTION 02 82 00

SECTION 02 83 00 – HEAVY METALS REMEDIATION

PART 1 – GENERAL

1.01 THE SCOPE OF WORK of this Section will be authorized by the Owner after submittal and review of the Hazardous Materials Assessment and Work Plan proposed, as required in Division-02 Section “Hazardous Materials Assessment”. Based upon specific direction and authorization by the Owner, provide provide Heavy Metals Remediation, that may include the following:

1.02 REMOVE AND CONTROL existing Heavy-Metal Materials (HMMs) discovered by application of proper cleaning techniques, engineered controls and application of best management practices. The Work includes containment and disposal of HMMs, and includes handling, legal disposal, and procedures and equipment required to protect workers, the environment, building occupants, and the existing building, from contact with HMMs, including the following:

A. Lead-Based Paint or Paint with Lead (LBPs),
B. Mercury containing lighting and switches

1.03 THIS SECTION INCLUDES various cleaning, removal and disposal protocols of existing building materials. The level of containment and requirements for cleaning and remediation of materials will depend on the existing conditions of the space and the materials being remediated. Furnish labor, materials, services, and equipment necessary in accordance with applicable Federal, State, and local regulations, and as follows:

1.04 ENGAGE THE SERVICES OF A COMPETENT PERSON (CP) who is a qualified and certified Planner / Project Designer to prepare a Heavy-Metals Remediation Control Plan (HM/RCP). Engage the CP to determine the specific needs for personnel protective equipment (PPE) to be used with the HM/RCP, and include an assessment of the risk for people to occupy areas adjoining the remediation areas while remediation work is occurring.

1.05 COORDINATE with Work being performed in adjacent areas. Detail coordination procedures in the HM/RCP and detail how lead exposure will be prevented to other Work, workers or other personnel performing Work unrelated to lead remediation activities.

1.06 THE OWNER RESERVES THE RIGHT to engage a separate CP to review and approve the HMM Assessment Survey, the HM/RCP, to monitor activities at the site at any time while Work is in progress, and to verify compliance with the HM/RCP, including verification of clearance testing. Remove Worker from the site if the Owner’s CP observes their non-compliance with the quality requirements specified herein.

1.07 REFERENCE STANDARDS AND REGULATORY AGENCIES: comply with applicable regulatory requirements, including the latest editions and most recent addenda, revisions and supplements of regulatory agencies, codes, and similar requirements, including but not limited to:

A. AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)
   (1) AIHA Z88.6: (2006) Respiratory Protection - Respirator Use-Physical Qualifications for Personnel
B. U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)
   (1) HUD 6780: (1995; Errata Aug 1996;Rev Ch. 7 - 1997) Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing
C. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
   (1) 29 CFR 1926.103: Respiratory Protection
   (2) 29 CFR 1926.21: Safety Training and Education
   (3) 29 CFR 1926.33: Access to Employee Exposure and Medical Records
   (4) 29 CFR 1926.55: Gases, Vapors, Fumes, Dusts, and Mists
   (5) 29 CFR 1926.59: Hazard Communication
   (6) 29 CFR 1926.62: Lead
   (7) 29 CFR 1926.65: Hazardous Waste Operations and Emergency Response
   (8) 40 CFR 260: Hazardous Waste Management System: General
   (9) 40 CFR 261: Identification and Listing of Hazardous Waste
   (10) 40 CFR 262: Standards Applicable to Generators of Hazardous Waste
   (11) 40 CFR 263: Standards Applicable to Transporters of Hazardous Waste
   (12) 40 CFR 264: Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
   (13) 40 CFR 265: Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
   (14) 40 CFR 268: Land Disposal Restrictions
   (15) 40 CFR 745: Lead-Based Paint Poisoning Prevention in Certain Residential Structures
   (16) 49 CFR 172: Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
   (17) 49 CFR 178: Specifications for Packagings
D. UNDERWRITERS LABORATORIES (UL)
   (1) UL 586: (2009) Standard for High-Efficiency Particulate, Air Filter Units

1.08 DEFINITIONS

A. ABATEMENT: means any set of measures designed to permanently eliminate lead-based paint hazards in accordance with standards established by appropriate Federal agencies. Such term includes:

(1) The removal of lead-based paint and lead-contaminated dust, the permanent containment or encapsulation of lead-based paint, the replacement of lead-painted surfaces or fixtures, and the removal or covering of lead contaminated soil; and
(2) All preparation, cleanup, disposal, and post-abatement clearance testing activities associated with such measures.

B. ACTION LEVEL: Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period in a work environment.
C. AREA SAMPLING: Sampling of lead concentrations within the lead control area and inside the physical boundaries, which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.
D. COMPETENT PERSON (CP): As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, State, and local regulations. The CP for this Project must be either a Certified Industrial Hygienist (CIH) who has been certified for comprehensive practice by the American Board of Industrial Hygiene, or a Certified Safety Professional (CSP) certified by the Board of Certified Safety Professionals. The CP must have completed an EPA Lead-Safe Certification Program and be certified by the EPA to conduct lead-based paint activities and renovations under the EPA's Lead-Based Paint Renovation, Repair and Painting (RRP) Program.
E. CONTAMINATED ROOM: Refers to a room for removal of contaminated personal protective equipment (PPE).
F. DECONTAMINATION SHOWER FACILITY: An enclosure that contains a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.
G. DELEADING: Activities conducted by a person who offers to eliminate lead-based paint or lead-based paint hazards or to plan such activities in commercial buildings, bridges or other structures.
H. EIGHT-HOUR TIME WEIGHTED AVERAGE (TWA): Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.
I. HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTER EQUIPMENT: HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.
J. LEAD: Metallic lead, inorganic lead compounds, and organic lead soaps.
K. LEAD-BASED PAINT (LBP): Paint or other surface coating that contains lead in excess of 1.0 milligrams per centimeter squared or 0.5 percent by weight.
L. LEAD-BASED PAINT ACTIVITIES: Lead-based paint activities include; a lead-based paint inspection, a risk assessment, or abatement of lead-based paint hazards.
M. LEAD-BASED PAINT HAZARD (LBP HAZARD): Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.
N. PAINT WITH LEAD (PWL): Any paint that contains lead as determined by the testing laboratory using a valid test method. The requirements of this section does not apply if no detectable levels of lead are found using a quantitative method for analyzing paint using laboratory instruments with specified limits of detection (usually 0.01 percent). An X-Ray Fluorescence (XRF) instrument is not considered a valid test method.
O. LEAD CONTROL AREA: A system of control methods to prevent the spread of lead dust, paint chips or debris to adjacent areas that may include temporary containment, floor or ground cover protection, physical boundaries, and warning signs to prevent unauthorized entry of personnel. HEPA filtered local exhaust equipment may be used as engineering controls to further reduce personnel exposures or building/outdoor environmental contamination.
P. LEAD PERMISSIBLE EXPOSURE LIMIT (PEL): Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a workday, the PEL shall be determined by the following formula:
Q. PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day
R. PERSONAL SAMPLING: Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour TWA concentration in accordance with 29 CFR 1926.62. Samples must be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and centered at the nose or mouth of an employee.
S. PHYSICAL BOUNDARY: Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside the physical boundary."

1.09 SUBMITTALS

A. PRODUCT DATA for Vacuum Filters and Respirators
B. TEST REPORTS for sampling results, and the Occupational and Environmental Assessment Data Report.
C. CERTIFICATES including Qualifications of CP, Testing Laboratory qualifications, Occupant Notification, Training Certification of Workers and Supervisors, Notification of the Commencement of LBP Hazard Abatement.
D. QUALITY CONTROL SUBMITTALS, including Lead-Based Paint / Paint with Lead Removal / Control Plan (RCP) including CP approval (with signature, date, and certification number), Rental equipment notification, Respiratory Protection Program, Hazard Communication Program, EPA or State approved hazardous waste treatment, storage, or disposal facility for lead disposal, Lead Waste Management Plan, and Vacuum filter certifications.
E. CLOSEOUT SUBMITTALS: Clearance Certifications, Completed and signed hazardous waste manifest from treatment or disposal facility, Certification of Medical Examinations, Employee Training Certification, and Waste turn-in documents or weight tickets for non-hazardous wastes that are disposed of at sanitary or construction and demolition landfills.

1.10 QUALITY ASSURANCES

A. QUALIFICATIONS OF CP: Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained [and licensed] [and certified] in accordance with Federal, State, and local laws.
B. TRAINING CERTIFICATION: Submit a certificate for each employee and supervisor, signed and dated by the authorized training provider meeting 40 CFR 745 (Subpart L) requirements, stating that the employee or supervisor has received the required lead training and is certified to perform or supervise deleading or lead removal. Submit proof the work will be performed by a certified firm.
C. TESTING LABORATORY (TL): Submit the name, address, and telephone number of the entity selected to perform the air and wipe sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis. Laboratories selected to perform blood lead analysis shall be OSHA approved.

1.11 COMPETENT PERSON (CP) RESPONSIBILITIES

A. Verify training meets all federal, State, and local requirements.
B. Review and approve lead-based paint/paint with lead removal/control plan for conformance to the applicable standards. Ensure work is performed in strict accordance with specifications at all times.
C. Continuously inspect lead-based paint removal/control work for conformance with the approved plan.
D. Perform air and wipe sampling.
E. Control work to prevent hazardous exposure to human beings and to the environment at all times.
F. Certify the conditions of the work as called for elsewhere in this specification.

1.12 HEAVY METALS REMOVAL & CONTROL PLAN (HM/RCP): Submit a detailed job-specific plan of the work procedures to be used in the removal/control of HMMs. Include drawings indicating the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include a description of equipment and materials, controls and job responsibilities for each activity from which lead is emitted. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that lead is not released outside the lead control area. Include site preparation, cleanup and clearance procedures. Include occupational and environmental sampling, training, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan. Include a description of arrangements made among contractors on multi-contractor worksites to inform affected employees and to clarify responsibilities to control exposures.

1.13 OCCUPATIONAL AND ENVIRONMENTAL ASSESSMENT DATA REPORT

A. IF INITIAL MONITORING IS NECESSARY, submit occupational and environmental sampling results to the Architect within three working days of collection, signed by the testing laboratory employee performing the analysis, the employee that performed the sampling, and the CP.
B. TO REDUCE THE FULL IMPLEMENTATION of 29 CFR 1926.62, the Contractor must provide documentation. Submit a report that supports the determination to reduce full implementation of the requirements of 29 CFR 1926.62 and supporting the HM/RCP.
C. THE INITIAL MONITORING SHALL REPRESENT each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures per 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead for stated work.
D. SUBMIT WORKER EXPOSURE DATA gathered during the task based trigger operations of 29 CFR 1926.62 with a complete process description. This includes manual demolition, manual scraping, manual sanding, heat gun, power tool cleaning, rivet busting, cleanup of dry expendable abrasives, abrasive blast enclosure removal, abrasive blasting, welding, cutting and torch burning where lead containing coatings are present.
E. THE INITIAL ASSESSMENT WILL DETERMINE the requirement for further monitoring and the need to fully implement the control and protective requirements including the lead compliance plan per 29 CFR 1926.62.
F. MEDICAL EXAMINATIONS: Initial medical surveillance as required by 29 CFR 1926.62 shall be made available to all employees exposed to lead at any time (1 day) above the action level. Full medical surveillance shall be made available to all employees on an annual basis who are or may be exposed to lead in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, and 29 CFR 1926.103. Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.

1.14 TRAIN EACH EMPLOYEE performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations where appropriate.

1.15 RESPIRATORY PROTECTION PROGRAM: Provide each employee required to wear a respirator a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62. Establish and implement a respiratory protection program as required by AIHA Z88.6, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.

1.16 HAZARD COMMUNICATION PROGRAM: Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.

1.17 HMM WASTE MANAGEMENT: Prepare a HMM Waste Management Plan to comply with applicable requirements of federal, State, and local hazardous waste regulations and as follows:

A. Identification and classification of hazardous wastes associated with the Work.

B. Estimated quantities of wastes to be generated and disposed of.
C. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location(s) and operator and a 24-hour point of contact. Furnish proof of EPA State and/or local hazardous waste permit applications, permits, manifests, and EPA Identification numbers or Transporter Number, as applicable.
D. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
E. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
F. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.
G. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily. Proper containment of the waste includes using acceptable waste containers (e.g., 55-gallon drums) as well as proper marking/labeling of the containers.
H. Unit cost for waste disposal according to this plan.

1.18 ENVIRONMENTAL, SAFETY AND HEALTH COMPLIANCE: In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

1.19 PRE-CONSTRUCTION CONFERENCE: Along with the CP, meet with the Architect and Owner to discuss in detail the lead waste management plan and the HM/RCP, including work procedures and precautions for the removal plan.

1.20 PROJECT/SITE CONDITIONS - PROTECTION OF EXISTING WORK TO REMAIN: Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.

PART 2 - EQUIPMENT

2.01 RESPIRATORS: Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.

2.02 SPECIAL PROTECTIVE CLOTHING: Furnish personnel who will be exposed to lead-contaminated dust with proper [disposable] [uncontaminated, reusable] protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.

2.03 RENTAL EQUIPMENT NOTIFICATION: If rental equipment is to be used during lead-based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Include a copy of the written notification with the Closeout Documents.

2.04 VACUUM FILTERS: Provide UL 586 labeled units with HEPA filters.

2.05 EQUIPMENT FOR ARCHITECT / OWNER'S REPRESENTATIVES: Provide up to two (2) complete sets of PPE daily for entry into and inspection of the paint removal work within the lead controlled area. PPE provided must include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor, for disposal.

PART 3 - EXECUTION

3.01 NOTIFY THE ARCHITECT twenty (20) days prior to the start of any HMM removal work.

3.02 NOTIFICATION OF THE COMMENCEMENT OF HMM HAZARD ABATEMENT: Submit a copy of the notification of the commencement of HMMs hazard abatement to appropriate AHJ's as required by applicable laws and regulations.

3.03 BOUNDARY REQUIREMENTS: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that lead will not escape outside the lead control area.

3.04 PROVIDE WARNING SIGNS at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.

3.05 FURNISHINGS: The Owner will remove furniture and equipment from the building before lead-based paint removal work begins.

3.06 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) SYSTEMS: Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead control area.

3.07 DECONTAMINATION SHOWER FACILITY: Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.

3.08 EYE WASH STATION: Where eyes may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes shall be provided within the work area.

3.09 MECHANICAL VENTILATION SYSTEM: Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62. To the extent feasible, use local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be evaluated and maintained in accordance with 29

CFR 1926.62. Vent local exhaust outside the building only and away from building ventilation intakes. Use locally exhausted, power actuated, paint removal tools.

3.10 PERSONNEL PROTECTION: Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

3.11 LEAD CONTROL AREA REQUIREMENTS: Establish a lead control area by situating critical barriers and physical boundaries around the area or structure where LBP removal/control operations will be performed. For full containment, contain removal operations by the use of critical barriers and HEPA filtered exhaust or a negative pressure enclosure system with decontamination facilities and with HEPA filtered exhaust when required by the CP. For containment areas larger than 1,000 square feet install a minimum of two 18 inch square viewing ports. Locate ports to provide a view of the required work from the exterior of the enclosed contaminated area. Glaze ports with laminated safety glass.

3.12 WORK PROCEDURES: Perform removal of lead-based paint in accordance with approved lead-based paint/paint with the HM/RCP. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-based paint is removed in accordance with 29 CFR 1926.62. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), State, and local requirements.

3.13 LEAD-BASED PAINT REMOVAL/CONTROL/DELEADING:

A. MANUAL OR POWER SANDING of interior and exterior surfaces is not permitted unless tools are equipped with HEPA attachments or wet methods. The dry sanding or grinding of surfaces that contain lead is prohibited. Provide methodology for LBP removal/control in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate. Avoid flash rusting or other deterioration of the substrate. Provide surface preparations for painting in accordance with Division-09 Section: “Painting”.

B. PROVIDE METHODOLOGY FOR LBP REMOVAL or abatement / control and processes to minimize contamination of work areas outside the control area with lead-contaminated dust or other lead-contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead. Describe this removal/control process in the HM/RCP.

C. INDOOR PAINT REMOVAL: Perform manual, mechanical, thermal or chemical paint removal in lead control areas using enclosures, barriers, or containments and powered locally exhausted paint removal tools. Collect residue debris for disposal in accordance with federal, State, and local requirements.

D. OUTDOOR PAINT REMOVAL: Perform outdoor removal as indicated in federal, State, and local regulations and in accordance with the HM/RCP. The worksite preparation (barriers or containments) shall be job dependent and presented in the HM/RCP.

E. PERSONNEL EXITING PROCEDURES: Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

(1) Vacuum themselves off.
(2) Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.
(3) Washing hands and face at the site, don appropriate disposable or uncontaminated reusable clothing; move to an appropriate facility and shower.
(4) Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

3.14 FIELD QUALITY CONTROL

A. PERFORM AIR AND WIPE SAMPLING for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.

(1) The CP shall be on the job site directing the air and non-clearance wipe sampling and inspecting the lead-based paint removal/control work to ensure that the requirements of the Contract have been satisfied during the entire lead-based paint removal operation.
(2) Collect personal air samples on employees who are expected to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.
(3) Submit results of air samples, within 72 hours after the air samples are taken.

3.15 BASELINE SAMPLES: Before any work begins, collect and analyze baseline wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead-based paint removal/control.

A. Collect surface wipe samples at a location no greater than 10 feet outside the lead control area at a frequency of once per day while lead removal work is conducted. Surface wipe results shall meet criteria in paragraph "Clearance Certification."

3.16 AIR SAMPLING DURING PAINT REMOVAL WORK: Conduct area air sampling daily, on each shift in which LBP removal operations are performed, in areas immediately adjacent to the lead control area.

A. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air.

B. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Determine if condition(s) require any further change in work methods.

C. Removal work shall resume only after the CP gives approval.

D. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3.17 SAMPLING AFTER PAINT REMOVAL/CONTROL: After the visual inspection, collect wipe samples according to the HUD protocol contained in HUD 6780 to determine the lead content of settled dust and dirt in micrograms per square meter foot of surface area.

3.18 TESTING OF REMOVED PAINT AND USED ABRASIVE: Test removed paint and used abrasive in accordance with 40 CFR 261 for hazardous waste.

3.19 CLEANUP: Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area, and comply with the following:

A. Do not dry sweep or use compressed air to clean up the area.
B. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP.
C. Re-clean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area.
D. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas.
E. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

3.20 CLEARANCE CERTIFICATION

A. THE CP SHALL CERTIFY IN WRITING that air samples collected outside the lead control area during paint removal operations are less than 30 micrograms per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of material and dust containing lead left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the certification by the CP.

(1) Certify that surface wipe samples are not significantly greater than the initial surface loading determined prior to work.
(2) For exterior paint removal/control work, soil samples taken at the exterior of the work site shall be used to determine if soil lead levels had increased at a statistically significant level (significant at the 95 percent confidence limit) from the soil lead levels prior to the work. If soil lead levels do show a statistically significant increase or is above any applicable Federal or State standard for lead in soil, the soil shall be remediated back to the pre-work level.
(3) Clear the lead control area in industrial facilities of all visible dust and debris.
(4) For lead-based paint hazard abatement work, surface wipe and soil sampling shall be conducted and clearance determinations made according to the work practice standards presented in 40 CFR 745.227.

3.21 DISPOSAL: Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing that may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 262. Dispose of lead-contaminated waste material at an EPA or State approved hazardous waste treatment, storage, or disposal facility off the Owner's property.

A. Place waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. For hazardous waste, the collection drum requires marking/labeling in accordance with 40 CFR 262 during the accumulation/collection timeframe.
B. Handle, transport, and dispose lead or lead-contaminated material classified as hazardous waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
C. All material, whether hazardous or non-hazardous shall be disposed in accordance with laws and provisions and Federal, State, or local regulations. Ensure waste is properly characterized. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

3.22 DISPOSAL DOCUMENTATION: Submit written evidence to demonstrate the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA, State or local regulatory agencies. Submit one copy of the completed hazardous waste manifest, signed and dated by the initial transporter in accordance with 40 CFR 262. Contractor shall provide a certificate that the waste was accepted by the disposal facility.

END OF SECTION 02 83 00

SECTION 02 84 00 – POLYCHLORINATED BIPHENYL (PCB) REMEDIATION

PART 1 – GENERAL

1.01 PROVIDE REMOVAL AND CONTROL of existing PCBs, by application of proper cleaning techniques, engineered controls and application of best management practices. The Work includes containment and disposal of PCB contaminated materials, and includes handling, legal disposal, and procedures and equipment required to protect workers, the environment, building occupants, and the existing building, from contact with PCBs.

1.02 THIS SECTION INCLUDES various removal and disposal protocols. The level of containment and requirements for cleaning and removal of materials will depend on the condition of the existing contaminated equipment. Furnish labor, materials, services, and equipment necessary in accordance with applicable Federal, State, and local regulations, and as follows:

A. Obtain advance approval of PCB disposal site
B. Maintain an access log of employees working in the PCB control area(s)
C. Inspect PCB and PCB-contaminated items and waste containers for leaks
D. Maintaining inspection, inventory and spill records, and
E. Package and mark PCB and legally dispose of off the site.

1.03 ENGAGE THE SERVICES OF A COMPETENT PERSON (CP), to prepare a PCB Removal Plan (PCB/RP). Engage the CP to determine the specific needs for personnel protective equipment (PPE) to be used with the PCB/RP, and include an assessment of the risk for people to occupy areas adjoining the remediation areas while remediation work is occurring. The CP must be onsite whenever remediation activities are ongoing.

A. The CP must be a Certified Industrial Hygienist (CIH) who has been certified for comprehensive practice by the American Board of Industrial Hygiene, and with demonstrable experience in removal of PCBs.

1.04 COORDINATE with Work being performed in adjacent areas. Detail coordination procedures in the PCB/RP and detail how PCB exposure will be prevented to other Work, workers or other personnel performing Work unrelated to PCB removal activities.

1.05 PROTECT WORKERS, supervisory personnel, subcontractors, or consultants from the hazard of exposure to PCBs, including but not limited to procedures and methods described herein, regulations of the U.S. Occupational Safety & Health Administration (OSHA), the U.S. Environmental Protection Agency (EPA), and applicable state and local regulations or requirements of AHJ representatives.

1.06 THE FINAL SCOPE OF WORK for this Section will be authorized by the Owner after submittal and review of the Hazardous Materials Assessment required under other Division-02 Sections. Based on specific directions regarding the Scope of Work to be performed, prepare and submit the PCB/RP for execution.

1.07 THE OWNER RESERVES THE RIGHT to engage a separate CP to review and approve the PCB Assessment Survey, the PCB/RP, to monitor activities at the site at any time while Work is in progress, and to verify compliance with the PCB/RP, including verification of clearance testing. Remove Worker from the site if the Owner's CP observes their non-compliance with the quality requirements specified herein.

1.08 REFERENCE STANDARDS AND REGULATORY AGENCIES: comply with applicable regulatory requirements, including the latest editions and most recent addenda, revisions and supplements of regulatory agencies, codes, and similar requirements, including but not limited to:

A. EPA: Environmental Protection Agency
B. CFR: CODE OF FEDERAL REGULATIONS, including but not limited to:
C. 40 CFR 761: Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
D. NIOSH: National Institute for Occupational Safety and Health
E. OSHA: Occupational Safety and Health Administration
F. USEPA: United States Environmental Protection Agency
G. Applicable state and local laws and regulations in which the Project is located

1.09 DEFINITIONS

A. LEAK: Leak or leaking means any instance in which a PCB Article, PCB Container, or PCB Equipment has any PCBs on any portion of its external surface.
B. PCBs: as used in this specification, means the same as PCBs, PCB Article, PCB Article Container, PCB Container, PCB Equipment, PCB Item, PCB Transformer, PCB-Contaminated Electrical Equipment, as defined in 40 CFR 761, Section 3, Definitions
C. PERMISSIBLE EXPOSURE LIMITS (PEL): For PCBs, the PEL is 3.1 E-08 lb/cubic foot on an 8-hour time weighted average basis.
D. SPILL: Both intentional and unintentional spills, leaks, and other uncontrolled discharges when the release results in any quantity of PCBs running off or about to run off the external surface of the equipment or other PCB source, as well as the contamination resulting from those releases.

1.10 SUBMITTALS

A. PRODUCT DATA, including manufacturer's catalog sheets, specifications, and application instructions for removal materials or products, if used.
B. WORKER'S QUALIFICATIONS DATA, including the name of each person who will be performing the Work and their employer's name, business address and telephone number. Include the names and addresses of three (3) similar projects that each person has worked on during the past three (3) years and documentation of completion of

appropriate PCB/Hazardous Waste training program and supervisors with appropriate PCB/Hazardous Waste supervisor training. Submit worker training certificates, prior to the start of work but after the PCB Removal Work Plan submittals, signed and dated by the CP and by each employee stating that the employee has received appropriate training. Certificates shall be organized by individual worker, not grouped by type of certificates.

C. QUALIFICATION OF the CP, including the name, address, and telephone number, and documentation of certification, including certification number and date of certification/recertification.
D. THE PCB/RP required under the following Quality Assurance requirements.
E. WASTE TRANSPORTER'S current waste transporter permit.
F. CLOSEOUT SUBMITTALS - DISPOSAL SITE RECEIPTS: Submit copy of waste shipment record and disposal site receipt showing the PCB-containing materials have been properly disposed of.

1.11 QUALITY ASSURANCES

A. INSTRUCT EMPLOYEES, supervisory personnel, and authorized observers of the Construction Work on dangers of PCB exposure, respirator use, decontamination, and applicable OSHA and EPA regulations related to PCB removal.
B. WORKER'S QUALIFICATIONS: Persons performing PCB removal must be personally experienced in PCB removal work and shall have been regularly employed by a company performing PCB removal for a minimum of 3 years. Train workers per OSHA and EPA requirements, arrange for medical clearances, including a recently issued pulmonary function test (PFT) and respirator fit tested by a trained professional.
C. PRE-WORK CONFERENCE: Before the Work of this Section begins, coordinate a conference at the Site to review the Contract Documents, discuss requirements for the Work, and to review the necessary Work procedures. Arrange for attendance by the Contractor, the PCB removal subcontractor, and the testing/monitoring laboratory.
D. PCB REMOVAL WORK PLAN (PCB/RP): At the conclusion of the pre-work conference but before the physical PCB removal Work begins, prepare a detailed, job-specific plan of the Work procedures to be used in the removal of PCB containing materials. Include drawings indicating the location, size, and details of PCB control areas, locations and details of decontamination rooms, change rooms, shower facilities, and mechanical ventilation system, as required. Include eating, drinking, and restroom procedures, interface of trades, sequencing of PCB related work, PCB disposal plan, respirators, protective equipment, and a detailed description of the method of containment of the operation to ensure that PCB contamination is not spread or carried outside of the control area.
E. PCB DISPOSAL PLAN: Comply with applicable requirements of Federal, State, and local PCB waste regulations and address the following:
    (1) Identification of PCB wastes associated with the work.
    (2) Spil prevention and containment measures to be implemented
    (3) Estimated quantities of wastes to be generated and disposed of.
    (4) Names and qualifications of the entity that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and a 24-hour point of contact. Furnish two copies of applicable EPA, State or local PCB waste permits, as applicable.
    (5) Names and qualifications (experience and training) of personnel who will be working on-site with PCB wastes.
    (6) List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
    (7) Work plan and schedule for PCB waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
F. PREPARE AN EMERGENCY PREPAREDNESS PLAN detailing as a minimum, the information required in this Section and as required by applicable laws or regulations. Develop this plan before start of any removal operations, and include the following:
    (1) Spill cleanup contingency measures to be implemented.
    (2) Include consideration for fire, electrical hazards, slips, trips and falls, spills or releases of hazardous materials and heat related injury. Develop written procedures and instruct workers of same.
    (3) Train employees in evacuation procedures in the event of work place emergencies.
    (4) For Non-Life-Threatening Situations, employees injured or otherwise incapacitated are to decontaminate following normal procedures with assistance from fellow workers, before exiting the work place to obtain proper medical treatment.
    (5) For Life-Threatening Injury or Illness, Worker decontamination shall take least priority. After measures to stabilize the injured worker, the injured worker shall be removed from the work place and secure proper medical treatment.
    (6) Include phone numbers of emergency response personnel, and prominently postin the clean area and equipment room, along with the location of the nearest telephone.
G. PROVIDE WRITTEN NOTIFICATIONS to police, fire and emergency medical personnel of planned removal activities, work schedule and layout of work area, particularly barriers that may affect response capabilities.

1.12 JOB CONDITIONS

A. POST REGULATION including, at all times in view at the job site management area.
B. POSTING REGULATIONS: Display the following documents in the clean changing area, and at the job-site management area in public view, for the full duration of the PCB removal Work:
    (1) Document 29 CFR 1910.1000 - 40 CFR 761,
    (2) The PCB/RP
    (3) Instructions for removing injured persons from the work area.
    (4) Emergency action plan, including phone numbers for hospital, doctor and Fire Department agencies.
C. PROTECTION OF EXISTING CONSTRUCTION: Perform PCB Removal Work without damage or contamination of adjacent areas and existing construction. Install 2 layers of 6 mil fire-retardant polyethylene sheeting over the inside

of all openings within 25 feet of the removal area to prevent contamination of the interior from the affected areas. Provide 6 mil fire retardant polyethylene drop cloths to collect debris from removal operation. Remove PCB contaminated materials to the exterior and place into drums or other suitable containers.

D. SURVEILLANCE PERSONNEL may enter PCB control areas for brief periods of time provided they wear disposable polyethylene gloves and disposal polyethylene foot covers, as a minimum. Additional protective equipment may be required if respiratory hazard or skin contact with PCBs is involved.

PART 2 - PRODUCTS & EQUIPMENT

2.01 PERSONAL PROTECTIVE EQUIPMENT (PPE), including but not limited to hard hats meeting the requirements of ANSI Standard Z89.1-1981, eye protection meeting the requirements of ANSI Standard Z87.1-1979, safety shoes meeting the requirements of ANSI Standard Z41.1- 1967, disposable PVC gloves or other work gloves. Furnish to workers and to authorized visitors, including representatives of the Owner or Architect. Provide non-skid footwear to removal workers, adequately sealed to disposable clothing to prevent body contamination.

2.02 RESPIRATORS: Approved for use by the Mine Safety and Health Administration (MSHA), Department of Labor, or the National Institute for Occupational Safety and Health (NIOSH), as applicable.

2.03 PROTECTIVE SUITS, protective gloves, eye protection and a minimum of half-face respirator with HEPA filter cartridges must be used by all Workers. Comply with OSHA regulation 1910.134 and ANSI Z88.2, as applicable.

2.04 REMOVAL EQUIPMENT: Provide a sufficient supply of the following:

2.05 DISPOSAL DRUMS: Metal or fiberboard units with locking ring tops, with warning labels as required by OSHA, and/or EPA.

2.06 PLASTIC SHEETING: Minimum 6 mil., opaque, fire-retardant polyethylene sheets. For floor-protective layer, provide a minimum 10 mil, reinforced polyethylene sheets.

2.07 CONSTRUCTION EQUIPMENT, including scaffolding, ladders, lifts, and hand tools such as scrapers, wire cutters, brushes, utility knives, or wire saws.

2.08 CLEANING EQUIPMENT, including disposable mops, rags, and sponges for work area decontamination.

2.09 VACUUM CLEANERS: Equip with HEPA filters.

2.10 PCB CAUTION LABELS: Comply with 40 CFR 761, Subpart C. Affix labels to PCB waste containers and other PCB-contaminated items. Provide label with sufficient print size to be clearly legible, with bold print on a contrasting background, displaying the following: “CAUTION: Contains PCBs (Polychlorinated Biphenyls)”.

2.11 PCB CAUTION SIGNS: Comply with 29 CFR 1910.145, providing signs at approaches to PCB control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area.

2.12 PCB SPILL KIT: Assemble and maintain at site, to include the following: six (6) pairs of polyethylene disposable gloves, 6 pairs of gloves with a high degree of impermeability to PCBs, four (4) each disposable coveralls with permeation resistance to PCBs, two (2) each chemical safety goggles, six (6) pairs of disposable polyethylene foot covers, two (2) each PCB Caution Signs, reading: “PCB Spill – Authorized Personnel Only”, 100 feet of banner guard or equivalent banner material, absorbent materials, five (5) bags of blue polyethylene waste bags, five (5) each cloth backed tape rolls, one (1) roll of blank area access logs, ten (10) 6 x 6 feet Brattice cloths, rags, ball-point pens, two (2) ea 4 x 4 ft Herculite panels, one (1) ea 8 x 8 ft Herculite panels, blank metal signs and grease pencils, and two (2) each 55 gallon waste container drums, used as a container for the spill kit.

PART 3 - EXECUTION:

3.01 NOTIFIY the Architect not less than TWENTY (20) working days prior to the start of PCB Removal Work.

3.02 WORK CONTROL AREAS: Provide materials and labor to construct a temporary (1) decontamination room, (2) clean room and a (3) shower facility room with doors and connect to the exit ways of PCB work areas. Rooms shall be of sufficient size to accommodate operation within. Existing facilities with water closets, wash basins and showers may be used if available, or provide portable toilet and shower facilities. Locate shower facilities between the clean room and decontamination room. Provide separate clothing lockers or containers in each room to prevent contamination of street and work clothes. Remove PCB-contaminated PPE’s in the decontamination room. Workers shall then proceed to showers. Workers shall shower before lunch and at the end of each day's work. Hot water, towels, soap, and hygienic conditions are the responsibility of the Contractor

3.03 PCB CONTROL AREA: Isolate by physical boundaries to prevent unauthorized entry of personnel. Food, drink and smoking materials shall not be permitted in areas where PCBs are handled or PCB items are stored.

3.04 WORKERS MUST WEAR AND USE PPE’S as recommended by the Industrial Hygienist, upon entering a PCB control area. If PPE’s is not required per the CP, specify in the PCB Removal Work Plan. Worker’s footwear must remain inside the work area until completion of the job.

3.05 PERFORM PCB REMOVAL WORK in accordance with the PCB Removal Work Plan. Use procedures and equipment as required to limit occupational and environmental exposure to PCB’s when PCB-containing materials are removed. Limit the production and dissemination of debris as much as possible. Perform manual wet scraping to the maximum extent feasible.

3.06 PCB REMOVAL: Select PCB removal procedure to minimize contamination of work areas with PCB or other PCB-contaminated debris/waste. Handle PCBs such that no skin contact occurs. PCB removal process should be described in the work plan.

3.07 CONFINED SPACES: As feasible, do not carry out PCB handling operations in confined spaces. A confined space shall mean a space having limited means of egress and inadequate cross ventilation.

3.08 CONTROL AREA: Establish a PCB control area around the PCB item as specified in paragraph entitled "PCB Control Area." Only personnel briefed on the elements in the paragraph entitled "Training" and on the handling precautions shall be allowed into the area.

3.09 SOLVENT CLEANING: Clean contaminated tools, containers, etc., after use by rinsing three times with an appropriate solvent or by wiping down three times with a solvent wetted rag. Suggested solvents are stoddard solvent or hexane.

3.10 SCRAPE RESIDUAL SURFACES of PCB contaminated materials to a bare, clean surface, using wet methods.

3.11 COLLECT all removed PCB contaminated materials and the contaminated poly sheeting and properly drum or otherwise containerize for disposal or incineration in accordance with applicable State and Federal regulations.

3.12 PCB TRANSFORMERS:

A. DRAIN TRANSFORMERS of free-flowing liquid prior to transportation. Place the drained liquids in DOT Spec 17E drums, not contain more than 50 gallons each. If equipment cannot be drained, then place it in DOT Spec 17C drums.
B. MARKINGS: Provide drums and drained PCB-contaminated electrical equipment with caution label markings as specified in paragraph entitled "PCB Caution Label."
C. LABORATORY ANALYSIS: Arrange for transformers to have a laboratory analysis for turn-in, unless the transformer is hermetically sealed (solder sealed or fusion sealed with no access ports or openings), or if the name plate states that the transformer contains pyranol, interteen, etc. Attach a copy of the lab analysis to both the DD 1348-1 and the transformer itself.
D. MARKINGS: Comply with DOT requirements for labels and stencil markings, to include date drum was filled, ppm's, serial number of transformer liquid originated, and other regulations. Do not mix different ppms in the same drum. Drums must have a 2 inch ullage space from the top of the drum.

3.13 CLEANUP

A. REMOVE POLYETHYLENE SHEETING from openings after clearance testing has confirmed complete removal of PCB containing materials. Include removed poly sheeting in disposal drum/container for disposal as PCB contaminated material.
B. CERTIFICATION OF REMOVAL: Schedule visual clearance inspection at the site, when the Work area is ready for clearance testing. Obtain a written affidavit and final assessment report from the testing laboratory stating that the visual clearance assessment conforms to standards set forth by applicable AHJ's. The Owner will have final authority to determine the acceptable clearance level.

3.14 DISPOSAL OF PCB WASTE MATERIALS

A. ARRANGE FOR legal transportation and disposal of PCB waste materials to an EPA approved recycling or incineration facility. Maintain appropriate records of materials packaging, labeling, transporting, disposal and other documents associated with the PCB waste and disposal in accordance with federal, state and local regulations, and include in Closeout Documentation.
B. CAREFULLY LOAD contaminated waste onto trucks or other appropriate vehicles for transport. Take necessary precautions so that no unauthorized persons will have access to the materials, before and during transport.
C. TRANSPORT CONTAINERIZED WASTE by a licensed transportation hauler with a valid, current permit issued in accordance with appropriate regulations. Provide the hauler with appropriate shipping records at the time of transfer. All waste manifests must show a complete chain-of-custody certification, from the site to the recycling or incineration facility. Transporters of PCB waste materials are prohibited from "back hauling" any other freight until decontamination of the vehicle and/or trailer is assured.
D. OBTAIN a tracking / manifest form executed by the recycling or incineration facility's authorized representative, certifying to receipt of the PCB materials delivered. Provide follow-up activities to assure that the PCB waste materials were received by the designated waste site in a timely manner and in accordance with applicable regulations.

3.15 RESTORATION: Remove temporary decontamination facilities and restore the area designated for these facilities to its original or better condition. When existing construction is damaged or contaminated by the Work of this Section, restore that Work to its original or better condition.

END OF SECTION 02 84 00

SECTION 02 85 00 – MOLD REMEDIATION

PART 1 - GENERAL

1.01 THE SCOPE OF WORK of this Section will be authorized by the Owner after submittal and review of the Hazardous Materials Assessment and Work Plan proposed in Division-02 Section “Hazardous Materials Assessment”. Based upon specific direction and authorization by the Owner, provide Mold Remediation, that may include the following.

1.02 REMOVE AND CONTROL existing mold, mildew spore fallout, and other microbial based environmental contaminates (herein afterwards referred to as “mold”), by application of proper cleaning techniques, engineered controls and application of best management practices. The Work includes containment and disposal of mold contaminated materials, and includes handling, legal disposal, and procedures and equipment required to protect workers, the environment, building occupants, and the existing building, from contact with mold. As a minimum, provide the following:

A. Damp wipe and HEPA vacuum all surfaces.
B. Remove and dispose of porous building materials with visible mold contamination

1.03 THIS SECTION INCLUDES various cleaning, removal and disposal protocols on existing building materials. The level of containment and requirements for cleaning and remediation of materials will depend on the existing conditions of the space and the materials being remediated. Furnish labor, materials, services, and equipment necessary in accordance with applicable Federal, State, and local regulations, and as follows:

A. MOLD ASSESSMENT SURVEY: The total scope of known mold contamination is not known to the Owner, Therefore, provide the services of a Testing and Inspection Entity qualified in inspection and analysis of mold to review conditions of the existing building, and to assess and recommend specific containment categories and remediation methods recommended for the various Work Areas of the existing building. Include the following, at a minimum:
B. ENGAGE THE SERVICES OF A COMPETENT PERSON (CP) to prepare a Mold Remediation Plan (MRP). Engage the CP to determine the specific needs for personnel protective equipment (PPE) to be used with the MRP, and include an assessment of the risk for people to occupy areas adjoining the remediation areas while remediation work is occurring. The CP must be onsite whenever remediation activities are ongoing.
C. COORDINATE with Work being performed in adjacent areas. Detail coordination procedures in the HM/RCP and detail how lead exposure will be prevented to other Work, workers or other personnel performing Work unrelated to lead remediation activities.
D. THE OWNER RESERVES THE RIGHT to engage a separate CP to review and approve the Mold Assessment Survey, the MRP, to monitor activities at the site at any time while Work is in progress, and to verify compliance with the MRP, including verification of clearance testing. Remove Worker from the site if the Owner’s CP observes their non-compliance with the quality requirements specified herein.

1.04 REFERENCE STANDARDS AND REGULATORY AGENCIES: comply with applicable regulatory requirements, including the latest editions and most recent addenda, revisions and supplements of regulatory agencies, codes, and similar requirements, including but not limited to:

A. AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)
   (1) AIHA IMOM08-679 - (2008) Recognition, Evaluation, and Control of Indoor Mold
   (2) AIHA Z9.2 - (2006) Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems
B. INSTITUTE OF INSPECTION, CLEANING, AND RESTORATION CERTIFICATION (IICRC)
   (1) IICRC S100 - (2002) Standard Reference Guide for Professional Carpet Cleaning
   (2) IICRC S500 - (2006) Standard and Reference Guide for Professional Water Damage Restoration
C. NATIONAL AIR DUCT CLEANERS ASSOCIATION (NADCA)
   (1) ACR - (2006) Standard for Assessment, Cleaning, and Restoration of HVAC Systems
D. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
   (1) 29 CFR 1910.134 - Respiratory Protection
   (2) 29 CFR 1926.1101 – Asbestos
E. UNDERWRITERS LABORATORIES (UL)
   (1) UL 586 - (2009) Standard for High-Efficiency Particulate, Air Filter Units
F. APPLICABLE STATE AND LOCAL LAWS and regulations in which the Project is located

1.05 DEFINITIONS

A. AFU: Air filtration unit with High Efficiency particulate air (HEPA) filtered vacuum and / or exhaust ventilation equipment with a filter system capable of collecting and retaining microbial contamination AIHA Z9.2. Filters shall retain 99.97 percent of particles 1.2 by 10-6 inch or larger as indicated in UL 586.
B. CATEGORIES OF WATER: (IICRC S500)
   (1) Category 1 Water: Water originating from a source that does not pose substantial harm to humans. Also referred to as "clean water."
   (2) Category 2 Water: Water containing a significant degree of chemical, biological and/or physical contamination and having the potential to cause discomfort or sickness if consumed by or exposed to humans. Also referred to as "gray water."
   (3) Category 3 Water: Grossly unsanitary water, containing pathogenic agents, arising from sewage or other contaminated water sources and having the likelihood of causing discomfort or sickness if consumed by or

exposed to humans. This category includes all forms of seawater, ground surface water and rising water from rivers or streams. Also referred to as "black water."

C. CONTAINMENT: Physical separation and engineering controls required to prevent contamination of undamaged materials and occupied areas. The level of containment varies depending on the extent of the contamination.

D. SOURCE CONTAINMENT: Use when the contaminated surface area is less than 10 square feet, in non-residential buildings only. At a minimum, source containment shall include the following:

(1) ISOLATION OF WORK AREAS: Install polyethylene barriers to isolate the areas or material to be demolished / remediated from non-remediation areas.
(2) FLOOR PROTECTION: Maintain protection for finished floors through all construction activities.
(3) HEPA VACUUMING: to control dust created during the demolition. Hold HEPA vacuum intake at source of dust.
(4) LIMITED CONTAINMENT: Use when contaminated surface area is between 10 square feet and 100 square feet per room in non-residential buildings and contaminated surface area less than 100 square feet per room in residential buildings. At a minimum, limited containment must include the following:

E. CONTAINMENT: For residential buildings, a containment shall include the entire room where work is being performed. The containment shall not extend past the extents of the room unless there are instances of contamination extending from one room to the next. For non-residential buildings, the containment shall include the area to be remediated, plus enough additional area to allow for all equipment and work activities.

(1) ISOLATION OF WORK AREAS: Install polyethylene barriers to isolate the areas to be demolished / remediated.
(2) FLOOR PROTECTION: Maintain protection for finished floors through all construction activities.
(3) AIR FILTRATION / PRESSURIZATION CONTROL. Install AFUs with HEPA filters in the containment. Configure the AFUs with splitters / diverters to allow some of the air to recirculate within the containment. Discharge the remainder of the air directly to the outside to maintain an overall negative pressure in the containment of 0.02 inch water column minimum to 0.04 inch water column maximum relative to the outside and other adjacent spaces not undergoing remediation. AFUs shall filter a minimum of four air changes per hour and a maximum of six air changes per hour.
(4) PROTECTION FOR ALL ITEMS REMAINING IN THE CONTAINMENT: Protective devices shall prevent physical damage (e.g., scratches and dents) and shall provide a positive seal to prevent dust from settling in or on the items.
(5) CONTAINMENT ENTRANCE: Install a triple-flap poly "door" to be used during demolition to minimize egress and provide a good separation between containment and occupied areas of the building.

F. FULL CONTAINMENT: Use when contaminated surface area is greater than 100 square feet in both residential or nonresidential buildings. At a minimum, full containment must include the following:

(1) CONTAINMENT. For residential buildings, a containment shall include the entire room where work is being performed. The containment shall not extend past the extents of the room unless there are instances of contamination extending from one room to the next. For non-residential buildings, the containment shall include the area to be remediated, plus enough additional area to allow for all equipment and work activities.
(2) ISOLATION OF WORK AREAS. Construct polyethylene barriers to isolate the areas to be demolished / remediated.
(3) FLOOR PROTECTION. Maintain protection for finished floors through all construction activities.
(4) AIR FILTRATION / PRESSURIZATION CONTROL. Install AFUs with HEPA filters in the containment. Configure the AFUs with splitters / diverters to allow some of the air to recirculate within the containment. Discharge the remainder of the air directly to the outside to maintain an overall negative pressure in the containment of 0.02 inch water column minimum to 0.04 inch water column maximum relative to the outside and other adjacent spaces not undergoing remediation. AFUs shall filter a minimum of four air changes per hour and a maximum of six air changes per hour.
(5) PROTECTION FOR ALL ITEMS REMAINING IN THE CONTAINMENT. Protective devices shall prevent physical damage (e.g., scratches and dents) and shall provide a positive seal to prevent dust from settling in or on the items.
(6) DECONTAMINATION. Construct a decontamination airlock for entry into and exit from the work area. The airlock shall be used to HEPA vacuum the sealed bags of contaminated debris. When possible, the decontamination airlock shall be located so that the sealed bags can be passed directly from the airlock to the outside, through a door or window.
(7) CONTAINMENT ENTRANCE. Install a triple-flap poly "door" at the entrance to the airlock, and between the airlock and the work area during demolition to minimize egress and provide a good separation between containment and occupied areas of the house / building.

G. COMPETENT PERSON (CP): As used in this section, refers to a person employed by the Contractor who an Industrial Hygienist (IH), being qualified by education, training, and experience to anticipate, recognize, evaluate, and develop controls for occupational and indoor air quality hazards. Education must include a minimum 12 semester hours or quarter hour equivalent of chemistry and 18 additional semester hours or quarter hour equivalent of courses in any combination of chemistry, physics, engineering, health physics, environmental health, biostatistics, biology, physiology, toxicology, epidemiology, or industrial hygiene. The Industrial Hygienist must be supervised by a Certified Industrial Hygienist, trained and experienced in mold hazards in accordance with current federal, State, and local regulations.

H. UNOCCUPIED BUILDING CONTAINMENT: Use when a building is unoccupied and large amounts of mold growth are present throughout the building:

(1) CONTAINMENT: The containment consists of the entire building. Install AFUs with HEPA filters in the building. Configure the AFUs to recirculate within the active remediation area. AFUs shall filter a minimum of four air changes per hour and a maximum of six air changes per hour based on the size of the area undergoing active remediation.
(2) ISOLATION OF WORK AREAS: Install polyethylene barriers to isolate the areas where remediation is not required. AFU discharge may be used to positively pressurize non-remediation areas from areas undergoing remediation to prevent the movement of spores into "clean" areas.
(3) FLOOR PROTECTION: Maintain protection for finished floors through all construction activities.
(4) PROTECTION FOR ALL ITEMS REMAINING IN THE CONTAINMENT: Protective devices shall prevent physical damage (e.g., scratches and dents) and shall provide a positive seal to prevent dust from settling in or on the items.
(5) DECONTAMINATION: Construct a decontamination airlock for entry into and exit from the building.
(6) CONTAINMENT ENTRANCE: A triple-flap poly "door" shall be used at the entrance to the work area during demolition to minimize egress.

I. CLEANING CONTAINMENT: A temporary containment structure set up to clean items removed from the containment. At a minimum, the cleaning area shall contain:

(1) TWO CHAMBERS: Construct walls with polyethylene. Items will be cleaned in the first chamber. The clean items shall be stored in the second chamber.
(2) AIR FILTRATION / PRESSURIZATION CONTROL CLEANING CHAMBER: Install AFUs with HEPA filters in the cleaning chamber. Configure the AFUs with splitters / diverters to allow some of the air to recirculate within the containment. Discharge the remainder of the air directly to the outside to maintain an overall negative pressure in the containment of 0.02 inch water column minimum to 0.04 inch water column (maximum) relative to the storage chamber.
(3) AIR FILTRATION, STORAGE CHAMBER: Install AFUs with HEPA filters in the storage chamber. The AFUs shall be configured to allow air to recirculate within the chamber. AFUs shall filter a minimum of four air changes per hour and a maximum of six air changes per hour.
(4) CONTAINMENT ENTRANCE: Install a triple-flap poly "door" at the entrance to the cleaning chamber, between the cleaning and storage chambers, and at the exit of the storage chamber to minimize egress and provide a good separation between the chambers.

J. DAILY LOG: The Microbial Remediation Supervisor’s daily written, project records documenting not less than the following: Work Date, Name of Industrial Hygienist monitoring work area, Number of workers on site, equipment utilized, Brief description of daily work activities, and a listing of any non-compliance noted, emergencies, stop work orders (with detailed explanation), exhaust system pressure differential recordings and descriptions of any other significant events.
K. DECONTAMINATION UNIT (AIRLOCK): An enclosed area adjacent to, and connected to, a regulated work area. It consists of various rooms that are used for the decontamination of workers, equipment, and materials.
L. DEHUMIDIFIER: Mechanism or machine to remove moisture from the air.
M. DETERGENT: A cleaning agent. The term refers to a prepared compound that may include surfactants, builders, dry solvents, softeners, etc, but does not include true soap.
N. DISINFECTANTS OR BIOCIDE SANITIZING SOLUTIONS: One of three groups of antimicrobials registered by the EPA for public health uses. The EPA considers an antimicrobial to be a disinfectant when it destroys or irreversibly inactivates infectious or other undesirable organisms, but not necessarily their spores.
O. FUNGICIDAL AGENT: A coating material that contains an EPA registered fungicide that inhibits the spread and growth of mold with the ability to withstand moist and humid conditions.
P. HEPA FILTER: A High Efficiency Particulate Air (HEPA) filter capable of trapping and retaining 99.97 percent of all particulate larger than 1.2 by 10-6 inch.
Q. NON-POROUS MATERIAL: A material that does not absorb nor is easily penetrated by liquids, especially water. Generally, non-porous materials have a permeable factor of less than 1. Some examples are metal, glass, plastic, ceramic tile, etc.
R. OCCUPIED SPACES (Areas): The phrase "occupied space" within this Section refers to spaces that are occupied by unprotected non-remediation personnel while work is in progress. It also refers to areas adjacent to work areas that are not currently undergoing remediation.
S. POROUS MATERIAL: Permeable materials having the physical properties that allow liquids or gasses to pass through. These materials include but are not limited to the following: gypsum wall board, insulation, wallpaper, ceiling material, carpet, padding, paper goods (i.e., cardboard boxes, loose paper, books, etc.), stuffed furniture, wicker, fabrics, etc.
T. PRESSURE DIFFERENTIAL MEASURING INSTRUMENT: Device used to measure the relative pressure difference between the work area and areas outside the work area. For mold remediation, the device must measure accurately in the 0 to 0.04 inch range.
U. SEMI-POROUS MATERIAL: A material that can absorb liquids if exposed over long periods of time. These materials include but are not limited to wood, concrete, linoleum, vinyl wall covering, wooden or hardboard furniture, plaster, etc.
V. WORK AREA: The area where remediation operations are actively performed and controlled to prevent the spread of dust / spores and entry by unauthorized personnel. A work area is the space, group of spaces, or the building, as defined by the Microbial Assessment Survey.

1.06 SUBMITTALS

A. PRODUCT DATA including manufacturer’s catalog sheets, specifications, and application instructions as applicable. Include Product Data for Personal Protective Equipment (PPE), Air Filtration Units; Dehumidifiers; Pressure

Differential Measuring Instrument; Fungicidal Agents, Disinfectants or Biocide Sanitizing Solutions, and other materials or equipment that will be used.

B. WORKER'S QUALIFICATIONS DATA including the name of each person who will be performing the Work and their employer's name, business address and telephone number. Include the names and addresses of three (3) similar projects that each person has worked on during the past three (3) years and documentation of completion of appropriate training program and supervisors with appropriate supervisor training. Submit worker training certificates, prior to the start of work but after the MRP submittals, signed and dated by the CP and by each employee stating that the employee has received appropriate training. Certificates shall be organized by individual worker, not grouped by type of certificates.
C. QUALIFICATION OF the CP, including the name, address, and telephone number, and documentation that the CP is certified as an Industrial Hygienist, including certification number and date of certification/recertification.
D. THE MRP required under the following Quality Assurance requirements.
E. THE MICROBIAL REMEDIATION SUPERVISOR'S qualifications and training certificates.
F. SUBMIT QUALIFICATIONS of the Ventilation System Mold Remediator, and submit the Contractor's Respiratory Protection Program.
G. SUBMIT THE WASTE TRANSPORTER'S current waste transporter permit.
H. CLOSEOUT SUBMITTALS - DISPOSAL SITE RECEIPTS: Submit copy of waste shipment record and disposal site receipt showing the PCB-containing materials have been properly disposed of.
I. CLOSEOUT PROJECT RECORDS: Within fourteen (14) days of completion of the Work of this Section, submit the following to the Architect for record: the Supervisor Logs, IH Daily Reports, Photographic Logs, and the Contractor's Industrial Hygienist Report certifying that the microbial remediation Work is complete.

1.07 QUALITY ASSURANCES

A. CONTRACTOR QUALIFICATIONS: The Work of this Section must be performed by a qualified remediation contractor, with Comprehensive General Liability insurance as required by Division-00 Contract Requirements that specifically covers mold remediation. The Remediation Contractor must employ a Microbial Remediation Supervisor (as follows).
B. MICROBIAL REMEDIATION SUPERVISOR The Remediation Contractor's on-site work supervisor, who will be responsible for the execution of the MRP. The Supervisor must be onsite whenever microbial remediation Work is being performed. Set-up activities may be performed without the supervisor being present, but the Supervisor must review the set-up activities before starting the Work of this Section. The designated supervisor must have one of the following certifications:
   (1) Certified Mold Remediator (CMR),
   (2) Certified Mold Remediation Supervisor (CMRS), or
   (3) Applied Microbial Remediation Specialist (AMRS).
C. MOLD REMEDIATION WORKERS must be provided training in PPE and mold remediation activities by the Remediation Contractor. The Microbial Remediation Plan is required to provide details of worker training.
D. HVAC CLEANING CONTRACTOR QUALIFICATIONS: The HVAC cleaning contractor must be a certified member of NADCA., and must have at least one individual with Ventilation System Mold Remediator (VSMR) Qualifications by the North American Duct Cleaning Association (NADCA) who will be at the Project Site during duct and HVAC system cleaning.
E. MICROBIAL REMEDIATION PLAN (MRP): Prepare a Project-specific, detailed work plan approved by the Contractor's CP for submittal to the Owner before the start of Work at the site. The plan shall address the following items at a minimum:
   (1) Description of materials to be remediated, providing location and quantities (with drawings) and methods to be used for remediation.
   (2) Types of biocides and fungicidal agents to be used
   (3) Containment procedures to include description and locations of engineering controls and decontamination unit to include entry and exit procedures (provide sketch of floor plan showing location of containment barriers and decontamination units). Plan shall include locations of AFUs and AFU discharges to the outside.
   (4) Description of personal protective equipment to be used during the remediation.
   (5) Construction barricades and barriers in occupied areas.
   (6) HVAC Shut down and start-up procedures.
   (7) HVAC Evaluation and remediation procedures.
   (8) Moisture and relative humidity control procedures and equipment.
   (9) Packaging and disposal procedures.
   (10) Safety Precautions, to include lockout / tag-out, fall protection, confined space entry procedures, and fire protection.
   (11) Description of the methods to be employed to control cross contamination of areas not in the work area. This shall include a risk assessment related to the suitability of people to occupy areas adjoin the remediation area while remediation activities are ongoing.
   (12) IH Quality Control procedures to include visual inspection.
   (13) Procedures to control, abate, and dispose of Asbestos Containing Materials (ACM) or Lead Based Paint (LBP) coincident with microbial remediation. Before Work in areas containing ACM and PACM is begun; identify the presence, location, and quantity of ACM, and/or PACM therein pursuant to paragraph (k)(1) of 29 CFR 1926.1101.
F. PRE-WORK CONFERENCE: Before the Work of this Section begins, coordinate a conference at the Site to review the Contract Documents, discuss requirements for the Work of this Section, and to review the Microbial Remediation Plan. Arrange for attendance by the Contractor, the microbial remediation subcontractor, and the testing/monitoring

laboratory. The prepared Plan will be enforced as if a part of this Section. Any variances to the requirements of this Section in the Plan must be specifically identified to allow for discussion and approval by the Owner in writing prior to starting work. Before work in areas containing Asbestos Containing Material (ACM) and Presumed Asbestos Containing Materials (PACM) and Lead is begun, identify the presence, location, and quantity of ACM, PACM and Lead. Ensure proper notification of regulatory authorities.

1.08 JOB CONDITIONS

A. POSTING REGULATIONS: Display the following documents in the clean changing area, and at the job-site management area in public view, for the full duration of the microbial remediation Work:

(1) The MRP and applicable regulations governing the Work of this Section
(2) Instructions for removing injured persons from the work area.
(3) Emergency action plan, including phone numbers for hospital, doctor and Fire Department agencies.

B. PROTECTION OF EXISTING WORK AREAS: Perform work in a manner to minimize damage or contamination to areas outside or directly adjacent to work areas. Inspect areas inside and outside work areas to identify existing damage. Where materials outside the work area are damaged or contaminated by the Contractors operations, restore the Work to its original condition or decontaminate at no expense to the Owner. If adjacent or outside areas become contaminated by Contractor's operations, stop the work immediately, and clean the newly contaminated areas. The work may proceed again at the discretion of the IH when the area has been verified as being restored.

C. TEMPORARY FIRE PROTECTION: Provide portable fire extinguishers within the containment areas and outside the decontamination unit. Fire extinguishers shall be rated for the class of fire hazards in the work area and shall be sized for coverage of the areas within the containment. At a minimum, one 10 pound ABC fire extinguisher for every 1,000 square feet shall be strategically placed around the containment. Personnel shall be trained for emergency egress and the use of fire extinguishers.

D. CONSTRUCTION BARRIERS: Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain. Shoring, bracing or support will be necessary when structural wood studs or metal framing need to be removed and replaced when they cannot be cleaned.

(1) Do not disturb microbial-contaminated building materials while isolating work areas. This precaution prevents the release of microbial spores.
(2) Workers shall wear respirators and other PPE as outlined in the microbial remediation plan when installing critical barriers where microbial contaminated surfaces (walls or surfaces with visible settled dusts) are likely to be disturbed. Operate an AFU if disturbance is likely during setup.
(3) Monitor the air pressure differential across work area containments. The monitoring system shall be in place before the start of remedial activities. Verification by the Industrial Hygienist is required prior to the start of the microbial remediation.

PART 2 - PRODUCTS & EQUIPMENT

2.01 DISINFECTANTS, BIOCIDES, SANITIZING SOLUTIONS AND FUNGICIDAL AGENTS: Provide materials approved by EPA for the use detailed in the Microbial Remediation Plan, and use in accordance with the manufacturer's specifications.

2.02 PROVIDE PROTECTIVE CLOTHING AND RESPIRATORS as required by the Microbial Remediation Plan for use by workers and authorized visitors. Provide manufacturer's certificate of compliance for all equipment used to contain the microbial contamination.

2.03 RESPIRATORS: Select units from those approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services. Provide personnel engaged in set-up, pre-cleaning, cleanup, handling, and removal of contaminated materials with the appropriate respiratory protection as specified in 29 CFR 1910.134. Microbial remediation plan shall consider Table 17.1 in AIHA IMOM08-679 "Recognition, Evaluation, and Control of Indoor Mold", which lists the minimum levels of respiratory protection based on the activity and size of the remediated area.

2.04 PROTECTIVE CLOTHING: Provide workers with protective clothing as appropriate for the work being accomplished, as required by the Microbial Remediation Plan. Do not permit any person to enter the work area without the appropriate protective clothing and equipment.

2.05 WARNING SIGNS AND LABELS: Provide warning signs at all approaches to the work areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Warning signs may be in the form of continuous plastic tape. Warning signs shall have black characters on a yellow background, and read as follows (or alternative approved language):

A. "WARNING
DO NOT ENTER
MICROBIAL REMEDIATION WORK IN PROGRESS"

2.06 DEHUMIDIFIERS: Install and use dehumidifiers as needed during the remediation to maintain relative humidity below 60 percent in the work area. Drain the condensate water to a permanent drain, or empty as needed to prevent water overflowing from the dehumidifiers.

2.07 AIR FILTRATION UNITS (AFU): Install and use AFUs with HEPA filters, and manufacturer specified pre-filters, as part of the exhaust ventilation system to develop and maintain the specified desired air pressure differential inside the enclosed work area relative to the outside areas. The Contractor will be responsible for acquiring and paying for any licenses needed for use of any equipment, including but not limited to, air pressure differential systems and air filtration systems.

A. Replace HEPA filters and pre-filters for AFUs as required to maintain pressurization performance requirements during demolition and cleaning. Do not reuse filters. Bag used filters at a minimum in clear 6 mil polyethylene bags within the containment and disposed as contaminated waste.

B. Discharge air from any AFUs located in the work area containment to the outside environment when creating a negative pressure containment to create a negative pressure relative to occupied areas of 0.02 inch H2O to 0.04 inch H20. Discharge air in excess of that required for creating the proper negative pressure to the work area. The AFUs shall provide four to six air changes per hour in the work area. Under no circumstances may air from AFUs discharge to an occupied area. Coordinate location of window sashes or doors required for discharge openings. Seal around openings used for discharge of exhaust air airtight. Exhaust discharge openings may be constructed of plywood.
C. Seal all exhaust and intake openings in AFUs with one layer of 6 mil polyethylene sheeting when not in use.

2.08 VACUUM CLEANERS EQUIPPED WITH HEPA FILTERS: Provide vacuum cleaners equipped with HEPA filters designed for continuous operation to perform the work in a timely and efficient manner. Provide nozzle attachments as required to adequately remove all dust. As a minimum, nozzle attachments shall include crevice and extended bristle brush nozzles. Any vacuum that is not equipped with a HEPA filter shall not be used at anytime. Provide sufficient vacuum cleaners equipped with HEPA filters designed for continuous operation in the work area during microbial remediation inside the containment area. Provide additional vacuum cleaners equipped with HEPA filters in the enclosed work area during remediation or cleaning work as required by the size (area) of the containment and to maintain timely progress of the work.

PART 3 - EXECUTION:

3.01 WASTE MANAGEMENT AND REMOVAL – GENERAL: Maintain the site and work areas free from accumulations of dust, waste materials, or rubbish caused by Work operations and free from flammable materials or other sources of fire hazard. Remove waste materials and rubbish from the work site in strict accordance with the specifications and applicable codes and regulations.

3.02 NOTIFIY the Architect not less than TWENTY (20) working days prior to the start of PCB Removal Work.

3.03 WORKERS MUST WEAR AND USE PPE'S as recommended by the CP, upon entering a control area. If PPE's is not required per the CP, specify in the Work Plan.

3.04 PERFORM REMOVAL WORK in accordance with the MRP. Use procedures and equipment as nessary or required to limit occupational and environmental exposure of workers. Limit the production and dissemination of debris as much as possible.

3.05 REMEDIATION OF FUNGALLY CONTAMINATED BUILDING MATERIALS: The removal of contaminated materials shall follow in general the listed sequence of work, making minor changes to improve work flow. Provide level of containment and PPE as required by the Microbial Remediation Plan. Disable all HVAC units and exhaust fans in the area to be remediated. Protect materials to remain in work area. Where possible, all materials to be salvaged should be cleaned in place to prevent possible cross-contamination created by moving materials through non-remediation areas. Remove undamaged items and materials to be cleaned and salvaged from the work area. Materials shall be stored in an area with relative humidity maintained below 60 percent and where temperatures will not damage the material. Notify the Architect of existing damage to items prior to removal, and proceed as follows:

A. Set up containments, including protection of materials remaining within the containment and AFUs.
B. Demolition and removal / cleaning of contaminated materials.
C. Perform final cleaning within the containment.
D. Clean carpet in the containment.
E. Perform clearance inspection by the CP.
F. Perform Duct and HVAC cleaning, if necessary.
G. Perform de-construction of containment, and removal of AFUs.
H. Clean previously removed items prior to returning to occupied area.

3.06 REMEDIATION PROCEDURES: Procedures for remediation depend on the amount of mold growth and the type of material with fungal growth.

3.07 REMEDIATION OF NON-POROUS MATERIALS: The method of remediating non-porous items includes the following:

A. HEPA vacuum all surfaces.
B. Damp wipe all surfaces using clean water or a detergent solution.

3.08 SEMI-POROUS MATERIALS (UNFINISHED WOOD): The method of remediating unfinished wood-based items, including wood and wood framing in wall cavities, includes the following:

A. CLEANING
B. HEPA vacuum all surfaces.
C. Scrub surfaces with a brush and detergent to remove mold.
D. HEPA vacuum all surfaces to remove dust.
E. Repair finishes as required to match original.
F. REMOVAL: Where unfinished wood product has been structurally damaged, remove and replace with an equivalent product, including but not limited to wall studs and sheathing used in flooring, wall, or roof construction.

3.09 SEMI-POROUS MATERIALS: The method of surface cleaning semi-porous materials such as concrete, vinyl wall covering, linoleum, leather furniture, and finished wood products includes the following:

A. HEPA vacuum all surfaces.
B. Damp wipe surfaces with using clean water or a detergent solution. Avoid over-wetting the material.

3.10 POROUS MATERIALS

A. CARPET: Removal carpet that has remained wet for 48 hours or longer. Use a dry absorbent compound cleaning method as designated by IICRC S100. This method uses an absorbent compound to dissolve, suspend and absorb carpet soils. It does not add moisture back into the carpet.
B. DRYWALL (GYPSUM WALLBOARD - GWB): Replace GWB that has remained wet for 48 hours or longer, or has visible mold growth. Where removal of GWB exposes insulation with visible mold growth, remove and replace the insulation with an insulation having equal characteristics for insulating value and permeability. Where GWB has a small amount of surface mold growth and the GWB is structurally sound, a surface cleaning method may be used. The method of surface cleaning GWB shall be HEPA vacuum of all surfaces. Surface cleaning cannot be used where mold growth penetrates wallboard substrate.
C. CEILING TILE: Remove ceiling tile that has remained wet for 48 hours or longer, or has visible mold growth. Where settled dust on ceiling tiles contains mold spores and the ceiling tile is structurally sound, is not sagging, and has not been wet, a surface cleaning method may be used only. The method of surface cleaning ceiling tile shall be HEPA vacuuming all surfaces, unless mold growth is visible on ceiling tiles.
D. TEXTILES: Discard textiles with visible mold growth. Clean textile based items, that do not have visible mold growth, but have been wet, in standard commercial or residential washing machines with standard washing machine detergent. Dry all items completely before returning to the building. When possible, use dryers to dry items. If dryers would cause irreversible harm to an item, hang the item on a drying rack in a temperature and humidity controlled space. Discard items not dry within 48 hours.

3.11 DETAILED SEQUENCES OF WORK FOR MOLD REMOVAL UNDER CONTAINMENT

A. PREPARATION FOR REMEDIATION WORK: Provide level of containment and PPE required for the remediation based on the Microbial Remediation Plan, and as follows:
   (1) Disable all HVAC units and exhaust fans in the area to be remediated.
   (2) Remove undamaged materials from the work area if they are to be salvaged but cannot be cleaned in place. Store materials in an area with relative humidity maintained below 60 percent and where temperatures will not damage the material. Notify Contracting Officer of existing damage to items prior to removal. Clean materials using procedures detailed in Remediation Procedures.
   (3) Remove supply diffusers, return grilles and exhaust grilles. Clean diffusers and grilles using procedures detailed in Remediation Procedures.
   (4) Construct containment barriers. Existing walls can be used as a portion of the containment barriers if existing openings in walls (such as doors, wall openings, vents, etc.) are sealed using polyethylene.
   (5) Install the AFUs and dehumidifiers.
   (6) Seal supply, return, and exhaust openings with polyethylene sheeting and protect intakes to air handling units. Air handling units shall remain off.
   (7) Install all equipment needed for removal work in the containment area to minimize egress during demolition.
   (8) Inspect the containment to verify that the containment is properly constructed and the containment area has an overall negative pressure of 0.02 to 0.04 inch water column relative to the outside and adjacent work areas not undergoing active remediation, prior to beginning demolition work.
B. DEMOLITION
   (1) REMOVE MOLD CONTAMINATED MATERIALS to be discarded, such as paper, and furniture. Double bag material in 6 mil poly bags. Seal poly bags using duct tape inside the containment. HEPA vacuum bags before removing them from the containment or airlock. When possible, pass the bags directly from the containment or airlock to the outside. Transport bags to a dumpster. Do not leave the bags at the building.
   (2) REMOVE CONTAMINATED GYPSUM WALLBOARD (GWB) at the preliminary limits of demolition specified in the Microbial Remediation Plan. Inspect back side of removed GWB. If mold is observed on the back side of the GWB, report this condition to the Contracting Officer. After obtaining Contracting Officer approval, continue removing GWB until no mold is observed. If hidden mold is discovered that will extend past the extents of the containment, stop work immediately and reconstruct the containment to extend past the suspected contamination. Re-evaluate level of containment and PPE. Continue to operate AFUs during reconfiguring of containment.
      (a) Remove drywall by cutting in pieces as large as possible to minimize aerosolization of fungal spores. Drywall screws can either be backed out during removal or later during cleanup.
      (b) Use dust collection attachments on all power tools, such as sanders, saws, etc., to capture dust created when using the tools. Outlet of dust collector should discharge into inlet of AFU.
      (c) Remove fiberglass insulation behind removed gypsum board.
      (d) If wood studs are contaminated, scrub them with a brush and detergent to remove mold. Replace wood studs with damage severe enough to reduce the structural capacity of the member. Prior to removal of any structural member consult with the Contracting Officer.
      (e) Clean all metal framing with a dilute detergent solution. Clean metal framing with light rust using steel wool and coat with a rust inhibiting paint. Replace metal framing with rust damage severe enough to reduce the structural capacity of the member.
      (f) Remove contaminated carpet scheduled for removal.
      (g) Place removed gypsum board, insulation, carpet and remaining debris in two layers of 6 mil poly bags. Seal poly bags using duct tape inside the containment. HEPA vacuum bags before removing them from the containment or airlock. When possible pass the bags directly from the containment or airlock to the outside. Transport bags to a dumpster. Do not leave the bags inside the building. Remediation workers shall HEPA vacuum their PPE, then remove them within the airlock chamber. Discard disposable coverall suits into a 6 mil poly bag.

C. POST-DEMOLITION INSPECTION: Inspect the containment area to verify that all contaminated materials have been removed. Allow a minimum of 12 hours after completion of removal work, with AFUs operating, for airborne dust in the containment to settle and / or be removed by the AFUs.

3.12 CLEANING AFTER DEMOLITION, AND CLEANING OF SETTLED SPORES FROM POROUS / NON-POROUS MATERIALS: Continue to operate AFUs during cleaning. Clean exposed surfaces, and as follows:

A. HEPA vacuum all surfaces.
B. Damp wipe all non-porous exposed surfaces including polyethylene sheets used to protect materials, external surfaces of ductwork, studs, and floors with clean rag and clean potable water or detergent solution.
C. Remove poly sheeting inside the containment.
D. HEPA vacuum all surfaces protected by poly sheeting.
E. Damp wipe non-porous surfaces protected by poly sheeting with clean water or a detergent solution.
F. Clean carpet using procedures in Remediation of Fungally Contaminated Building Materials.

3.13 DUCT AND HVAC SYSTEM CLEANING

A. THE CP MUST VISUALLY INSPECT the HVAC system serving all work areas and determine if additional remediation is needed to clean the HVAC system, thus preventing re-contamination. If necessary and only upon approval by the Owner, proceed with HVAC microbial remediation, as follows:
   (1) Follow requirements of the NADCA ACR "Standard for Assessment, Cleaning, and Restoration of HVAC Systems".
   (2) Use of "gassing" or "fogging" cleaning methods with gaseous chlorine dioxide or ozone will not be allowed.
   (3) Disable all HVAC equipment prior to cleaning any component of the system.
   (4) Clean air handling units, terminal units, blowers and exhaust fans as follows:
   (5) Construct a limited containment around equipment to be cleaned. Provide appropriate PPE for workers.
   (6) Remove filters. Seal filters in 6 mil poly bags for disposal.
   (7) Disassemble units as necessary to clean components. Contractor is responsible for reassembling equipment after cleaning.
   (8) Clean disassembled components within the containment or in a separate two chamber cleaning containment. Seal disassembled components in 6 mil poly bags for transport out of building / house.
   (9) HEPA vacuum all surfaces.
   (10) Damp wipe all non-porous surfaces and components with clean water or a detergent solution.
   (11) The method of cleaning HVAC coils shall be:
   (12) Clean coils using a method which will render the coil visibly clean. Coil cleaners shall be non-acidic / alkaline, detergent based. Clean condensate drain pans. The drain for the condensate drain pan shall be operational during the cleaning.
   (13) Rinse coils and drain pans with clean water to remove any latent residues. Cleaning methods shall not cause damage to the coil surface or fins. Cleaning must restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed. If the original pressure drop is not known, the coil shall be considered clean only if the coil is free of foreign matter and chemical residue.

B. Clean duct systems as follows:
   (1) During cleaning, connect a vacuum collection system to the downstream end of the section being cleaned. The vacuum collection device must be of sufficient power to render all areas of duct being cleaned under negative pressure relative to rooms and areas of duct not being cleaned. Negative pressure must be verified at the furthest point from the collection system with a micromanometer and verification measurements included in the Daily Report.
   (2) Equip the vacuum collection systems with HEPA filters. Exhaust the vacuum collection systems directly to the outside.
   (3) Use mechanical agitation devices to dislodge debris adhered to the ductwork, such that debris may be safely conveyed to vacuum collection devices. Cleaning methods shall not damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork.
   (4) HEPA vacuum duct surfaces.
   (5) When possible, damp wipe metal duct surfaces with clean water or detergent solution. Do not wet fibrous glass thermal or acoustical insulation.
   (6) Identify areas where there is evidence of damage to or uncleanable mold in duct insulation, and discard contaminated insulation.
   (7) Final clearance of HVAC and duct system will be based on a visual assessment (no visible dust, no visible mold) by the CP.

3.14 CLEARANCE CRITERIA: Remediation clearance will be based on a visual assessment that visible mold is removed - visible dust is removed, based on a "white glove" test to be performed by the by CP. Testing must consist of wiping the surfaces with a clean cloth of a color suitable to reveal expected type of dust. For most surfaces, a white cloth is suitable. For drywall dust, a dark cloth may be more appropriate. Remediation areas that fail clearance testing must be re-cleaned and AFUs kept in operation not less than twelve (12) hours after testing, followed by another “white-glove” clearance assessment. Subsequent failures will follow the same routine until passing.

3.15 CLEAN-UP AND DISPOSAL

A. RESTORATION: Remove temporary decontamination facilities and restore the area designated for these facilities to its original or better condition. When existing construction is damaged or contaminated by the Work of this Section, restore that Work to its original or better condition.
B. DISPOSAL OF MATERIAL: Dispose of contaminated bagged waste materials removed during this remediation as general construction debris. Follow all applicable local, State, and Federal requirements for the disposal.

C. MATERIAL PACKAGING: Place waste, as waste is removed, into a disposal container promptly. Disposal containers shall consist of at a minimum, two layers of clear 6 mil polyethylene bags. Tape bags in a gooseneck fashion to form an airtight seal and label appropriately. Bag waste from vacuums equipped with HEPA filters in 6 mil polyethylene bags.
D. BUILDING EXIT (WASTE DISPOSAL): HEPA vacuum and damp wipe bags of contaminated waste material prior to removal from the building.

END OF SECTION 02 85 00

DIVISION 03 – CONCRETE

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

SECTION 03 35 05 – SEALED CONCRETE FINISHING

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

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

(1) Footings.
(2) Foundation walls.
(3) Slabs-on-grade.
(4) Suspended slabs.
(5) Concrete toppings.
(6) Building frame members.
(7) Building walls.

B. Related Sections:

(1) Section 033713 "Shotcrete" for shotcrete applied by wet or dry mix process.
(2) Section 033816 "Unbonded Post-Tensioned Concrete" for post tensioning reinforcement and accessories and post tensioning operations.
(3) Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.
(4) Section 316329 "Drilled Concrete Piers and Shafts" for drilled pier operations.
(5) Section 321313 "Concrete Paving" for concrete pavement and walks.
(6) Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.03 DEFINITIONS

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

1.04 ACTION SUBMITTALS

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

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

(a) Mix identification number (unique for each mix submitted).
(b) Statement of intended mix use.
(c) Mixture proportions.
(d) Water/cementitious materials ratio.
(e) Wet and dry unit weight.
(f) Total air content.
(g) Design slump and allowable range after additions of all admixtures.
(h) Time limits on discharge: If time of discharge exceeds ACI 301 90 minute time limit, submit concrete properties criteria at permissible time of discharge and additional special inspection and testing requirements associated with time limits.
(i) Compressive strength tests.

(3) Shrinkage testing per ASTM C 157.
(4) Lightweight Concrete:

(a) Submit data relating strength to cement content.
(b) Submit data demonstrating splitting tensile strength exceeds 5.7 times the square root of specified design compressive strength, f'c.
(c) For lightweight concrete placed by pumping, separate mix designs are required for each 100 feet of vertical or horizontal distance from pump to point of discharge. Requirement may be waived if evidence acceptable to Architect is submitted demonstrating, by previous successful experience, that proposed mix will meet all requirements of these specifications, when sampled at point of discharge over full range of distances required.
(d) Data correlating air-dry unit weight to fresh unit weight.

(5) Maximum embodied carbon of Concrete Mix. Reference drawings for embodied carbon goals.
(6) Concrete strength maturity curves: For concrete specified with a 56-day f'c concrete strength, either develop and submit strength-maturity relationship curves in accordance with ASTM C 1074 with maturity testing extended to 56 days or submit compressive strength test results at 7, 28 and 56 days.

C. Before submitting concrete design mixtures to the architect for review, contractor shall review concrete design mixture for applications, state on the submittal where the concrete mix will be used, establish procedures for ensuring quality of concrete materials and verify suitability of mix design for placement and finishing.
D. Mass concrete thermal control plans. See “Concrete Mixtures, General – Mass Concrete Performance and Design Requirements” section of this specification.
E. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
   (1) Show all reinforcing, top and bottom profile of concrete element, supports below, including beams, columns and walls, grade beams, concrete walls, joists, etc. framing into elements.
   (2) Provide one continuous elevation at 1/4" (1:48) scale for all beams, joists or walls in a continuous line. Show pockets and openings in shear walls, structural slabs, beams, elevations of top of beams, walls, columns, sections through beams, pilasters, columns, and placing sequence of reinforcing for items with more than one reinforcing layer.
   (3) Show locations of approved construction joints, locations of pour strips, splices of reinforcing, type of splice used and splice location. Identify all ASTM A706 and epoxy coated reinforcing locations.
F. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   (1) Location of construction joints is subject to approval of Architect.
G. Samples: For waterstops, vapor retarder, expansion joint material, decorative paving finishes.
H. Void Forms: Provide manufacturer’s data on factory made void pieces. Submit evidence void is of proper size and shape after concrete placement. Submit evidence of void form material degradation as specified herein.

1.05 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:
   (1) Cementitious materials.
   (2) Admixtures.
   (3) Form materials and form-release agents.
   (4) Steel reinforcement and accessories.
   (5) Fiber reinforcement.
   (6) Waterstops.
   (7) Curing compounds.
   (8) Floor and slab treatments.
   (9) Bonding agents.
   (10) Adhesives.
   (11) Vapor retarders.
   (12) Semirigid joint filler.
   (13) Joint-filler strips.
   (14) Repair materials.
   (15) Supplementary Cementitious materials.
   (16) Corrosion inhibitors.
B. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
   (1) Aggregates: Submit test reports indicating that aggregates are not potentially reactive based on the ASTM C295 or ASTM 1260 testing limits set forth in section 5.1 of “Guide Specification for Concrete Subject to Alkali-Silica Reactions” (2007 Portland Cement Association). Alternatively, submit ASTM C1567 test reports indicating that the combination of mix ingredients reduces the expansion due to Alkali aggregate reactivity such that the mix complies with section 5.2 of “Guide Specification for Concrete Subject to Alkali-Silica Reactions” (2007 Portland Cement Association). All tests for submitted reports shall have been performed within one year of the submittal date.
C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
   (1) Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
E. Field quality-control reports.
F. Minutes of preinstallation conference.
G. Placement Notification: Advance notification of concrete placement. Submit notification to Architect at least 24 hours in advance of placement.
H. Certification of chloride screen effectiveness for penetrating sealers.
I. Proposed location of saw cut joints not indicated on Drawings.
J. Curing compound data demonstrating specified moisture loss performance.
K. Evaporative retarder product and application data.
L. Mass concrete thermal monitoring records.
M. Corrosion Inhibitor testing results.
N. Sustainability Submittals:
   (1) Submit product data or other published information verifying that this product has an environmental product declaration (EPD). Submit in accordance with Section 018113.

(2) Concrete Mix environmental product declaration (EPD) Disclosure: For each concrete mix type used on the project provide a current, product specific, third party verified, type III EPD conforming to ISO 14025 and the North American product category rule (PCR) for ready mix concrete.

(a) Submitted EPDs shall demonstrate conformance to the global warming potential limits indicated in the construction documents.

(3) Steel reinforcement environmental product declaration (EPD) disclosure: Provide a current, product specific, third party verified, type III EPD conforming to ISO 14025 and the North American product category rule (PCR) for steel construction products for all deformed bar reinforcing and welded wire reinforcing utilized on the project.

(a) If steel reinforcement is sourced from multiple facilities, EPD data shall be provided for each facility with a statement outlining the applicability of each EPD submitted.
(b) Submitted EPDs shall demonstrate conformance to the global warming potential limits indicated in the construction documents.

(4) For products having recycled content, submit documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
(5) Location Valuation Factor

(a) Submit product data or other published information verifying the location of manufacturing facility including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc. and the distance between this location and the project site. Also include material cost (excluding costs of installation).
(b) Include information on USGBC's v4.1 Building Product Disclosure and Optimization Calculator.

(6) General Contractor's Sustainability Statement Letter: In the event that a sustainability goal or submittal requirement will not be met, contractor shall state in a letter the reasons why the goal or submittal requirement is not being met. Letter shall state whether alternative sustainability measures are viable for the project. If there are viable alternatives, letter shall include details of proposed alternatives and associated project costs and schedule impacts (if any) for the Owner's consideration.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Associate and a supervisor who is an ACI-certified [Advanced] Concrete Flatwork Finisher.
B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

(1) Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

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

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

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
F. Formwork: Contractor shall be responsible for design and engineering of formwork. Design of formwork and preparation of formwork drawings shall be performed under supervision of a qualified engineer registered in the state of the project.
G. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

(1) ACI 301, "Specifications for Structural Concrete," Sections 1 through 5 and Section 7, "Lightweight Concrete".
(2) ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

H. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
I. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.

(1) Build panel approximately 200 sq. ft. for slab-on-grade and 100 sq. ft. for formed surface in the location indicated or, if not indicated, as directed by Architect.
(2) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

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

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

(a) Contractor's superintendent.
(b) Independent testing agency responsible for concrete design mixtures.
(c) Ready-mix concrete manufacturer.
(d) Concrete subcontractor.
(e) Special concrete finish subcontractor.
(f) Owner's Testing/Inspection Agency.
(g) Engineer by video call
(h) Architect by video call

(2) Review as applicable to Project special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving floor and slab flatness and levelness, floor and slab flatness and levelness measurement, concrete repair procedures, concrete protection, field sampling procedures for concrete cylinders and air testing, initial curing and field curing of field test cylinders (ASTM C31/C31M), protection of field cured field test cylinders.

(3) Minutes of the meeting shall be recorded by Contractor and distributed to all parties within five days. Provide one copy to Owner's representative and Architect.

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

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

1.07 DELIVERY, STORAGE, AND HANDLING

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

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

PART 2 - PRODUCTS

2.01 FORM-FACING MATERIALS

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

(1) Plywood, metal, or other approved panel materials.

(2) Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

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

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

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

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

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

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

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

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

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

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

(1) Furnish units that will leave no corrodible metal closer than 1 1/2" inch to the plane of exposed concrete surface.

(2) Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

(3) Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.02 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Total recycled content not less than 95 percent.

B. All steel reinforcement shall be produced using an electric arc furnace.

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

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

E. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60, ASTM A 706/A 706M for bars that may be field bent, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M for bars that are prefabricated, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.
F. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
G. Deformed-Steel Wire: ASTM A 496/A 496M.
H. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain and deformed steel wire, with less than 2 percent damaged coating in each 12-inch wire length.
I. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.
J. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
K. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain and deformed steel.

2.03 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.
C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
D. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.
E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   (1) For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
   (2) For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
F. Mechanical Splices: Mechanical Splices shall comply with ASTM A1034, Type 2.
G. Deformed Bar Anchors: Heads on deformed bar anchors shall conform to ASTM A970 including Annex A1 requirements for class HA heads.

2.04 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   (1) Ordinary Portland Cement: ASTM C 150, Type as indicated on drawings, gray. Alternate cementitious materials, when proposed to control alkali-silica reactions and tested as part of a representative concrete mix in accordance with ASTM C1567, may be used subject to approval.
   (2) Blended Hydraulic Cement: ASTM C 595, Type IL, portland-limestone.
   (3) Performance-Based Hydraulic Cement: ASTM C1157, Type GU, general use, Type HE, high early strength, Type MS, moderate sulfate resistance, Type HS, high sulfate resistance, Type MH, moderate heat of hydration, Type LH, low heat of hydration.
   (4) Supplementary Cementitious Materials (SCM): Of proportions and type to meet concrete performance criteria as indicated in the structural drawings. Available SCM's that may be incorporated into the Work include, but are not limited to, the following:
      (a) Fly Ash or Natural Pozzolans: ASTM C 618, Class F, C or N.
      (b) Slag Cement: ASTM C 989, Grade 100 or 120.
      (c) Silica Fume: ASTM C 1240, amorphous silica.
      (d) Ground Glass Pozzolan: ASTM C1866, Type GS or GE.
B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. All coarse and fine aggregate shall be tested per ASTM C 295 or ASTM C 1293 in accordance with section 5.1 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association).
   (1) Maximum Coarse-Aggregate Size: As indicated on Drawings.
   (2) Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
C. Lightweight Aggregate: ASTM C 330, with size as indicated on Drawings.
D. Water: ASTM C 1602 tested non-potable which is compatible with admixtures. Provide sample and obtain approval from architect of color and finish of exposed concrete mixes where non-potable water is used.

2.05 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.
B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   (1) Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   (2) Retarding Admixture: ASTM C 494/C 494M, Type B.
   (3) Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   (4) High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   (5) High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

(6) Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
(7) Mid-Range Water Reducing Admixture: ASTM C 494/C 494M, Type A.
(8) Carbon Dioxide Mineralization: ASTM C494 Type S.

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

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

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

D. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete complying with and ASTM C1582 for corrosion-inhibitor use.

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

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

2.06 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

(1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

(a) Greenstreak.
(b) Williams Products, Inc.

(2) Profile: As indicated in drawings.
(3) Dimensions: Non-tapered.

B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

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

(a) JP Specialties, Inc.; Earth Shield TPE-Rubber.
(b) Vinylex Corp.; PetroStop.
(c) WESTEC Barrier Technologies, Inc.; 600 Series TPE-R.

(2) Profile: As indicated in drawings.
(3) Dimensions: Non-tapered.

C. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

(1) Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

(a) BoMetals, Inc.
(b) Greenstreak.
(c) Paul Murphy Plastics Company.
(d) Vinylex Corp.

(2) Profile: As indicated in drawings.
(3) Dimensions: Non-tapered.

D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

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

(a) Carlisle Coatings & Waterproofing, Inc.; MiraSTOP.
(b) CETCO; Volclay Waterstop-RX.
(c) Concrete Sealants Inc.; Conseal CS-231.
(d) Greenstreak; Swellstop.
(e) Henry Company, Sealants Division; Hydro-Flex.
(f) JP Specialties, Inc.; Earth Shield Type 20.

E. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.
   (1) Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      (a) Adeka Ultra Seal/OCM, Inc.; Adeka Ultra Seal.
      (b) Greenstreak; Hydrotite.
      (c) Vinylex Corp.; Swellseal.

2.07 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
   (1) Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      (a) Carlisle Coatings & Waterproofing, Inc.; Blackline 400.
      (b) Fortifiber Building Systems Group; Moistop Ultra [15] [10].
      (c) Grace Construction Products, W. R. Grace & Co.; Florprufe 120.
      (d) Insulation Solutions, Inc.; Viper VaporCheck [16] [10] [6.5].
      (e) Meadows, W. R., Inc.; Perminator [15 mil] [10 mil].
      (f) Raven Industries Inc.; Vapor Block [15] [10].
      (g) Reef Industries, Inc.; Griffolyn [Type-105] [Type-65G] [15 mil Green] [10 mil Green].
      (h) Stego Industries, LLC; Stego Wrap [15 mil Class A] [10 mil Class A].

B. Sheet Vapor Retarder: ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.
   (1) Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      (a) Fortifiber Building Systems Group; Moistop Ultra 6.
      (b) Raven Industries Inc.; Griffolyn [Type-65] [10 mil Green].
      (c) Stego Industries, LLC; Stego Wrap, 10 mil Class A.

C. Sheet Vapor Retarder: ASTM E 1745, Class C. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.
   (1) Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      (a) Fortifiber Building Systems Group; Moistop Plus.
      (b) Raven Industries Inc.; Vapor Block 6.
      (c) Reef Industries, Inc.; Griffolyn [Type-65] [Type-85].
      (d) Stego Industries, LLC; Stego Wrap, 10 mil Class C.

D. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

E. Bituminous Vapor Retarder: 110-mil-thick, semiflexible, 7-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories including bonding asphalt, pointing mastics, and self-adhering joint tape.
   (1) Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      (a) Meadows, W. R., Inc.; Premoulded Membrane Vapor Seal.
   (2) Water-Vapor Permeance: 0.00 grains/h x sq. ft. x inches Hg; ASTM E 154.
   (3) Tensile Strength: 140 lbf/inch (24.5 kN/m); ASTM E 154.
   (4) Puncture Resistance: 90 lbf (400N); ASTM E 154.

F. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

G. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

H. Vapor Barrier Accessories: Provide accessories manufactured by or recommended in writing by vapor barrier Manufacturer for sealing seams, penetrations and perimeter edges, including; seam tape, mastics, edge termination bar, double-sided tape, and other special tapes and accessories for complete under-slab vapor barrier assembly.
   (1) Seam Tape: 4-inch minimum width; water vapor transmission less than 0.3 perms per ASTM F 1249 or ASTM E 96.
   (2) Pipe Boots: Construct and install pipe boots from vapor barrier material and pressure sensitive tape in accordance with Manufacturer's instructions.

2.08 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing No. 4 sieve.

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

(a) Anti-Hydro International, Inc.; Emery.
(b) Dayton Superior Corporation; Emery Tuff Non-Slip.
(c) Lambert Corporation; EMAG-20.
(d) L&M Construction Chemicals, Inc.; Grip It.
(e) Metalcrete Industries; Metco Anti-Skid Aggregate.

B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

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

(a) Anti-Hydro International, Inc.; A-H Alox.
(b) BASF Construction Chemicals - Building Systems; Frictex NS.
(c) L&M Construction Chemicals, Inc.; Grip It AO.

C. Emery Dry-Shake Floor Hardener: Pigmented or unpigmented, factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.

(1) Color: As selected by Architect from manufacturer's full range.

D. Metallic Dry-Shake Floor Hardener: Pigmented or unpigmented, factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

(1) Color: As selected by Architect from manufacturer's full range.

E. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

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

(a) BASF Construction Chemicals - Building Systems; Maximent.
(b) ChemMasters; ConColor.
(c) Conspec by Dayton Superior; Conshake 500.
(d) Dayton Superior Corporation; Quartz Tuff.
(e) Edoco by Dayton Superior; Burke Non Metallic Floor Hardener 250.
(f) Euclid Chemical Company (The), an RPM company; Surflex.
(g) Kaufman Products, Inc.; Tycron.
(h) Lambert Corporation; Colorhard.
(i) L&M Construction Chemicals, Inc.; Quartzplate FF.
(j) Metalcrete Industries; Floor Quartz.
(k) Scofield, L. M. Company; Lithochrome Color Hardener.
(l) Symons by Dayton Superior; Hard Top.

F. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

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

(a) BASF Construction Chemicals - Building Systems; Mastercron.
(b) ChemMasters; ConColor.
(c) Conspec by Dayton Superior; Conshake 600 Colortone.
(d) Dayton Superior Corporation; Quartz Tuff.
(e) Edoco by Dayton Superior; Burke Non Metallic Floor Hardener 200 - 205.
(f) Euclid Chemical Company (The), an RPM company; Surflex.
(g) Kaufman Products, Inc.; Tycron.
(h) Lambert Corporation; Colorhard.
(i) L&M Construction Chemicals, Inc.; Quartz Plate FF.
(j) Metalcrete Industries; Floor Quartz.
(k) Scofield, L. M. Company; Lithochrome Color Hardener.
(l) Symons by Dayton Superior; Color Hardener.

(2) Color: As selected by Architect from manufacturer's full range.

2.09 LIQUID FLOOR TREATMENTS

A. VOC Content: Liquid floor treatments shall have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

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

(a) ChemMasters; Chemisil Plus.
(b) ChemTec Int'l; ChemTec One.
(c) Conspec by Dayton Superior; Intraseal.
(d) Curecrete Distribution Inc.; Ashford Formula.
(e) Dayton Superior Corporation; Day-Chem Sure Hard (J-17).
(f) Edoco by Dayton Superior; Titan Hard.
(g) Euclid Chemical Company (The), an RPM company; Euco Diamond Hard.
(h) Kaufman Products, Inc.; SureHard.
(i) L&M Construction Chemicals, Inc.; Seal Hard.
(j) Meadows, W. R., Inc.; LIQUI-HARD.
(k) Metalcrete Industries; Floorsaver.
(l) Nox-Crete Products Group; Duro-Nox.
(m) Symons by Dayton Superior; Buff Hard.
(n) US SPEC, Division of US Mix Products Company; US SPEC Industraseal.
(o) Vexcon Chemicals, Inc.; Vexcon StarSeal PS Clear

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

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

(a) Advanced Floor Products; Retro-Plate 99.
(b) L&M Construction Chemicals, Inc.; FGS Hardener Plus.
(c) QuestMark, a division of CentiMark Corporation; DiamondQuest Densifying Impregnator Application.

D. Penetrating Liquid Floor Treatment for Vehicular Surfaces: Material suitable for application on horizontal surfaces subject to vehicle traffic shall contain not less than 40% silane. Provide certification of 95% chloride screen effectiveness when tested in accordance with procedure of NCHRP Report Number 244 “Southern Climate Exposure” at manufacturer’s recommended rate of application. Also provide certification that product meets Alberta Transportation and Utilities BT-003 at 45% relative moisture results greater than 85% both initial and post abrasion performance.

2.10 CURING MATERIALS

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

(1) VOC Content: Evaporation retarders shall have a VOC content of 780 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
(2) Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

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

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
D. Water: Potable.
E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. Film must chemically break down in a four to six week period. Membrane-Forming Curing Compounds shall have a VOC content of 350 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

2.11 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
C. Reglets: Fabricate reglets of not less than 0.022-inch-thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
D. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034-inch-thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.12 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   (1) Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   (2) Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   (3) Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
   (4) Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.
B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
   (1) Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   (2) Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   (3) Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
   (4) Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.13 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   (1) Use a qualified testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
B. Supplementary Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement while meeting the embodied carbon limits listed on the drawings. Where indicated on the drawings, limit percentage, by weight, of cementitious materials other than Portland cement in concrete.
C. Limit water-soluble, chloride-ion content in hardened concrete as listed on the drawings.
D. Admixtures: Use admixtures according to manufacturer's written instructions.
   (1) Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
   (2) Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   (3) Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
   (4) Use corrosion-inhibiting admixture in concrete mixtures where indicated.
E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
F. Performance and Design Requirements:
   (1) Shrinkage: Shrinkage strain, determined in accordance with ASTM C 157 as amended and modified herein, shall not exceed the values below for each concrete class:
      (a) Amendments and modifications to ASTM C 157:
         (i) Storage: After initial 24 hour comparator reading, specimens are placed back in lime saturated water until age of seven days. At seven days another comparator reading is taken. This reading is used as the base reading which is used to calculate percent shrinkage. The specimens are stored at 50% humidity and 73° F.
         (ii) Test Reports: Report gage length (average of three) after 4, 7, 14, 28, and 56 days. In addition to the information required by ASTM C 157, Section 11, shrinkage test reports shall include gage lengths (initial length measurements) used to determine reported shrinkage strains.
      (b) 28 Day Shrinkage Strain: Shrinkage strains shall not exceed the following:
         (i) Concrete for slab-on-grade placed directly on vapor barrier: 0.046%.
         (ii) Concrete for bearing walls (basement walls excluded) and/or columns: 0.046%.

(2) Mass Concrete Requirements: See drawings for dimensional limits on structural elements requiring a thermal control plan. Contractor to submit thermal control plan for mass concrete elements following the requirements of ACI 301-20, Section 8. Thermal control plan for mass concrete shall be prepared by qualified concrete specialty engineer. Maximum post placement concrete temperature shall not exceed 160°F unless substantiating data is submitted indicating higher temperature is acceptable. Maximum differential temperature shall not exceed 35°F. Thermal monitoring to verify compliance with thermal control plan is required. Monitoring locations shall be indicated in plan. Qualified Consultants: MJ2 Consulting, mj2consulting.com. Other qualified specialty consultants are acceptable; submit qualifications.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

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

2.15 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.16 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

(1) When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

(1) For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
(2) For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
(3) Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.01 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117. Concrete adjacent to elevator hoistway shall be installed to tolerances required by elevator manufacturer.
C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

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

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

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

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
H. Chamfer exterior corners and edges of permanently exposed concrete.
I. At intersecting planes, provide sharp, clean corners without visible edges.
J. Form openings, chases, offsets, depressions, recesses, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
K. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
L. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

M. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement. Form release agent shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
N. Protect void form from moisture at all times before concrete placement.
O. Voids: Provide voids of full-size and extent shown on Drawings. Specified void form may be used at the Contractor's option. Where void forms are used below structural slab-at-grade, provide protective cover sheet in accordance with void manufacturer's recommendations. Prevent concrete from entering void space.
P. All formwork surfaces that support concrete exposed to view must be accepted by Architect prior to concrete placement.

3.02 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   (1) Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."
      (a) Tolerance of Embedded Items: Comply with ACI 117.
         (i) Anchor Rods:
            1. Plumbness: Within +/- 1/16 inch over anchor rod projection.
         (ii) Embedded Plates and Weldments:
            1. Location: +/- 1 inch vertical, +/- 1 inch horizontal.
            2. Plumb and Alignment: 1/4 inch in 12 inches (1:48).
   (2) Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
   (3) Install dovetail anchor slots in concrete structures as indicated. Where masonry or veneer intersects concrete, provide one vertical dovetail slot for each 8 inches of masonry thickness. Where concrete serves as the backup, space slots at 16 inches on center.

3.03 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
   (1) Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
   (2) Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
   (3) Leave formwork and shoring in place a minimum of 15 days after concrete placement unless reshoring is used.
B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 SHORES AND RESHORES

A. Comply with ACI 301 for design, installation, and removal of shoring, backshoring and reshoring.
   (1) Do not remove shoring or reshoring until measurement of slab tolerances is complete.
B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.
D. Reshoring:
   (1) If formwork and shoring are removed before concrete is 15 days old, reshoring shall remain in place a minimum of 15 days after placement irrespective of concrete strength.
   (2) For multi-story construction, reshoring shall remain in place a minimum of 15 days after placing of concrete deck above irrespective of concrete strength.

3.05 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
   (1) Lap joints 6 inches and seal with manufacturer's recommended tape.
B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.
C. Granular Course: Cover vapor retarder with granular fill or fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.
   (1) Place and compact a 1/2-inch-thick layer of fine-graded granular material over granular fill.

3.06 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
   (1) Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete in accordance ASTM E1643.
B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   (1) Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
D. Size, length, number and placement of supports shall be sufficient as to maintain reinforcing position within specified tolerances during construction traffic and concrete placement.
E. On vertical formwork, use approved bar chairs or spacers as required to maintain concrete cover and bar position. Do not staple or use any other metallic fastener to secure bolsters, chairs, etc. to formwork for concrete surfaces exposed to exterior.
F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
G. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
H. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.
I. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

3.07 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   (1) Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
   (2) Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
   (3) Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   (4) Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   (5) Space vertical joints in walls as indicated. Locate joints beside pilasters integral with walls, near corners, and in concealed locations where possible. Locate at centerline of support or middle third of span.
   (6) Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   (7) Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   (1) Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   (2) Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
   (3) Interior Slabs-on-Grade to Receive Carpet or Wood Floor Covering: Construct slabs as large a placement area as practical. Unless noted otherwise on Drawings, locate construction joints on column centerlines. Provide control joints at column centerlines and at intervals not more than 30 feet each way.
   (4) All Other Interior Slabs-on-Grade: Unless noted otherwise on Drawings, locate construction joints on column centerlines. Locate control joints where shown on Drawings. If not shown, provide control joints at column centerlines and at intervals not more than 10 feet each way.
D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   (1) Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   (2) Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
   (3) Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.
F. Joints in Slabs-on-Metal Deck: Locate construction joints as shown on Drawings. For slabs with welded wire reinforcing, continue reinforcing through construction joint and lap in adjacent pour. For slabs without welded wire

reinforcing, provide #4 bar 4 feet in length spaced at 12 inches on center staggered along the joint. Do not provide control joints.

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

3.08 WATERSTOPS

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

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

3.09 CONCRETE PLACEMENT

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

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

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

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

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

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

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

(1) Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
(2) Maintain reinforcement in position on chairs during concrete placement.
(3) Screed slab surfaces with a straightedge and strike off to correct elevations.
(a) Slabs supported by metal deck shall be gaged to provide the specified slab thickness over beams.
(b) Slabs supported by metal deck shall be poured level except that variation in slab thickness at any point shall be equal to or less than minus ¼ inch, plus 1 ½ inch.
(4) Slope surfaces uniformly to drains where required.
(5) Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

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

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

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

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

3.10 FINISHING FORMED SURFACES

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

(1) Apply to concrete surfaces not exposed to public view or as noted in architectural drawings.

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

(1) Apply to concrete surfaces exposed to public view or as noted in architectural drawings.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

(1) Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

(2) Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

(3) Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

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

3.11 FINISHING FLOORS AND SLABS

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

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

(1) Apply scratch finish to surfaces as indicated in the architectural drawings.

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

(1) Apply float finish to surfaces as indicated in the architectural drawings.

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

(1) Apply a trowel finish to surfaces as indicated in the architectural drawings.

E. Top of surface for slabs:

(1) Slabs on ground shall be +/- 0.75”.
(2) Formed suspended slabs, before removal of supporting shores +/- 0.75”.

F. Slab surface finish tolerance: Finish slab surfaces to the following tolerances according to ASTM E 1155 (ASTM E 1155M) for a randomly trafficked floor surface:

Surface Type	**SOF(F) Overall Flatness**	**SOF(L) Overall Levelness**	**MLF(F) Min. Local Flatness**	**MLF(L) Min. Local Levelness**
Slabs on grade (conventional)	20	15	17	15
Slabs on grade (moderately flat)	25	20	17	15
Slabs on grade (flat)	35	25	24	17
Suspended formed slabs (values prior to formwork removal)	30	20	20	15
Suspended slabs on metal deck	30	No limit	20	No limit
Slabs on grade (very flat)	45	35	30	24
Slabs on grade (Super flat)	60	40	36	27

(1) Floor Finishes that require local flatness numbers more restrictive than those specified above shall be achieved by the use of floor leveling compound or by grinding.

(2) At construction joints, finish and measure surface so gap at any point along the joint between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch. Grind or fill-in surface of concrete to meet limits above at construction joints.

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

G. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces as indicated in the architectural drawings. While concrete is still plastic, slightly scarify surface with a fine broom.

(1) Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

H. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

(1) Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

I. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate or aluminum granule finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

(1) Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate or aluminum granules over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
(2) After broadcasting and tamping, apply float finish.
(3) After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate or aluminum granules.

J. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:

(1) Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
(2) Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
(3) After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

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

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

(2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Moisture-retaining-cover shall be inspected each day by Contractor. Any areas which do not show condensation on underside of cover or any slab areas which are not wet shall be immediately rewetted and cover replaced to prevent moisture loss.

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

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

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

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

3.14 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
   (1) Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   (2) Do not apply to concrete that is less than 28 days' old.
   (3) Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Polished Concrete Floor Treatment: Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.
   (1) Machine grind floor surfaces to receive polished finishes level and smooth.
   (2) Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
   (3) Continue polishing with progressively finer grit diamond polishing pads to gloss level to match approved mockup.
   (4) Control and dispose of waste products produced by grinding and polishing operations.
   (5) Neutralize and clean polished floor surfaces.

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

3.15 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   (1) Defer joint filling until concrete has aged at least six month(s). Do not fill joints until construction traffic has permanently ceased.

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

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

3.16 CONCRETE SURFACE REPAIRS

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

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

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning and that are unacceptable to Architect. Allow Architect and Structural Engineer to observe concrete surfaces upon removal of forms and prior to repair of surface defects. Defects in structural concrete shall be brought to the attention of the Architect and Structural Engineer.
   (1) Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   (2) Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   (3) Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template. Submit proposed repair to Architect for review prior to commencement of work.
   (1) Repair finished surfaces containing defects that are unacceptable to Architect. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.031 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   (2) After concrete has cured at least 14 days, correct high areas by grinding.
   (3) Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   (4) Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   (5) Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

(6) Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

(7) Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

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

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

3.17 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on Drawings.

3.18 PROTECTION OF LIQUID FLOOR TREATMENTS

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

END OF SECTION 03 30 00

SECTION 03 35 05 – SEALED CONCRETE FINISHING

PART 1 - GENERAL

1.01 PROVIDE SEALED CONCRETE FINISH at interior exposed concrete floor surfaces that are not indicated to be finished with other finish materials or concrete surface treatments on the Drawings, including but not limited to exposed concrete floors or slabs, stair treads and risers, and stair platforms. Provide sealed concrete finish even if not specifically indicated or scheduled on the Drawings.

PART 2 - PRODUCTS

2.01 SEALED CONCRETE FINISH: Clear, high-solids, water based, non-yellowing membrane-forming, inorganic curing, sealing and hardener, material for treatment of uncovered concrete floor surfaces, complying with ASTM C 1315 – Type 1, Class A, and being classified as “low-odor” with a VOC content of less than 350 g/L. Do not apply to concrete surfaces that will receive subsequent cementitious toppings, sealers, hardeners, ceramic tile, resilient flooring, wood flooring, carpeting, or resinous flooring systems, unless sealer manufacture certifies that their product conforms to requirements required by the floor finish manufacturer and will not adversely affect floor finish application.

A. BASIS-OF-DESIGN: “MasterKure HD 200WB” by Master Builders Solutions, or approved equivalent

2.02 PARKING GARAGE CONCRETE SEALER (for all floor slab surfaces of parking garage): clear, solvent-based, water and chloride-ion repelling, penetrating sealer of 100% silane penetrating sealer, which reacts chemically with the concrete surface to function as a chloride Ion screen with a minimum 90% factor when tested in accordance with NCHRP #244, Series II:

A. BASIS-OF-DESIGN: “MasterProtect H1001” (Hydrozo 100 Plus), by Master Builders Solutions, or approved equal

PART 3 - INSTALLATION

3.01 CONCRETE SEALER INSTALLATION: Install a minimum of TWO (2) COATS, in accordance with Manufacturer’s recommendations.

END OF SECTION 03 35 05

END OF DIVISION 3

DIVISION 04 – MASONRY

SECTION 04 20 00 – UNIT MASONRY

SECTION 04 20 10 – REINFORCED UNIT MASONRY

SECTION 04 40 00 – SITE STONE ASSEMBLIES

SECTION 04 20 00 – UNIT MASONRY

PART 1 - GENERAL

1.01 PROVIDE UNIT MASONRY where indicated on the drawings and as specified herein. Install steel lintels and shelf angles for unit masonry where indicated.

1.02 PRODUCTS INSTALLED, BUT NOT FURNISHED, under this Section include the following:

A. Steel lintels and shelf angles for unit masonry, furnished under Division-05 Section "Metal Fabrications."

1.03 REFERENCES

A. ACI 530/ASCE 5/TMS 402-99: Building Code Requirements for Masonry Structures.
B. ACI 530.1/ASCE 6/TMS 602-99: Specifications for Masonry Structures.
C. ASTM A153/A153M-98: Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
D. ASTM A580/A580M-98: Standard Specification for Stainless Steel Wire.
E. ASTM C144-99: Standard Specification for Aggregate for Masonry Mortar.
F. ASTM C150-98: Standard Specification for Portland Cement.
G. ASTM C207-97: Standard Specification for Hydrated Lime for Masonry Purposes.
H. ASTM C270-99: Standard Specification for Mortar for Unit Masonry.
I. International Masonry Institute All-Weather Council: Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

1.04 SUBMITTALS

A. PRODUCT DATA: For each different masonry unit, accessory, and other manufactured product specified.
B. SHOP DRAWINGS: Show fabrication and installation details for the following:
C. REINFORCING STEEL. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
D. MASONRY TRIM: Indicate profiles of custom-fabricated trim units
E. MATERIAL SAMPLES FOR PRODUCT VERIFICATION:

(1) FULL-SIZE UNITS of each different exposed masonry unit required, showing the full range of exposed colors, textures, and dimensions to be expected in the completed construction.
(2) CUSTOM BRICK SHAPES required for the Project
(3) WEEP HOLES/VENTS in color to match mortar color.
(4) ACCESSORIES EMBEDDED in the masonry

F. LIST OF MOCKUP MATERIALS: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents, unless such deviations are specifically brought to the attention of the Architect and approved in writing.
G. ADVERSE-WEATHER PROCEDURES: Detailed description of methods, materials, and equipment to be used to comply with either cold- or hot-weather requirements.

1.05 QUALITY ASSURANCE

A. SOURCE LIMITATIONS FOR MASONRY UNITS: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
B. SOURCE LIMITATIONS FOR MORTAR MATERIALS: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.
C. PRECONSTRUCTION TESTING: Provide the services of a qualified independent testing agency to perform preconstruction testing indicated below as a part of the Work of this Section.

(1) Concrete Masonry Unit Test: For each concrete masonry unit indicated, per ASTM C 140.
(2) Mortar Test: For mortar properties per ASTM C 270.
(3) Grout Test: For compressive strength per ASTM C 1019.

D. FIRE-RESISTANCE RATINGS: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.

1.06 MOCKUP:

A. PROVIDE MASONRY MATERIALS for construction of a field mockup of each different exposed masonry material and color indicated, showing the full range of exposed colors, textures, and dimensions to be expected in the completed construction. Materials include but are not limited to:

(1) MASONRY UNITS of each different exposed masonry unit, including special shapes, if applicable.
(2) WEEP HOLES/VENTS
(3) ACCESSORIES EMBEDDED in the masonry

B. BEFORE INSTALLING UNIT MASONRY, build mockup to verify selections made under sample Submittals and to demonstrate aesthetic effects. Refer to Division-1 Section Quality Requirements for general requirements of Mockup. Clean exposed faces of mockup panels with masonry cleaner indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. STORE MASONRY UNITS on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
B. PROTECT CONCRETE MASONRY UNITS from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.
C. STORE CEMENTITIOUS MATERIALS on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
D. DELIVER PREBLENDED, DRY MORTAR MIX in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
E. STORE MASONRY ACCESSORIES, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.08 PROJECT CONDITIONS

A. WEATHER PROTECTION: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress. Extend cover a minimum of 24 inches down both sides and hold cover securely in place. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
B. DO NOT APPLY UNIFORM FLOOR OR ROOF LOADS for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
C. PREVENT GROUT, MORTAR, AND SOIL FROM STAINING the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry. Protect base of walls from rain-splashed mud and from mortar splatter by coverings spread on ground and over wall surface. Protect sills, ledges, and projections from mortar droppings. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
D. COLD-WEATHER REQUIREMENTS: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
E. HOT-WEATHER REQUIREMENTS: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required. When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 - PRODUCTS

2.01 CONCRETE MASONRY UNITS (CMU's):

A. PROVIDE NORMAL WEIGHT (unless otherwise indicated) ASTM C 90 open-ended per allowable shrinkage rate of C-90 paragraph 5.2, with minimum average net-area compressive strength of 1900 PSI; face size: 8 inches nominal - 7-5/8 inches actual height x 16" nominal – 15-5/8 inch actual width, in total nominal wall thickness as indicated in the Drawings. Provide manufacturer's standard light-gray colored units with "smooth" (not textured) exposed face surface suitable for painting typically, and, provide textured-face units made with gap-graded aggregates where units are indicated to receive a direct application of plaster or similar material.
B. PROVIDE SPECIAL SHAPED CMU'S at lintels, corners, jambs, sash, control joints, headers, bonding, and other similar conditions.
C. PROVIDE BULLNOSE CORNER CMU'S at all exposed outside corners, unless otherwise indicated.
D. PRECAST CMU LINTELS OR BOND BEAMS: Provide either prefabricated concrete lintels or built-in place masonry lintels using bond beam shapes with reinforcing bars indicated and filled with coarse grout. Fabricate from concrete matching CMU color, texture, joint pattern and compressive strength, and with reinforcing bars as required. Cure precast lintels by same method used for the concrete masonry units.

2.02 FACE BRICK:

A. PROVIDE CLAY UNITS complying with ASTM C 216, Grade SW, Type FBX, FBS, FBA, with initial rate of absorption less than 30 g/30 sq. In. per minute when tested per ASTM C 67, "not effloresced" when tested per ASTM C-79, and with no observable surface coloring difference in applied finish when viewed from 10 feet after 50-cycles of freezing and thawing per ASTM C-67 (except for flashed or sand-finished units).

B. **E-BV1: Exterior Units**

(1) AMBASSADOR UNIT SIZE: Provide units manufactured to actual dimensions of 3-5/8 inches wide x 2-1/4 high by 15-5/8 inches long, except when indicated otherwise.
(2) Manufacturer: Taylor Clay Products
(3) Color: #316 Gray
(4) Finish: Smooth
(5) Install: Offset Running Bond

C. **E-BV2: Exterior Units**

(1) MODULAR UNIT SIZE: Provide units manufactured to actual dimensions of 3-5/8 inches wide x 2-1/4 high by 7-5/8 inches long, except when indicated otherwise.

(2) Manufacturer: Taylor Clay Products
(3) Color: #316 Gray
(4) Finish: Smooth
(5) Install: Custom Stepping Pattern as indicated in the Drawings.

D. **E-BV3: Exterior Units**

(1) AMBASSADOR UNIT SIZE: Provide units manufactured to actual dimensions of 3-5/8 inches wide x 2-1/4 high by 15-5/8 inches long, except when indicated otherwise.
(2) Manufacturer: Endicott Clay Products
(3) Color: Medium Ironspot 46
(4) Finish: Wirecut
(5) Install: Offset Running Bond

E. **BV1: Interior Units**

(1) AMBASSADOR UNIT SIZE: Provide units manufactured to actual dimensions of 1 inches wide x 2-1/4 high by 15-5/8 inches long, except when indicated otherwise.
(2) Manufacturer: Taylor Clay Products
(3) Color: #316 Gray
(4) Finish: Smooth
(5) Install: Offset Running Bond

F. MANUFACTURER/PRODUCT COLOR & TEXTURE: Provide brick as indicated in the Drawings. Do not substitute materials or colors indicated without approval of the Architect.

2.03 CAST-STONE MASONRY PARAPET CAPS AND TRIM UNITS

A. High-density pre-finished concrete masonry trim-units conforming to ASTM C90-96, typically fabricated with an integral-cut drip-edge on bottom surface and with sloped surfaces where exposed, in special profile shapes as indicated in the Drawings for “Cast Stone” trims or parapet caps. Provide shop-drawings of special-shapes or product-data submittals for standard shaped products. Provide units manufactured by the following, or approved equal (sawn-faces are not acceptable):

2.04 MORTAR AND GROUT MATERIALS

A. PORTLAND CEMENT-LIME MIX: Provide pre-packaged blend of natural or white Portland cement (as required to produce mortar color required), complying with ASTM C 150, Type I or Type II (except that Type III may be used for cold-weather construction), with hydrated lime complying with ASTM C 207, Type S. Masonry cement mixes are not acceptable.
B. PROVIDE INTEGRAL WATER-REPELLENT ADMIXTURE factory blended in mix complying with ASTM E-514 when tested as a wall assembly obtaining a Class E Rating, at all exterior masonry wall construction (including masonry veneers).
C. PRE-PACKAGED COLORED CEMENT: Project WILL include colored mortar. Provide pre-packaged Portland cement-lime mix containing pigments to produce color indicated, or if not indicated, as selected from manufacturer’s standard colors. Pigments shall not exceed 10 percent of Portland cement by weight.

(1) Basis Of Design: SpecMix

D. AGGREGATE FOR MORTAR: ASTM C 144. For mortar exposed to view, use washed aggregate consisting of natural sand or crushed stone. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve. Provide natural white sand if necessary to produce required mortar color.
E. AGGREGATE FOR GROUT: ASTM C 404.
F. COLD-WEATHER ADMIXTURE: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated Available products include:

(1) Accelguard 80; Euclid Chemical Co.
(2) Polarset; GCP Applied Technologies.
(3) MasterSet FP 20; Master Builders Solutions

G. WATER-REPELLENT ADMIXTURE: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer. Available products include:

(1) BlockTite; Euclid Chemical
(2) Dry-Block Mortar Admixture; GCP Applied Technologies..
(3) MasterPel 240MA; Master Builders Solutions.

H. WATER: Potable.

2.05 RELATED MASONRY MATERIALS:

A. REINFORCING STEEL: Uncoated steel reinforcing bars: ASTM A 615/A 615M; ASTM A 616/A 616M, including Supplement 1; or ASTM A 617/A 617M, Grade 60 (Grade 400).
B. JOINT REINFORCEMENT: ASTM A 951, hot-dip galvanized, carbon-steel wire for both interior and exterior walls, with W2.8 or 0.188-inch diameter side-rods and W2.8 or 0.188-inch diameter cross-rods. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units. For single-wythe masonry, provide either ladder or truss type with single pair of side rods and cross rods spaced not more than 16 inches o.c. At multi-wythe masonry, provide ladder type with perpendicular cross rods spaced not more than 16 inches o.c. and 1 side rod for each face shell of hollow masonry units more than 4 inches (in width, plus 1 side rod for each wythe of masonry 4 inches (or less in width).

C. TIES AND ANCHORS - GENERAL: ASTM A-82 hot-dip galvanized carbon-steel wire with ASTM A 153, Class B-2 coating; ASTM A-653 steel sheet with G60 hot-dipped galvanized coating, and ASTM A-36 steel plates, shapes, and bars with G60 hot-dipped galvanized. coating.

D. BENT WIRE TIES: Rectangular units with closed ends and not less than 4 inches wide. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units or hollow units laid with cells horizontal. Fabricated from 3/16-inch- diameter, hot-dip galvanized steel wire.

E. ADJUSTABLE ANCHORS FOR CONNECTING TO STEEL FRAME: Two-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall. Fabricate anchor section of crimped 1/4-inch- diameter, hot-dip galvanized steel wire for welding to steel. Fabricate tie section of triangular-shaped 0.1875-inch diameter hot-dip galvanized steel wire, sized to extend within 1 inch of masonry face.

F. ANCHORS FOR CONNECTING TO CONCRETE: Two-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall. Fabricate dovetail anchor section from 0.0966-inch- thick, steel sheet, galvanized after fabrication. Fabricate tie section from triangular-shaped 0.1875-inch-diameter, hot-dip galvanized steel wire, sized to extend within 1 inch of masonry face, made from.

G. ADJUSTABLE MASONRY-VENEER ANCHORS: Two-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch. Fabricate anchor section from rib-stiffened, 0.0677-inch thick sheet metal plate galvanized after fabrication with screw holes top and bottom, 2-3/4 inches wide by 3 inches high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section.. Fabricate wire-tie section from triangular- shaped 0.1875-inch- diameter hot-dip galvanized steel wire tie sized to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following:

(1) Thermal HB-213; Hohmann & Barnard, Inc.
(2) 2-SEAL Thermal Wing Anchor; Hohmann & Barnard, Inc.
    (a) 2X-HOOK; Hohmann & Barnard, Inc.

H. THERMAL BRICK SUPPORT SYSTEM: Multi-piece, hot-dipped galvanized, thermally-broken brick veneer support system.

(1) TBS System; Hohmann & Barnard, Inc.

I. STEEL DRILL SCREWS FOR STEEL STUDS: No 10 diameter minimum ASTM C 954 except manufactured with hex washer head and with neoprene washer, length required to penetrate steel stud flange by not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

(1) Dril-Flex; Elco Industries, Inc.
(2) Hohmann & Barnard, Inc.
(3) Traxx; ITW-Buildex.

J. ANCHOR BOLTS: Headed type steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated.

K. THRU-WALL MASONRY FLASHING SYSTEM: Provide a fully integrated thru-wall masonry flashing system throughout the project as manufactured by

(1) Basis of Design: “Illinois Products Corporation” (IPCO), phone: 800-383-8183, website: Illinois Products Flashing System or;
    (a) Mortar Net; Mortar Net USA, Ltd.

Including the following components:

(2) Self Adhering Membrane Flashing; min. 40 mil thickness, to be integrated with the stainless steel flashing drip edge behind the masonry as counter flashing.
(3) Pre-formed flashing corners and end-dams
(4) 3/8” (exposed hemmed drip edge) x 0.015 x 3-inch deep sheet metal drip-edge
    (a) Stainless steel
(5) Pre-formed inside and outside drip-edge corners
(6) 15 mil (28 gage) Type 304 stainless steel cavity bridges
(7) Rubberized asphalt flashing mastic, to seal edges of flashing

L. COMPRESSIBLE FILLER: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 50 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

M. PREFORMED CONTROL-JOINT GASKETS: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

(1) STYRENE-BUTADIENE-RUBBER COMPOUND: ASTM D 2000, Designation M2AA-805.
(2) PVC: ASTM D 2287, Type PVC-65406.

N. BOND-BREAKER STRIPS: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

O. RECTANGULAR PLASTIC WEEP/VENTS: Clear butyrate or PVC , 3/8 by 1-1/2 by 3-1/2:

(1) Cell Vent; Dur-O-Wal, Inc., or Hohmann & Barnard # 343 louvered Weep Vent or equal

P. CAVITY DRAINAGE MATERIAL: 1-inch- thick, free-draining mesh; made from polyethylene strands and shaped to avoid being clogged by mortar droppings.

(1) Mortar Break; by Advanced Building Products, Inc.
(2) Polytite MortarStop, by Dayton Superior Corporation, Dur-O-Wal Division
(3) Mortar Net; Mortar Net USA, Ltd.

Q. REINFORCING BAR POSITIONERS: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.

(1) D/A 811; Dur-O-Wal, Inc.
(2) D/A 816; Dur-O-Wal, Inc.
(3) No. 376 Rebar Positioner; Heckman Building Products, Inc.
(4) #RB Rebar Positioner; Hohmann & Barnard, Inc.
(5) #RB-Twin Rebar Positioner; Hohmann & Barnard, Inc.
(6) Double O-Ring Rebar Positioner; Wirebond.
(7) O-Ring Rebar Positioner; Wirebond.

R. MASONRY CLEANER: Provide standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by manufacturer of masonry units being cleaned.

2.06 MORTAR AND GROUT MIXES

A. DO NOT USE admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride in mortar or grout.
B. ADD COLD-WEATHER ADMIXTURE (IF USED) at the same rate for all mortar, regardless of weather conditions, to ensure that mortar color is consistent.
C. PREBLENDED, DRY MORTAR MIX: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
D. MORTAR FOR UNIT MASONRY: Comply with ASTM C 270, Property Specification, and as follows:

(1) Typical Unit masonry or masonry veneer: Type N.
(2) For masonry below grade, in contact with earth, and where indicated, use Type M.
(3) For reinforced masonry and where specifically indicated, use Type S.

E. GROUT FOR UNIT MASONRY: Comply with ASTM C 476, and provide material with 2,000 PSI compressive strength when tested at 28 days, unless noted otherwise. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 5 of ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.
F. EPOXY POINTING MORTAR: Mix epoxy pointing mortar to comply with mortar manufacturer's directions.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.

(1) Verify that foundations are within tolerances specified.
(2) Verify that reinforcing dowels are properly placed.
(3) Proceed with installation only after unsatisfactory conditions have been corrected.

B. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.

3.02 INSTALLATION, GENERAL

A. THICKNESS: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual widths of masonry units, using units of widths indicated.
B. BUILD CHASES AND RECESSES to accommodate items specified in this Section and in other Sections of the Specifications.
C. LEAVE OPENINGS FOR EQUIPMENT TO BE INSTALLED before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.
D. CUT MASONRY UNITS with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
E. SELECT AND ARRANGE UNITS for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
F. WETTING OF BRICK: Wet brick before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at the time of laying.

3.03 CONSTRUCTION TOLERANCES

A. COMPLY WITH ACI 530.1/ASCE 6/TMS 602 and the following:

(1) FOR CONSPICUOUS VERTICAL LINES, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.

(2) FOR VERTICAL ALIGNMENT OF EXPOSED HEAD JOINTS, do not vary from plumb by more than 1/4 inch in 10 feet, nor 1/2 inch maximum.
(3) FOR CONSPICUOUS HORIZONTAL LINES, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.
(4) FOR EXPOSED BED JOINTS, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
(5) FOR EXPOSED HEAD JOINTS, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

3.04 LAYING MASONRY WALLS

A. LAY OUT WALLS IN ADVANCE for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Lay exposed masonry in “running bond” or as otherwise indicated in the Drawings. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
B. STOPPING AND RESUMING WORK: In each course, rake back one-half-unit length for one-half running bond or one-third-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.
C. BUILT-IN WORK: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
D. FILL SPACE BETWEEN HOLLOW-METAL FRAMES and masonry solidly with grout, unless otherwise indicated.
E. WHERE BUILT-IN ITEMS ARE TO BE EMBEDDED in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
F. FILL CORES IN HOLLOW CMU’s with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
G. BUILD NON-LOAD-BEARING INTERIOR PARTITIONS full height of story to underside of solid floor or roof structure above, unless otherwise indicated. Install compressible filler in joint between top of partition and underside of structure above. At fire-rated partitions, install firestopping in joint between top of partition and underside of structure above to comply with Division 7 Section "Firestopping."

3.05 MORTAR BEDDING

A. LAY HOLLOW MASONRY UNITS with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.
B. LAY SOLID BRICK-SIZE MASONRY UNITS with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
C. SET CAST-STONE TRIM UNITS in full bed of mortar with full vertical joints (except as required for sealant joints noted below). Fill all dowel, anchor, and similar holes. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water. Wet joint surfaces thoroughly before applying mortar.

3.06 JOINTING

A. TOOL EXPOSED MORTAR JOINTS SLIGHTLY CONCAVE when thumbprint hard, using a jointer larger than the joint thickness, unless otherwise indicated.
B. CUT JOINTS FLUSH FOR MASONRY WALLS to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.
C. SEALANT JOINTS: Rake-back mortar 3/4 inch deep minimum, sponge clean, and provide sealant joints in accordance with Division-7 Section “Joint Sealers” at the following locations:
(1) Head joints of all horizontal surfaces on solid masonry copings
(2) Between all brick and CMU or cast-stone masonry units
(3) At horizontal surfaces of all projecting masonry units, including sills or running trims
(4) At all horizontal relieving angles
(5) At all masonry control-joints or building expansion joints

3.07 MASONRY JOINT REINFORCEMENT

A. PROVIDE CONTINUOUS MASONRY JOINT REINFORCEMENT by installing entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches. Space reinforcement not more than 16 inches o.c. typically, and at not more than 8 inches o.c. in foundation walls, free-standing enclosure walls, and parapet walls. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings, in addition to continuous reinforcement.
B. CUT OR INTERRUPT JOINT REINFORCEMENT at control and expansion joints, unless otherwise indicated. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.
C. ANCHOR MASONRY TO STRUCTURAL MEMBERS where masonry abuts or faces structural members by providing an open space not less than 1/2 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials. Install anchors embedded in masonry joints and attached to structure. Space anchors not more than 24 inches o.c. vertically and 36 inches o.c. horizontally or more as indicated on the Drawings.

D. ANCHOR MASONRY VENEERS to wall framing with masonry-veneer anchors by fastening screw-attached anchors through sheathing to wall framing with a minimum of two (2) metal fasteners unless anchor design only uses one fastener. Apply sealant at all penetrations of anchors through sheathing material – either before or after anchor installation to maintain the air-moisture barrier at the sheathing face. Embed tie sections in masonry joints. Locate anchor sections to allow maximum vertical differential movement of ties up and down. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches around perimeter.

3.08 CONTROL AND EXPANSION JOINTS

A. PROVIDE MASONRY CONTROL JOINTS where indicated on the Drawings, and as follows:

(1) Install control joints at spacing not to exceed 24 feet horizontally if not indicated on the drawings.
(2) Install control joints above both sides of lintels or shelf-angles when the open span exceeds six (6) feet in width.

B. EXPANSION JOINTS: Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

C. FORM CMU CONTROL JOINTS by (1) fitting bond-breaker strips into hollow contour at ends of units on one side of control joint, filling resultant core with grout, and raking joints in the exposed faces., or (2) by using control-joint gaskets designed to fit standard sash block, or (3) by installing special shaped interlocking units designed specifically for control joints. Install bond-breaker strips at all control joints. Keep head joints free and clear of mortar or rake out joint for application of sealant. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete.

D. FORM CONTROL JOINTS IN BRICK by forming open joint of not less than 3/8 inch for installation of sealant and backer rod specified in Division 7 Section "Joint Sealants." Keep joint free and clear of mortar.

E. CONSTRUCT HORIZONTAL, PRESSURE-RELIEVING JOINTS by inserting a compressible filler of 3/8-inch high minimum for installing sealant and backer rod specified in Division 7 Section "Joint Sealants." Locate horizontal, pressure-relieving joints beneath all shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.09 FLASHING, WEEPS AND CAVITY DRAINAGE

A. INSTALL EMBEDDED FLASHING AND WEEP HOLES in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. PREPARE MASONRY SURFACES so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

C. AT MASONRY-VENEER WALLS, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, or behind exterior sheathing board when building paper does not exist, lapping flashings at least 4 inches.

D. INSTALL SELF-ADHERING FLASHING SYSTEM in strict accordance with flashing system manufacturer's installation instructions and recommendations. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge. Install cavity-bridge units to span any openings that would not support the flashing material. Place metal drip-edge in a bead of urethane sealant, and apply flashing material to top of drip-edge starting 1 inch from outside edge of masonry. Apply flashing material to the face of glass-mat gypsum sheathing panels with the flashing manufacturer's primer, and extend up face of sheathing at least 8 inches. Seal top edge with manufacturer's flashing mastic per manufacturer's recommendations.

E. INSTALL WEEP UNITS in the head joints in exterior wythes of the first course of masonry immediately above embedded flashing, spaced at 24 inches o.c. Place cavity drainage material immediately above flashing in cavities at each weep.

F. INSTALL CAVITY VENTS in the highest available head joint (excluding rowlocks) at the top of ALL cavity spaces at same spacing as weep vents.This includes below all through wall flashing and/or lintels with brick below and above. *NOTICE: INTENT IS TO HAVE AIR FLOW BEHIND THE MASONRY*

G. INSTALL REGLETS AND NAILERS for flashing and other related construction where they are shown to be built into masonry.

3.10 REINFORCED UNIT MASONRY INSTALLATION

A. TEMPORARY FORMWORK AND SHORES: Construct formwork and shores to support reinforced masonry elements during construction. Construct formwork to conform to shape, line, and dimensions shown. Make it sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. PLACING REINFORCEMENT: Comply with requirements of ACI 530.1/ASCE 6/TMS 602.

C. GROUTING: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure. Comply with requirements of ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

3.11 FIELD QUALITY CONTROL

A. ENGAGE A TESTING AGENCY to perform field quality-control testing of installed Work.

B. FREQUENCY: Each 5000 SF of wall area or portion thereof maximum.

C. MORTAR PROPERTIES: ASTM C 780.

D. GROUT COMPRESSIVE STRENGTH: ASTM C 1019.

E. BRICK of each type and grade used: ASTM C 67.
F. CMU's of each type used: ASTM C 140.
G. MASONRY PRISMS: For each type of wall construction indicated to be "Prism-Tested", prepare prisms per ASTM C-1314 standards, 1 set for testing at 7 days, and a second set for testing at 28 days.

3.12 REPAIRING, POINTING, AND CLEANING

A. REMOVE AND REPLACE masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
B. POINTING: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application.
C. IN-PROGRESS CLEANING: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

3.13 FINAL CLEANING:

A. AFTER MORTAR IS THOROUGHLY SET AND CURED, clean all exposed masonry. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Protect adjacent surfaces from contact with cleaner by covering with liquid strippable masking agent, polyethylene film, or waterproof masking tape. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing the surfaces thoroughly with clear water.
B. CLEAN brick by the bucket-and-brush hand-cleaning method described in BIA Technical Notes No. 20, using job-mixed detergent solution. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions that is approved for use by the manufacturer of the masonry. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain on exposed surfaces.
C. REMOVE ALL EXCESS MASONRY from Project site.

END OF SECTION 04 20 00

SECTION 04 20 10 – REINFORCED UNIT MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

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

1.03 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).
B. Reinforced Unit Masonry: Masonry containing reinforcing steel in grouted cells.

1.04 PERFORMANCE REQUIREMENTS

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

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

1.05 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Contractor will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense. Materials tested shall be the same in every way to the materials used to construct this project and shall be from the same lots or batches used for constructing this project.

Material / Unit Type	Test	Property Tested	Standard
Clay Masonry Units	Clay Masonry Unit Test	Compressive strength	ASTM C 67
Concrete Masonry Units	Concrete Masonry Unit Test	Compressive strength	ASTM C 140
Mortar (Property Specification)	Mortar Test	Compressive strength	ASTM C 109/C 109M
Grout	Grout Test	Compressive strength	ASTM C 1019
Masonry Assembly (Prism)	Prism Test	Compressive strength	ASTM C 1314

1.06 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. LEED Submittals:

(1) Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

C. Shop Drawings: For the following:

(1) Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
(2) Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
(3) Reinforcing Steel: Detail bending and placement of reinforced unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls. Drawings shall include:

(a) 1/4” scale elevations of all beams, columns, and walls with all openings and reinforcing shown.
(b) Top and bottom elevations of walls and bearing elevations of all elements supported.
(c) Size and location of all openings, pockets, embedments, and anchor bolts.
(d) Bar sizes, location and quantities of reinforcing steel.
(e) Location and arrangement of supporting and spacing devices.
(f) Bending and cutting schedules.
(g) All control joints, expansion joints and horizontal relief joints.

(h) All other framing and/or special conditions affecting the work.
(i) Mechanical rebar splice locations.

1.07 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.
B. Material Certificates: For each type and size of the following:
   (1) Masonry units.
      (a) Include material test reports substantiating compliance with requirements.
      (b) Include data and calculations establishing average net-area compressive strength of units.
   (2) Cementitious materials. Include brand, type, and name of manufacturer.
   (3) Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   (1) Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   (2) Grout: Submit grout strength test data. Data shall be in conformance with the requirements for concrete mix designs per Division 3 section "Cast-in-Place Concrete."
      (a) Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
      (b) For self-consolidating grout, include test reports for slump flow and visual stability index (VSI) as determined by ASTM C 1611.
D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in TMS 602/ACI 530.1/ASCE 6.
E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.08 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
D. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 latest edition unless modified by requirements in the Contract Documents.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.
E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.10 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   (1) Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
   (2) Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   (1) Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   (2) Protect sills, ledges, and projections from mortar droppings.
   (3) Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   (4) Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace reinforced unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
   (1) Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. CMUs: ASTM C 90.
   (1) Unit Compressive Strength: Provide units with minimum average net-area compressive strength as required to meet the specified prism strength, but in no case shall units be less than 1900 psi.
   (2) Density Classification: Lightweight unless otherwise indicated.

2.02 MASONRY LINTELS

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

2.03 BRICK

A. Hollow Brick: ASTM C 652, Grade SW, Class H60V (void areas between 40 and 60 percent of gross cross-sectional area).
   (1) Unit Compressive Strength: Provide units with minimum average net-area compressive strength as required to meet the specified prism strength, but in no case shall units be less than 3500 psi.

2.04 MORTAR AND GROUT MATERIALS

A. Blended Hydraulic Cement: ASTM C 595 Type IL, Portland-limestone cement.
B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
C. Hydrated Lime: ASTM C 207, Type S.
D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
E. Aggregate for Mortar: ASTM C 144.
F. Aggregate for Grout: ASTM C 404.
G. Water: Potable.
H. Additives: None permitted, except as specified herein. Specifically do not lower freezing point of mortar or grout by use of calcium chloride or other antifreeze agents.

2.05 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
   (1) Interior Walls: Galvanized, carbon steel.
   (2) Exterior Walls: Hot-dip galvanized, carbon steel.
   (3) Wire Size for Side Rods: As indicated on drawings.
   (4) Wire Size for Cross Rods: 0.148-inch diameter.
   (5) Wire Size for Veneer Ties: 0.148-inch diameter.
   (6) Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   (7) Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
D. Masonry Joint Reinforcement for Multiwythe Masonry: Provide one of the following:
   (1) Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches wide, plus 1 side rod at each wythe of masonry 4 inches wide or less.
   (2) Tab type, ladder design, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.
   (3) Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

2.06 MISCELLANEOUS ANCHORS

A. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.
B. Anchor Bolts: Headed steel bolts complying with ASTM F1554 Grade 36, or ASTM A307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.07 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   (1) Do not use calcium chloride in mortar or grout.

(2) For reinforced masonry, use portland cement-lime mortar.

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

C. Mortar for Reinforced Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

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

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

(1) Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 7 in TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
(2) Grout shall attain a minimum compressive strength of 2000 psi at 28 days when tested in accordance with ASTM C 1019.
(3) Except for self-consolidating grout, mix and proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated.
(4) Provide grout with a slump of 8 to 11 inches for grout heights less than 5 feet 4 inches, or 10 to 11 inches for grout lift heights greater than 5 feet 4 inches as measured according to ASTM C 143/C 143M, unless self-consolidating grout is used.
(5) Self-consolidating grout, if used, shall comply with the material requirements of ASTM C 476; have a slump flow of 24 to 30 inches as determined by ASTM C 1611/C 1611M; and has a Visual Stability Index (VSI) less than or equal to 1 as determined in accordance with ASTM C 1611/C 1611M, Appendix X.1.
(6) Proportioning of self-consolidating grout at the project site is not permitted. Do not add water at the project site except in accordance with the self-consolidating grout manufacturer's recommendations.
(7) Do not use admixtures unless acceptable. Field addition of admixtures is not permitted in self-consolidating grout.

PART 3 - EXECUTION

3.01 LAYING MASONRY WALLS

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

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

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

3.02 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

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

3.03 COMPOSITE MASONRY

A. Bond wythes of composite masonry together using one of the following methods:

(1) Masonry Joint Reinforcement: Installed in horizontal mortar joints.

(a) Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
(b) Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.

(2) Header Bonding: Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not over 8 inches clear horizontally and 16 inches clear vertically.

B. Bond wythes of composite masonry together using bonding system indicated on Drawings.

C. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.

D. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.

(1) Provide continuity with masonry joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.

E. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:

(1) Provide individual metal ties not more than 8 inches o.c.
(2) Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.
(3) Provide rigid metal anchors not more than 24 inches o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.04 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   (1) Space reinforcement not more than 16 inches o.c.
   (2) Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   (3) Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
C. Provide continuity at wall intersections by using prefabricated T-shaped units.
D. Provide continuity at corners by using prefabricated L-shaped units.

3.05 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
   (1) Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   (2) Anchor masonry with anchors embedded in masonry joints and attached to structure.
   (3) Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.06 CONTROL AND EXPANSION JOINTS

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

3.07 LINTELS

A. Install steel lintels where indicated.
B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.08 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   (1) Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   (2) Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6, latest edition.
   (1) Support reinforcement to prevent displacement caused by construction loads or by placement of grout or mortar, beyond the allowable tolerances.
   (2) Completely embed reinforcing bars in grout.
   (3) Maintain clear distance between reinforcing bars and the interior of masonry unit or formed surface of at least 1/4 inch for fine grout and 1/2 inch for coarse grout, except where cross webs of hollow units are used as supports for horizontal reinforcement.
   (4) Place reinforcing bars maintaining the following minimum cover:
      (a) Masonry face exposed to earth or weather: 2 inches for bars larger than No. 5; 1-1/2 inches for No. 5 bars or smaller.
      (b) Masonry not exposed to earth or weather: 1-1/2 inches.
   (5) Maintain minimum clear distance between parallel bars of the nominal bar size or 1 inch, whichever is greater.
   (6) In columns and pilasters, maintain minimum clear distance between vertical bars of one and one-half times the nominal bar size or 1-1/2 inches, whichever is greater.
   (7) Splice only where indicated on the Project Drawings, unless otherwise acceptable. When splicing by welding, provide welds in conformance with the provisions of AWS D1.4.
   (8) Unless accepted by the Architect/Engineer, do not bend reinforcement after it is embedded in grout or mortar.
   (9) Noncontact Lap Splices: Position bars spliced by noncontact lap splice no farther apart transversely than one-fifth the specified length of lap nor more than 8 inches.
   (10) Joint Reinforcement:
      (a) Place joint reinforcement so that longitudinal wires are embedded in mortar with a minimum cover of 1/2 inch when not exposed to weather or earth; or 5/8 inch when exposed to weather or earth.
      (b) Provide minimum 6-inch lap splices for joint reinforcement.
      (c) Ensure that all ends of longitudinal wires of joint reinforcement at laps are embedded in mortar or grout.
   (11) Placement Tolerances:
      (a) Place reinforcing bars in walls and flexural elements within a tolerance of 1/2 inch.
      (b) Place vertical bars within:
         (i) 2 inches of the required location along the length of the wall when the wall segment length exceeds 24 inches.
         (ii) 1 inch of the required location along the length of the wall when the wall segment length does not exceed 24 inches.

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

C. Cleanouts: Provide cleanouts in the bottom course of masonry for each grout pour when the grout pour height exceeds 5 feet 4 inches.
(1) Construct cleanouts so that the space to be grouted can be cleaned and inspected. In solid grouted masonry, space cleanouts horizontally a maximum of 32 inches on center.
(2) Construct cleanouts with an opening of sufficient size to permit removal of debris. The minimum opening dimension shall be 3 inches.
(3) After cleaning, close cleanouts with closures braced to resist grout pressure.

D. Grout Placement:
(1) Placing Time: Place grout within 1-1/2 hours from introducing water in the mixture and prior to initial set.
(a) Discard site-mixed grout that does not meet the specified slump without adding water after initial mixing.
(b) For ready-mixed grout:
(i) Addition of water is permitted at the time of discharge to adjust slump.
(ii) Discard ready-mixed grout that does not meet the specified slump without adding water, other than the water that was added at the time of discharge. The time limitation is waived as long as the ready-mixed grout meets the specified slump.
(2) Confinement: Confine grout to the areas indicated on the Project Drawings. Use material to confine grout that permits bond between masonry units and mortar.
(3) Grout Pour Height:
(a) Definition: The total height of masonry to be grouted prior to erection of additional masonry. A grout pour consists of one or more grout lifts.
(b) Do not exceed the maximum grout pour height given in TMS 602/ACI 530.1/ASCE 6, Table 7.
(4) Grout Lift Height:
(a) Definition: An increment of grout height within a total grout pour. A grout pour consists of one or more grout lifts.
(b) For grout except self-consolidating grout:
(i) Where the following conditions are met, place grout in lifts not exceeding 12 feet 8 inches.
1. The masonry has cured for at least 4 hours.
2. The grout slump is maintained between 10 and 11 inches.
3. No intermediate reinforced bond beams are placed between the top and the bottom of the pour height.
(ii) When there are intermediate bond beams within the grout pour, limit the grout lift height to the bottom of the lowest bond beam that is more than 5 feet 4 inches above the bottom of the lift, but do not exceed a grout lift height of 12 feet 8 inches.
(iii) When the conditions above are not met, place grout in lifts not exceeding 5 feet 4 inches.
(5) For self-consolidating grout:
(a) When placed in masonry that has cured for at least 4 hours, place in lifts not exceeding the grout pour height.
(b) When placed in masonry that has not cured for at least 4 hours, place in lifts not exceeding 5 feet 4 inches.

E. Consolidation:
(1) Consolidate grout at the time of placement.
(a) Consolidate grout pours 12 inches or less in height by mechanical vibration or by puddling.
(b) Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.
(c) Consolidation or reconsolidation is not required for self-consolidating grout.

F. Grout Key: When grouting, form grout keys between grout pours. Form grout keys between grout lifts when the first lift is permitted to set prior to placement of the subsequent lift.
(1) Form a grout key by terminating the grout a minimum of 1-1/2 inches below a mortar joint.
(2) Do not form grout keys within beams.
(3) At beams or lintels laid with closed bottom units, terminate the grout pour at the bottom of the beam or lintel without forming a grout key.

G. At the top of wall, grout shall be flush with the top of the masonry units.

3.09 FIELD QUALITY CONTROL

A. Testing and inspection requirements: [As indicated on Drawings and Division 01 quality requirements — coordinate special inspection scope with structural engineer of record].

END OF SECTION 04 20 10

SECTION 04 40 00 - SITE STONE ASSEMBLIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.02 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the site stone assemblies as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

(1) Granite steps.
(2) Native sandstone steps.
(3) Monolithic native sandstone seatwall.
(4) Stacked native sandstone ledge retaining wall.
(5) Monolithic granite retaining wall.
(6) Monolithic granite seatwall.
(7) Granite stone flush curb

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed stone masonry similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance. General contractor to receive bids from subcontractor for both the fabrication of the stone and for the masonry.
B. Standard Practice: The Landscape Architect reserves the right to approve the material supplier for cut stone before this portion of the work is awarded.
C. Stone and workmanship quality for stone shall be in accordance with Industry Standards and Practices
D. Source Limitations for Stone: Obtain each variety of stone from a single quarry with resources to provide materials of consistent quality in appearance and physical properties without delaying the work.
E. Source Limitations for Mortar Grout Materials: Obtain mortar ingredients of uniform quality for each cementitious component from a single manufacturer and aggregate from one source or producer.
F. Cutting and Setting Drawings: The cut stone supplier shall prepare and submit to the Landscape Architect for approval, complete cutting and setting drawings for all of the cut stone work. Such drawings shall show in detail the sizes, sections, and dimensions of stone, the arrangement of joints and bonding, anchoring and other necessary details. All jointing as shown by the Landscape Architect on the contract drawings shall be followed, unless modifications are agreed upon in writing, or indicated upon the approved shop drawings. If the contract drawings do not show the intent of the jointing, it will be the fabricator's responsibility to establish the jointing in accordance with industry standards and practices. The general contractor shall furnish all field dimensions necessary for fabrication.
G. The cutting and setting drawings shall be based upon and follow the drawings and details prepared by the Landscape Architect except where it is agreed in writing or shown on the approved shop drawings that changes be made. Each stone indicated on the setting drawings shall bear the corresponding number marked on an unexposed surface. Provision for the anchoring, dowelling, and cramping of work, in keeping with standard practices, and for the support of stone by shelf angles and loose steel, etc., when required, shall be clearly indicated on the cutting, and setting drawings.
H. Cutting and Drilling for Other Trades: Any miscellaneous cutting and drilling of stone necessary to accommodate other trades will be done by the cut stone fabricator only when necessary information is furnished in time to be shown on their shop drawings and details, and when work can be executed before fabrication. Cutting and fitting, due to jobsite conditions, will be the responsibility of the general contractor.
I. Incidental cutting such as for gate frame clips, etc., which is normally not considered to be the responsibility of the stone supplier, will be provided only by arrangement by the contractor with the stone supplier.
J. Loading and Shipment: The cut stone shall be carefully packed for transportation with exercise of all customary and reasonable precautions against damage in transit. All cut stone under this contract shall be loaded and shipped in the sequence and quantities mutually agreed upon by the general contractor or erector and the material supplier.
K. Mockups: Before installing stone masonry, construct sample units of work to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of stone materials indicated for completed work.

(1) Locate mockups in the locations indicated or, if not indicated as directed by the Landscape Architect.
(2) Build mockups for each type of stone masonry:

(a) One (1) section of at least three (3) granite steps.
(b) One (1) section of at least three (3) native sandstone steps.
(c) One (1) 6-foot-long min. section of monolithic native sandstone seatwall.
(d) One (1) 6-foot-long min. section of stacked native sandstone ledge retaining wall.
(e) One (1) 6-foot-long min. section of monolithic granite retaining wall.
(f) One (1) 6-foot-long min. section of monolithic granite seatwall.

(g) One (1) 6-foot-long min. section of granite stone flush curb.

(3) Notify Landscape Architect 10 days in advance of the dates and times when mockups will be constructed.

(4) Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.

(5) Approval of mockups does not constitute approval of deviations from Contract Documents contained in mockups, unless such deviations are specifically approved by Landscape Architect in writing.

(6) Approved mockups may become part of the completed work if undisturbed at time of substantial completion.

1.04 SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and other manufactured product specified.

B. Stone Samples for Verification: Sets for each color, grade, finish, and variety of stone required. Include 2 or more Samples in each set showing the full range of variations expected in these characteristics.

C. Colored Pointing Mortar Samples for Verification: For each color required.

D. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names, and addresses of architects and owners, and other information specified.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to Project site in undamaged condition.

B. Store and Handle stone and related materials to prevent deterioration or damage due moisture, temperature changes, contaminants, corrosion, breaking, chipping, or other causes.

C. Store cementitious materials off the ground, under cover, and in a dry location.

D. Store aggregates, covered and in a dry location, where grading and other required characteristics can be maintained and contamination avoided.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.06 PROJECT CONDITIONS

A. Protection of Stone Masonry. During erection, cover tops of walls, projections, and sills with waterproof sheeting at the end of each day's work. Extend cover a minimum of 48 inches down both sides of wall and hold securely in place. Cover partially completed stone masonry when construction is not in progress.

B. Stain Prevention: Immediately remove grout, mortar, and soil to prevent them from staining the face of stone masonry.

(1) Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on the ground and over the wall surface.

(2) Protect sills, ledges, and projections from mortar droppings.

(3) Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

(4) Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace stone masonry damaged by frost or freezing conditions. Lime mortar to be protected from freezing for at least 28 days.

(1) Cold-Weather Construction: When ambient temperature is within limits indicated, use the following procedures:

(a) 40-32 deg. F and below: Heat mixing water and sand to produce mortar temperatures between 40 and 80 deg. F. Maintain mortar above freezing until used in masonry. Heat stone to 40 deg F. Provide enclosures and use heat on both sides of walls under construction to maintain temperatures above 40 deg F within enclosures.

(2) Cold-Weather Protection: When mean daily temperature is within limits indicated, provide the following protection:

(a) 40 deg F and below: Provide enclosure and heat to maintain temperatures above 40 deg F within enclosure for 48 hours after construction.

(3) Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg and above and will remain so until stone masonry has dried out, but not less than 7 days after completing cleaning.

D. Hot-Weather Requirements: Protect stone masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar. Provide artificial shade and wind breaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F. and above.

E. Other Weather Requirements: Protect lime mortar from sun, wind, and rain for at least 14 days after setting stone.

PART 2 - PRODUCTS

2.01 STONE SOURCES

A. Varieties and Sources: Subject to compliance with requirements, provide stone varieties as approved through the job-site mock-up and as specified in the finished schedule on the drawings.

2.02 STONE

A. Match Landscape Architect's samples for variety, color, finish, and other stone characteristics relating to aesthetic effects. Minimum 4'-0" to 6'-0" sections for granite and native sandstone steps; minimum 6'-0" to 8'-0" sections for monolithic native sandstone seatwall, stacked native sandstone ledge retaining wall, monolithic granite retaining wall, and monolithic granite seatwall, and 4-0" to 8'-0" sections of granite stone flush curb unless otherwise noted or approved by Landscape Architect.
   (1) Arkansas sandstone, finish per drawings, from Ibison Stone Supply in Hackett, AR.
   (2) Washburn Granite, thermal finish all exposed faces, from Quarra Stone in Madison, WI.

2.03 LIME MORTAR

A. General: Mortar mix shall be 1 part lime putty to 2 parts sand. (Other mix may be used in mock-up and approved for use by Owner or Landscape Architect.)
B. Lime Putty: ASTM C 1489.
C. Aggregate: ASTM C 144 and as indicated below:
   (1) For joints narrower than 1/4 inch use aggregate graded with 100 percent passing No. 16 sieve.
   (2) For pointing mortar, use aggregate graded with 100 percent passing No. 16 sieve.
   (3) Colored-Mortar Aggregates: Natural, colored sand or ground marble, granite, or other sound stone as approved.
D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in stone masonry mortars.
E. Sealer: Prosoco Block Guard and Graffiti Control or equivalent as approved, if needed.
F. Water: Potable.

2.04 MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Type 2, Class A, Grade 1; compressible up to 35 percent; of width and thickness indicated; formulated from the following material:
   (1) Urethane.

2.05 MASONRY CLEANERS

A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry-measure tetrasodium polyphosphate and 1/2-cup dry-measure laundry detergent dissolved in 1 gal. of water.

2.06 STONE FABRICATION

A. General: All stone shall be cut accurately to shape and dimensions and full to the square with jointing as shown on approved shop drawings.
B. Dress joints (bed and vertical) straight and at right angle to face, unless otherwise indicated.
C. Shape stone for type of masonry (pattern) indicated: Reference drawings for patterns.
D. Finish exposed faces and edges of stone to comply with requirements indicated for finish and to match approved samples and mockups. Reference requirements above and drawings for finishes.
E. Carefully inspect stone units at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
F. Cutting for Anchoring, Supporting, and Lifting Devices: Holes and sinkages shall be cut in stones for all anchors, cramps, dowels, and other support devices per industry standard practice and/or approved shop drawings. However, expansion anchor holes shall be drilled at jobsite by mason or erector to facilitate alignment.
G. No holes or sinkages will be provided for contractor's handling devices unless arrangement for this service is made by the contractor with the stone supplier.
H. NOTE: It is not recommended that Lewis pins be used for stones less than 3 ½" thickness.

PART 3 - EXECUTION

3.01 EXAMINATION

A. All stone shall be received and unloaded at the site with necessary care in handling to avoid damaging or soiling.
B. Stone to be examined by mason and Landscape Architect to verify compliance with specifications and submittals.
C. Stone shall be stored clear of the ground on non-staining skids (cypress, white pine, poplar, or yellow pine without an excessive amount of resin). Chemically treated wood should not be used. DO NOT use chestnut, walnut, oak, fir, and other woods containing tannin.
D. Stone shall be covered with waterproof paper, clean canvas, or polyethylene.

3.02 PREPARATION

A. Advise installers of other work about specific requirements for placement of reinforcement, anchors, ties, flashing, and similar items to be built into stone masonry.
B. Protect stone masonry during erection as directed in 1.06 "Project Conditions."
C. Protect adjacent surfaces from mortar droppings.
D. Clean stone surfaces that have become dirty or stained by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.03 SETTING STONE MASONRY, GENERAL

A. Execute stone masonry by skilled masons experienced with the kind and form of stone and installation method indicated.
   (1) Employ skilled stone fitters at the Project site to do necessary field cutting as stone is set. Use power saws to cut stone. Produce lines cut straight and true, with edges eased slightly to prevent snipping.
   (2) Arrange stones for good fit with joint widths within tolerances indicated, and to provide offset between vertical joints as indicated.
B. Set stone to comply with requirements indicated on Drawings. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
C. Maintain uniform joint widths, except for variations due to stone size variations and minor variations required to maintain bond alignment, if any. Lay walls with joints as indicated on Drawings.
D. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.
   (1) Sealing expansion and other joints with sealant approved during submittal process.
   (2) Keep expansion joints free of mortar and other rigid materials.
E. All stone shall be set accurately in strict accordance with the contract and shop drawings.
F. When necessary, before setting in the wall, all stones shall be thoroughly cleaned on all exposed surfaces by washing with fiber brush and soap powder, followed by a thorough drenching with clear water.
G. All stone joint surfaces not thoroughly wet shall be drenched with clear water just prior to setting.
H. Joints, if mortared, can be tooled when initial set has occurred, or raked out 1" and pointed later.
I. All stone areas either partially or totally horizontal should be set with unfilled vertical joints.
J. In cold weather, International Masonry Industry All Weather Council recommendations for setting from 40 degrees to 20 degrees F shall be followed, except that no additives shall be used in the setting mortar, and below 40 degrees F all work shall be done in heated enclosures.

3.04 CONSTRUCTION TOLERANCES

A. Measure variation from plumb, level, and position shown in plan as the variation of the average plane of the face of each stone from a plumb, level, or dimensioned plane.
B. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
C. Variation in Plane between Adjacent Stones and on the Face of Individual Stone: Do not exceed tolerances as approved in the mock-up.

3.05 INSTALLING STONE MASONRY

A. Fill collar joint solid as stone is set.

3.06 STONE ANCHORS AND ATTACHMENTS

A. Provide anchors and attachments of type and size required to support the stone work fabricated from the following metals for conditions indicated below:
   (1) Stainless Steel, AISI Type 304 or 316, for anchors and expansion bolts embedded within the stone.

3.07 POINTING

A. Prepare stone joint surfaces for pointing with mortar (if called out to be mortared on the plans) by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar first in layers not greater than 3/8 inch until a uniform depth is formed.
B. Point stone joints by placing and compacting pointing mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.
C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the approved joint profile from the mock-up:
   (1) Joint Profile: Raked 3/4" minimum below surface, refer to drawings and to mock-up.

3.08 PROTECTION OF FINISHED WORK

A. Receipt, storage, and protection of cut stonework prior to, during and subsequent to installation shall be the responsibility of the mason contractor.

B. During construction, tops of walls shall be carefully covered at night, and especially during any precipitation or other inclement weather.
C. At all times, walls shall be adequately protected from droppings.
D. Whenever necessary, substantial wooden covering shall be placed to protect the stonework. Non-staining building paper or membrane shall be used under the wood. Maintain all covering until removed to permit final clearing of the stonework.

3.09 ADJUSTING AND CLEANING

A. Remove and replace stone masonry of the following description:
   (1) Broken, chipped, stained, or otherwise damaged stone.
   (2) Defective joints.
   (3) Stone masonry and joints not matching approved samples and mockups.
   (4) Stone masonry not complying with other requirements indicated.
B. Replace in a manner that results in stone masonry units matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
   (1) Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   (2) Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Landscape Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   (3) Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
   (4) Wet stone surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
   (5) Wash stone with fiber brushes, mild soap powder or detergent and clean water or approved mechanical cleaning process.
E. Protection: Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure stone masonry is without damage and deterioration at the time of Substantial Completion.

3.10 EXCESS MATERIALS AND WASTE

A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.
B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including unusable stone, waste mortar, and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
C. Masonry Waste: Remove clean masonry waste that cannot be used as fill, as described above, and other masonry waste and legally dispose of off Owner's property.

END OF SECTION 04 40 00

END OF DIVISION 4

DIVISION 05 – METALS

SECTION 05 12 00 – STRUCTURAL STEEL FRAMING

SECTION 05 31 00 – STEEL DECKING

SECTION 05 12 00 – STRUCTURAL STEEL FRAMING

SECTION 05 40 00 – COLD-FORMED METAL FRAMING

SECTION 05 50 00 – METAL FABRICATIONS

SECTION 05 70 00 – DECORATIVE METAL

SECTION 05 73 00 – DECORATIVE METAL RAILINGS

SECTION 05 12 00 – STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

(1) Structural steel.
(2) Prefabricated building columns.
(3) Grout.

B. Related Sections:

(1) Section 01 40 00 "Quality Requirements" for independent testing agency procedures and administrative requirements.
(2) Section 05 12 13 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
(3) Section 05 31 00 "Steel Decking" for field installation of shear connectors through deck.
(4) Section 05 50 00 "Metal Fabrications" for miscellaneous steel fabrications including steel lintels and shelf angles not attached to structural-steel frame and other metal items not defined as structural steel.
(5) Section 05 51 00 "Metal Stairs."
(6) Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting" and Section 09 96 00 "High-Performance Coatings" for surface-preparation and priming requirements.
(7) Section 13 34 19 "Metal Building Systems" for structural steel.

1.03 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
C. Heavy Sections: Rolled and built-up sections as follows:

(1) Shapes included in ASTM A 6/A 6M with flanges thicker than 2 inches.
(2) Welded built-up members with plates thicker than 2 inches.
(3) Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches included in the Seismic-Load-Resisting System.
(4) Connection plates and column base plates thicker than 2 inches included in the Seismic-Load-Resisting System.

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.04 PERFORMANCE REQUIREMENTS

A. Connections:

(1) Provide connections as shown or noted on Drawings. Design of connections not shown or noted shall be provided by Structural Engineer-of-Record upon request.
(2) Alternate connections designed by the Contractor's registered design professional may be substituted by the Contractor, subject to Structural Engineer-of-Record approval. Proposed changes to connections shall be submitted as a substitution request in advance of the submittal of shop drawings for conceptual approval of Structural Engineer-of-Record. Connections shall be designed for loads indicated on Drawings or provided by Structural Engineer-of-Record. Loads indicated are developed using Load and Resistance Factor Design (LRFD) load combinations unless noted otherwise. One set of calculations for all alternate connections signed and sealed by a qualified engineer shall be submitted with or in advance of applicable shop drawings. Contractor shall submit alternate connections to the AHJ in accordance with IBC section [A]107.3.4.1 Deferred Submittal and [A]107.4 Amended Construction Documents.

B. Moment Connections: Type PR (partially), and FR (fully) restrained.
C. Construction: Refer to the Drawings for description of lateral load resisting system.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop and Erection Drawings: Show location, fabrication, and assembly of structural-steel components.

(1) Location of each piece or detail within the structure.
(2) Include details of cuts, connections, splices, camber, holes, and other pertinent data.
(3) Include embedment piece and setting drawings.

(4) Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
(5) Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
(6) Identify members and connections of the seismic-load-resisting system.
(7) Indicate locations and dimensions of protected zones.
(8) Identify demand critical welds.
(9) Provide material quantity summary (Bill of Materials) for each erection sheet including the total weight of material of all pieces documented on the page being considered.
    (a) Material quantity summary to include breakdown of total weight by steel material types shown in the construction documents.
(10) For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
(11) Drawings submitted in multiple packages shall contain individual submittals complete with all applicable erection drawings, details, and piece drawings.
(12) Reproduction of Contract Documents is not permitted.
(13) Provide schedule for submittal of shop and erection drawings.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
    (1) Power source (constant current or constant voltage).
    (2) Electrode manufacturer and trade name, for demand critical welds.
D. Charpy V-Notch testing results for heavy sections and weld metal when required.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and fabricator.
B. Welding certificates.
C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
D. Mill test reports for structural steel, including chemical and physical properties and steel mill of origin.
    (1) For structural steel products that are manufactured in a different facility than where the raw material is produced, the mill test report or separate letter included with the report shall clearly indicate the location of both facilities.
    (2) If structural steel elements are sourced from multiple facilities, mill test reports shall be provided for each facility with a statement outlining the applicability of each report submitted.
E. Product Test Reports: For the following if present on project:
    (1) Bolts, nuts, and washers including mechanical properties and chemical analysis.
    (2) Direct-tension indicators.
    (3) Tension-control, high-strength bolt-nut-washer assemblies.
    (4) Shear stud connectors.
    (5) Shop primers.
    (6) Nonshrink grout.
F. Source quality-control reports.
G. Fabricator qualifications: Provide written documentation from the fabricator summarizing their commitment to sustainable practices as outlined in Part 2 - Products.
H. Environmental Product Declaration (EPD) Disclosure: For each type of structural steel element used on the project provide a current, product specific, third party verified, type III EPD conforming to ISO 14025 and the North American product category rule (PCR) for Steel Construction Products.
    (1) If structural steel elements are sourced from multiple facilities, EPD data shall be provided for each facility with a statement outlining the applicability of each EPD submitted.
    (2) Submitted EPDs shall demonstrate conformance to the global warming potential limits indicated in the construction documents.

1.07 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
C. Shop-Painting Applicators: Qualified according to AISC 420 "Certification Standard for Shop Application of Complex Protective Systems" Paint Endorsement Enclosed (CCE-1), Covered (CCE-2) or Exposed (CCE-3).
D. Field Painting Applicators: Qualified according to SSPC-QP1, "Standard Procedure for Evaluating Qualifications of Painting Contractors 'Field Application to Complex Structures'."
E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

(1) Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

F. Comply with applicable provisions of the following specifications and documents:

(1) AISC 303-2022 as amended below:

(a) Section 3.3: Replace entire section with the following: "Requirements for structural steel including quantities, sizes, locations, arrangement, and details shall be shown or noted in the overall Contract Drawing package. Fabricator is responsible for incorporating all such information from structural, architectural, mechanical, and electrical drawings, as well as those of other disciplines."

(b) Section 3.6: Remove all text after first sentence.

(c) Section 3.2.2: Replace entire section with the following: "When alternative delivery methods are implemented, release of structural drawings shall constitute release for construction only if specifically noted as such on the drawing. Drawings indicated 'preliminary' or 'not for construction' shall not be used for detailing or construction except where the risk of any cost or delay associated with subsequent revisions to Contract Documents is accepted by the Owner, Contractor or Fabricator."

(d) Section 4.4: Revise second sentence to read the following: "The shop and erection drawings shall be returned in accordance with the schedule defined in Division 1 of the project Specification. In the absence of such schedule, the Owner's Designated Representative for Design shall return submittals within 14 calendar days of receipt from the Owner's Designated Representative for Construction."

(2) AISC 341 and AISC 341s1.

(3) AISC 360.

(4) RCSC's "Specification for Structural Joints Using High-Strength Bolts."

G. Preinstallation Conference: Conduct conference at Project site.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

(1) Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

(1) Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.

(2) Clean and relubricate bolts and nuts that become dry or rusty before use.

(3) Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.09 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

A. Supply structural steel materials produced and manufactured in the United States of America or Canada for all elements.

B. Shapes: As indicated on Drawings.

C. Welding Electrodes: Comply with AWS requirements, 70 Series.

(1) Conform to Charpy V-Notch test requirements of AISC 360.

(2) Conform to Charpy V-Notch test requirements of AISC 341 for components included in the Seismic-Load-Resisting System.

D. Heavy Sections:

(1) Conform to Charpy V-Notch test requirements of AISC 360.

(2) Conform to Charpy V-Notch test requirements of AISC 341 for components included in the Seismic-Load-Resisting System.

2.02 BOLTS, CONNECTORS, AND ANCHORS

A. Use Tension-Control, High-Strength Bolt-Nut-Washer Assemblies whenever possible unless indicated otherwise.

B. High-Strength Bolts, Nuts, and Washers: ASTM F 3125, Group 120, Type 1 A325 or F1852. Heavy-hex steel structural bolts; ASTM A 563, Type 1 Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; or Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers all with plain finish.

(1) Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   (1) Finish: Plain.
D. Steel Headed Stud Anchors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
E. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable.
   (1) Configuration: Straight.
   (2) Nuts: ASTM A 563 heavy-hex carbon steel.
   (3) Plate Washers: ASTM A 36/A 36M carbon steel.
   (4) Washers: ASTM F 436, Type 1, hardened carbon steel.
   (5) Finish: Plain.
F. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.
   (1) Nuts: ASTM A 563 heavy-hex carbon steel.
   (2) Plate Washers: ASTM A 36/A 36M carbon steel.
   (3) Washers: ASTM F 436, Type 1, hardened carbon steel.
   (4) Finish: Plain.
G. Threaded Rods: ASTM A 36/A 36M.
   (1) Nuts: ASTM A 563 heavy-hex carbon steel.
   (2) Washers: ASTM A 36/A 36M carbon steel.
   (3) Finish: Plain.
H. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.
J. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.
K. Deformed Anchor Studs (DAS) / Deformed Bar Anchors (DBA): Made from ASTM A 108 low carbon steel, cold worked and deformed per ASTM A 1064. Minimum yield stress = 60 ksi (415 MPa); minimum tensile strength = 80 ksi (550 MPa).
L. Rebar: Rebar used for welding shall meet the requirements of ASTM A-706. Minimum bend diameters per ACI 318.
M. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.
   (1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      (a) Amscot Structural Products Corp.
      (b) Fluorocarbon Company Limited.
      (c) R.J. Watson Bridge & Structural Engineered Systems.
      (d) Seismic Energy Products, L.P.
      (e) Con-Serv, Inc.
      (f) Fluorocarbon Company.
      (g) COSMEC, Inc.
      (h) Tobi Engineering.
   (2) Mating Surfaces: PTFE and mirror-finished stainless steel.
   (3) Coefficient of Friction: Not more than 0.06.
   (4) Design Load: Not less than 2,000 psi.
   (5) Total Movement Capability: 2 inches.
   (6) Applicable Temperature Range: 0 deg F to 100 deg F.
N. Expansion Anchors, Screw Anchors, and Adhesive Anchors: Size and Manufacturer as indicated on Drawings. Complete assemblies with required rods, nuts, washers, and adhesive system as applicable. Installed in accordance with Manufacturer's installation instructions. Current ICC approval and published ICC Research Report required.
   (1) Finish for use in conditioned environments free from potential moisture (interior): Plain or in accordance with Manufacturer's standard.
   (2) Finish for use in exposed or potentially wet environments and for attachment of exterior cladding materials: Galvanized in conformance with ASTM A 153 or stainless steel, Series 316.
   (3) Finish for use exposed to ocean or waterfront environments: Type 316 stainless steel.

2.03 PRIMER

A. Primer: Where steel is to be field painted, provide fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
B. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.04 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time. Minimum compressive strength = 6000 psi.
B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. Minimum compressive strength = 6000 psi. Required where grout is exposed to view or weathering.

2.05 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
   (1) Camber structural-steel members where indicated.
   (2) Fabricate beams with rolling camber up.
   (3) Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
   (4) Mark and match-mark materials for field assembly.
   (5) Complete structural-steel assemblies, including welding of units, before starting shop-priming operations, if applicable.

B. Sustainable Fabrication: Fabricate structural steel products in a facility that has demonstrated a commitment to sustainable practices in accordance with one of the following:
   (1) An internal sustainability plan or policy with consideration of energy consumption, waste output, and education of employees on sustainability of steel.
   (2) Commitment to the American Institute of Steel Construction (AISC) sustainability partner program.

C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   (1) Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

D. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces. Do not enlarge bolt holes by burning.

E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning" or SSPC-SP 3, "Power Tool Cleaning."

G. Steel Headed Stud Anchors and Deformed Anchor Studs / Deformed Bar Anchors: Prepare steel surfaces as recommended by manufacturer of anchors. Use automatic end welding of anchors according to AWS D1.1/D1.1M and manufacturer's written instructions.

H. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.

I. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated.

J. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   (1) Cut, drill, thermal cut, or punch holes perpendicular to steel surfaces.
   (2) Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   (3) Weld threaded nuts to framing and other specialty items indicated to receive other work.

K. Splices: Splicing of members to obtain required lengths is not permitted without prior approval of Structural Engineer-of-Record unless indicated on the Drawings.

L. Substitutions: Where exact sizes and weights indicated on Drawings are not readily available, secure approval of alternate sizes from Structural Engineer-of-Record in time to prevent project delay.

2.06 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
   (1) Joint Type: As indicated on Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   (1) Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.07 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   (1) Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   (2) Surfaces to be field welded, including top flange of beams to receive steel headed stud anchors.
   (3) Surfaces to be high-strength bolted with slip-critical connections.
   (4) Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
   (5) Galvanized surfaces.
   (6) Surfaces not otherwise indicated to be painted that are not exposed to view or weather in the final condition.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to either of the following specifications and standards:
   (1) SSPC-SP 2, "Hand Tool Cleaning."
   (2) SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   (1) Stripe paint corners, crevices, bolts, welds, and sharp edges.
   (2) Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection.

D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.08 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
   (1) Fill vent and drain holes in closed sections (HSS or Pipe) that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
   (2) Galvanize lintels and shelf angles located in exterior walls.

2.09 SOURCE QUALITY CONTROL

A. Testing and Inspection: As indicated on Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
   (1) Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

3.02 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
   (1) Coordinate installation of non-structural steel items that load the temporarily supported steel frame such that temporary supports are adequate to resist all imposed loads.
   (2) Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.
   (3) Do not apply permanent loading other than the weight of supported concrete slab-on-deck assemblies to composite beams and girders until concrete has achieved 75 percent of its design strength without prior approval of Structural Engineer-of-Record.

3.03 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
   (1) Set plates for structural members on wedges, shims, or setting nuts as required.
   (2) Weld plate washers to top of baseplate where indicated on Drawings.
   (3) Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
   (4) Clean and moisten surfaces to receive grout. Immediately remove any remaining free water. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   (1) Level and plumb individual members of structure.
   (2) Make allowances for difference between temperature at time of erection and mean temperature of 70 deg F when structure is completed and in service.
E. Splice members only where indicated.
   (1) Fasten splices in compression after bearing surfaces have been brought into contact. Close all gaps greater than 1/16 inch by driving non-tapered mild steel shims full depth of bearing surface along full length of gap.
F. Do not use thermal cutting during erection unless approved by Structural Engineer-of-Record. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Steel Headed Stud Anchors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.04 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
   (1) Joint Type: As indicated on Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   (1) Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   (2) Remove backing bars or runoff tabs where indicated on Drawings, back gouge, and grind steel smooth.
   (3) Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.05 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on Drawings.

3.06 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   (1) Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION 05 12 00

SECTION 05 31 00 – STEEL DECKING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

(1) Roof deck.
(2) Composite floor deck.
(3) Noncomposite form deck.

B. Related Requirements:

(1) Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
(2) Section 035216 "Lightweight Insulating Concrete" for lightweight insulating concrete fill over steel deck.
(3) Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
(4) Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
(5) Section 099113 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
(6) Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.
B. LEED Submittals:

(1) Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
(2) Laboratory Test Reports for Credit EQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:

(1) Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.
B. Product Certificates: For each type of steel deck.
C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

(1) Power-actuated mechanical fasteners.
(2) Acoustical roof deck.

D. Evaluation Reports: For steel deck.
E. Field quality-control reports.
F. Sustainability Submittals:

(1) Submit product data or other published information verifying that this product has a Type III environmental product declaration. Submit in accordance with Section 018113 ARCH
(2) Product Sourcing:

(a) Submit product data or other published information indicating total weight of product to be provided for the Project, percent of post-consumer recycled material by weight and percent post-industrial recycled material by weight.

(3) Maximum embodied carbon and recycled content of steel products. Reference drawings for embodied carbon and recycled content goals.
(4) General Contractor's Sustainability Statement Letter: In the event that a sustainability goal or submittal requirement will not be met, contractor shall state in a letter the reasons why the goal or submittal requirement is not being met. Letter shall state whether alternative sustainability measures are viable for the project. If there are viable alternates, letter shall include details of proposed alternatives and associated project costs and schedule impacts (if any) for the Owner's consideration.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
C. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.

D. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
   (1) Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   (1) Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
C. Recycled Content of Steel Products: Provide products with an average recycled content of steel products not less than as indicated on the structural drawings.
D. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.02 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   (1) ASC Profiles, Inc.; a Blue Scope Steel company.
   (2) Canam United States; Canam Group Inc.
   (3) CMC Joist & Deck.
   (4) Consolidated Systems, Inc.; Metal Dek Group.
   (5) Cordeck.
   (6) DACS, Inc.
   (7) Epic Metals Corporation.
   (8) Marlyn Steel Decks, Inc.
   (9) New Millennium Building Systems, LLC.
   (10) Nucor Corp.; Vulcraft Group.
   (11) Roof Deck, Inc.
   (12) Valley Joist; Subsidiary of EBSCO Industries, Inc.
   (13) Verco Manufacturing Co.
   (14) Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Deck," and with the following:
   (1) Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings. G60 zinc coating, shop primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at interior locations.
      (a) Color: [as selected by Architect]
   (2) Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G90 zinc coating. Use at exterior locations not indicated to be painted and exposed to view.
   (3) Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G90 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at exterior locations indicated to be painted and exposed to view.
      (a) Color: [as selected by Architect]
   (4) Deck Profile: As indicated on the structural drawings.
   (5) Span Condition: As indicated on the structural drawings.
   (6) Side Laps: Overlapped.

2.03 COMPOSITE FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   (1) ASC Profiles, Inc.; a Blue Scope Steel company.
   (2) Canam United States; Canam Group Inc.
   (3) CMC Joist & Deck.
   (4) Consolidated Systems, Inc.; Metal Dek Group.
   (5) Cordeck.

(6) DACS, Inc.
(7) Epic Metals Corporation.
(8) Marlyn Steel Decks, Inc.
(9) New Millennium Building Systems, LLC.
(10) Nucor Corp.; Vulcraft Group.
(11) Roof Deck, Inc.
(12) Verco Manufacturing Co.
(13) Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Steel Deck," with the minimum section properties indicated, and with the following:

(1) Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard baked-on, rust-inhibitive primer. May be used at interior locations.
(2) Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G60 zinc coating. May be used at interior or exterior locations not indicated to be painted and exposed to view.
(3) Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), G60 zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at exterior locations indicated to be painted and exposed to view.
(4) Profile Depth: As indicated on the structural drawings.
(5) Span Condition: As indicated on the structural drawings.

2.04 NONCOMPOSITE FORM DECK

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

(1) ASC Profiles, Inc.; a Blue Scope Steel company.
(2) Canam United States; Canam Group Inc.
(3) CMC Joist & Deck.
(4) Consolidated Systems, Inc.; Metal Dek Group.
(5) Cordeck.
(6) DACS, Inc.
(7) Marlyn Steel Decks, Inc.
(8) New Millennium Building Systems, LLC.
(9) Nucor Corp.; Vulcraft Group.
(10) Roof Deck, Inc.
(11) Valley Joist; Subsidiary of EBSCO Industries, Inc.
(12) Verco Manufacturing Co.
(13) Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Noncomposite Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Steel Deck," with the minimum section properties indicated, and with the following:

(1) Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), grade, thickness, and profile as indicated on the structural drawings. G60 zinc coating, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
    (a) Color: [as selected by Architect]
(2) Profile Depth: As indicated on the structural drawings.
(3) Span Condition: As indicated on the structural drawings.
(4) Side Laps: Overlapped.

2.05 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated but not less than recommended by SDI for overhang and slab depth.
G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch-wide flanges and level or sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
L. Galvanizing Repair Paint: ASTM A 780.
M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. When steel headed stud anchors are to be welded through metal deck and/or corrugated metal forming, the top flange of beams to receive such anchors shall be unpainted and free of debris prior to installation of the deck and/or forming.

3.02 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI, manufacturer's written instructions, and requirements in this Section.
B. Install temporary shoring before placing deck panels if required to meet deflection limitations. Obtain prior written approval from Structural Engineer-of-Record before installing shoring.
C. Locate deck bundles to prevent overloading of supporting members.
D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
   (1) Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
   (1) Refer to Drawings for opening sizes requiring reinforcement and typical reinforcement options.
   (2) Miscellaneous openings not shown on the Drawings such as those required for vents, risers, conduits, etc. shall be cut and reinforced if necessary, by the trade requiring the opening.
H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
I. Mechanical fasteners may be used in lieu of welding to fasten deck with prior written approval of Structural Engineer-of-Record. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.03 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels as indicated on the structural drawings. Provide weld washer at each location where uncoated deck of thickness 0.028 inches or less is being fastened to supporting members by welding.
B. End Bearing: Install deck ends over supporting frame with a minimum end bearing length as indicated on the structural drawings, with end joints as follows:
   (1) End Joints: Lapped as indicated on the structural drawings.
C. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 12 inches apart with at least one weld or fastener at each corner.
   (1) Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.
D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
   (1) Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.04 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   (1) Weld Diameter: As indicated on the structural drawings, nominal.
   (2) Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart. Steel headed stud anchors may be substituted for welds one for one in meeting spacing requirements.
   (3) Weld Washers: Install weld washers at each weld location when the minimum uncoated steel thickness is less than 0.028 inches.
B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows unless otherwise indicated:

(1) Mechanically fasten with self-drilling, No. 10 diameter (or larger) carbon-steel screws.
(2) Mechanically clinch or button punch.
(3) Fasten with a minimum of 1-1/2-inch-long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing as indicated on the structural drawings, with end joints as follows:

(1) End Joints: As indicated on the structural drawings.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

F. Install piercing hanger tabs at minimum spacing indicated in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.

G. Fastening Corrugated Metal Forming: Secure to supporting member with 1/2 inch minimum diameter fusion welds made through 0.0747 inch welding washers. Minimum weld requirements as follows:

(1) End Laps: In valley of side laps and at center of sheet.
(2) Intermediate Supports: In valley of side lap on every other support and in valley of center corrugation on the remaining supports (to form an X pattern).
(3) Exterior Edges: 12 inches on center.
(4) Minimum Number of Welds Per 100 square foot of Deck Area:

(a) 0.0164 inches (0.4 mm) thick and thinner – 25.
(b) Thicker than 0.0164 inches (0.4 mm) – 15.

H. Steel headed stud anchors shall be field welded to the structural members only after all steel framing, deck and/or forms are in place and shored when required. Deck and/or forming shall be installed such that the bottom rib plate is in continuous contact with the surface to receive anchors.

I. Steel Headed Stud Anchor Capacity: Number of steel headed stud anchors indicated on Drawings is based on the allowable capacity for anchors in normal weight or light weight concrete as listed in AISC 360 for the composite deck specified. If additional anchors are required due to decreases in anchor capacity for the type of deck and stud placement supplied, such additional anchors shall be provided at no additional cost to the Owner.

J. Steel Headed Stud Anchor Installation:

(1) Install anchors in accordance with Manufacturer's instructions. Use only personnel and equipment authorized by the Manufacturer.
(2) Use through-deck anchor welding where deck material thickness permits proper weld fusion to develop required anchor capacity. Provide adequate test results to verify feasibility of through-deck welding for the particular anchor sizes and deck thicknesses involved.
(3) If through-deck anchor welding is not feasible, install anchors through pre-punched holes in deck. Provide pre-punched holes only where required for anchor installation and keep hole oversize to minimum required to develop a proper weld.

K. At the beginning of each shift of work, and after each time welding equipment has been moved, two test anchors shall be installed and bent to 45 degrees by the Contractor. If failure occurs, adjust equipment and repeat test. Two consecutive test studs shall be welded and found satisfactory before production for that shift begins or is resumed.

3.05 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on the structural drawings.

3.06 PROTECTION

A. Galvanizing Repairs: Where deck is exposed to weather or moisture, prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

(1) Do not use deck units for storage or as a working platform until permanently secured in position.
(2) Contractor shall assure that completed deck is not damaged by use as a runaway, storage of materials or subsequent work.
(3) Contractor shall assure that construction loads are not allowed which exceed the safe carrying capacity of the deck.

END OF SECTION 05 31 00

SECTION 05 40 00 – COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

(1) Exterior load-bearing wall framing.
(2) Interior load-bearing wall framing.
(3) Exterior non-load-bearing and soffit wall framing.
(4) Floor joist framing.
(5) Roof trusses.
(6) Roof rafter framing.
(7) Ceiling joist framing.

B. Related Sections include the following:

(1) Division 05 Section “Metal Fabrications” for masonry shelf angles and connections.
(2) Division 09 Section “Non-Structural Metal Framing” for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.
(3) Division 09 Section “Gypsum Board Shaft Wall Assemblies” for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.

(1) Deflection Limits: Design framing systems to withstand design loads without deflections greater than indicated on the drawings.
(2) Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
(3) Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate deflection of primary building structure as indicated on the drawings.

B. Cold-Formed Steel Framing, General: Design according to AISI's “Standard for Cold-Formed Steel Framing - General Provisions.”

(1) Headers: Design according to AISI's “Standard for Cold-Formed Steel Framing - Header Design.”
(2) Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
(3) Roof Trusses: Design according to AISI's “Standard for Cold-Formed Steel Framing - Truss Design.”

1.04 SUBMITTALS

A. Product Data: For each type of cold-formed metal framing product and accessory indicated.
B. Shop Drawings: Provide ¼” = 1'-0” scale elevations of all walls and plans of all soffits comprised of cold-formed metal framing. Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

(1) For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

A. Sustainability Submittals:

(1) Submit product data or other published information verifying that this product has a Type III environmental product declaration. [ARCH] Submit in accordance with Section 018113 ARCH.
(2) Product Sourcing:

(a) Submit product data or other published information indicating total weight of product to be provided for the Project, percent of post-consumer recycled material by weight and percent post-industrial recycled material by weight.

(3) Maximum embodied carbon and recycled content of steel products. Reference drawings for embodied carbon and recycled content goals.
(4) General Contractor's Sustainability Statement Letter: In the event that a sustainability goal or submittal requirement will not be met, contractor shall state in a letter the reasons why the goal or submittal requirement is not being met. Letter shall state whether alternative sustainability measures are viable for the project. If there are viable alternates, letter shall include details of proposed alternatives and associated project costs and schedule impacts (if any) for the Owner's consideration.

B. Welding certificates.
C. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:
   (1) Vertical deflection clips.
   (2) Horizontal drift deflection clips.
   (3) Miscellaneous structural clips and accessories.

1.06 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.
B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.
C. Special Inspections and Testing: Special inspections and tests indicated on the construction documents and indicated within this specification are minimum requirements. The cold-formed metal framing construction documents shall include the minimum testing and inspection requirements as indicated on the construction documents and shall include additional testing and inspections that the engineer of the cold-formed metal framing engineer requires. All special inspections and tests (minimum design requirements on construction documents and those specified by cold-formed metal framing engineer) shall be paid for by the Owner.
D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.
E. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
F. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code--Steel,” and AWS D1.3, “Structural Welding Code--Sheet Steel.”
G. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
H. AISI Specifications and Standards: Comply with AISI's “North American Specification for the Design of Cold-Formed Steel Structural Members” and its “Standard for Cold-Formed Steel Framing - General Provisions.”
   (1) Comply with AISI's “Standard for Cold-Formed Steel Framing - Truss Design.”
   (2) Comply with AISI's “Standard for Cold-Formed Steel Framing - Header Design.”
I. Comply with AISI's “Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings.”
J. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section “Project Management and Coordination.”

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
   (1) Allied Studco.
   (2) AllSteel Products, Inc.
   (3) California Expanded Metal Products Company.
   (4) Clark Steel Framing.
   (5) Consolidated Fabricators Corp.; Building Products Division.
   (6) Craco Metals Manufacturing, LLC.
   (7) Custom Stud, Inc.
   (8) Dale/Incor.
   (9) Design Shapes in Steel.
   (10) Dietrich Metal Framing; a Worthington Industries Company.
   (11) Formetal Co. Inc. (The).
   (12) Innovative Steel Systems.
   (13) MarinoWare; a division of Ware Industries.
   (14) Quail Run Building Materials, Inc.
   (15) SCAFCO Corporation.
   (16) Southeastern Stud & Components, Inc.
   (17) Steel Construction Systems.
   (18) Steeler, Inc.
   (19) Super Stud Building Products, Inc.
   (20) United Metal Products, Inc.

2.02 MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
   (1) Grade: As required by structural performance.
   (2) Coating: G60.

B. Steel Sheet for Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
   (1) Grade: As required by structural performance.
   (2) Coating: G90.
   (3) Gauge: 14 gauge minimum.

2.03 LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
   (1) Minimum Base-Metal Thickness: 0.0428 inch and as indicated.
   (2) Minimum Flange Width: 1-5/8 inches and as indicated.
   (3) Section Properties: As indicated.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
   (1) Minimum Base-Metal Thickness: Matching steel studs.
   (2) Minimum Flange Width: 1-1/4 inches and as indicated.

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, punched, with stiffened flanges, and as follows:
   (1) Minimum Base-Metal Thickness: 0.0538 inch and as required.
   (2) Flange Width: 1-5/8 inches and as required.
   (3) Section Properties: As indicated.

2.04 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
   (1) Minimum Base-Metal Thickness: 0.0329 inch and as indicated.
   (2) Minimum Flange Width: 1-5/8 inches and as indicated.
   (3) Section Properties: As indicated.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
   (1) Minimum Base-Metal Thickness: Matching steel studs.
   (2) Minimum Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips: Manufacturer's standard bypass and head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
   (1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      (a) Dietrich Metal Framing; a Worthington Industries Company.
      (b) MarinoWare, a division of Ware Industries.
      (c) SCAFCO Corporation.
      (d) The Steel Network, Inc.

D. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure.

E. Stiff Clips: Clip capable of supporting design loads indicated through positive mechanical attachment to the stud web. Maximum deflection of the clip/stud assembly under design loads shall be the smaller of 1/8” or the elastic limit load.

2.05 CEILING AND EXTERIOR SOFFIT JOIST FRAMING

A. Steel Ceiling and Soffit Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
   (1) Minimum Base-Metal Thickness: 0.0329 inch.
   (2) Minimum Flange Width: 1-5/8 inches.
   (3) Section Properties: As indicated.

2.06 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   (1) Supplementary framing.
   (2) Bracing, bridging, and solid blocking.
   (3) Web stiffeners.
   (4) Anchor clips.

(5) End clips.
(6) Foundation clips.
(7) Gusset plates.
(8) Stud kickers, knee braces, and girts.
(9) Joist hangers and end closures.
(10) Hole reinforcing plates.
(11) Backer plates.

2.07 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
B. Anchor Bolts: ASTM F 1554, Grade 55, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
D. Powder-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
(1) Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
F. Welding Electrodes: Comply with AWS standards.

2.08 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.
B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.
D. Shims: Load bearing, high-density multimonomer plastic, nonleaching.
E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.09 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
(1) Fabricate framing assemblies using jigs or templates.
(2) Cut framing members by sawing or shearing; do not torch cut.
(3) Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
(a) Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
(b) Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
(4) Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.
B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
(1) Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
(2) Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
(1) Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.
D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.03 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.
B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   (1) Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
   (1) Cut framing members by sawing or shearing; do not torch cut.
   (2) Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
      (a) Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      (b) Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   (1) Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.04 LOAD-BEARING WALL INSTALLATION

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
   (1) Anchor Spacing: To match stud spacing and as shown on Shop Drawings.
B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
   (1) Stud Spacing: As indicated.
C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
E. Align floor and roof framing over studs. Where framing cannot be aligned, continuously reinforce track to transfer loads.
F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.
G. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
   (1) Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
   (2) Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
   (1) If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
I. Install horizontal bridging in stud system, spaced as indicated on Shop Drawings. Fasten at each stud intersection.
   (1) Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of 2 screws into each flange of the clip angle for framing members up to 6 inches deep.

(2) Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
(3) Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

J. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.05 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:
(1) Maximum Stud Spacing: 16 inches and as indicated.
C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
(1) Connect vertical deflection clips to bypassing and infill studs and anchor to building structure.
(2) Connect drift clips to cold formed metal framing and anchor to building structure.
E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.06 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
B. Field and shop welds will be subject to testing and inspecting.
C. Testing agency will report test results promptly and in writing to Contractor and Architect.
D. Remove and replace work where test results indicate that it does not comply with specified requirements.
E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.07 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

SECTION 05 50 00 – METAL FABRICATIONS

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide miscellaneous metal fabrications where indicated on the Drawings, as specified herein, and as necessary for complete installation. The Work of this Section Includes, but is not limied to:

A. Steel framing and supports for overhead doors and trash enclosure doors
B. Steel framing and supports for mechanical and electrical equipment.
C. Steel framing and supports for applications where framing and supports are not specified in other Sections.
D. Shelf angles.
E. Metal bollards.

1.02 RELATED SECTIONS

1. Section 018113 Certification Requirements.

1.03 PRODUCTS FURNISHED, but not installed, under this Section include the following:

A. Loose steel lintels.
B. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
C. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.04 SUBMITTALS

A. SHOP DRAWINGS - TYPICAL: Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
B. SUBMIT STRUCTURAL ANALYSIS DATA indicating compliance with design loads and provide shop drawings signed and sealed by the qualified Professional Engineer responsible for their preparation.
C. LEED DOCUMENTATION REQUIREMENTS

1. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
2. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.
3. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material (this includes components of the mix design). Include distance to Project and cost for each regional material. (if applicable)

1.05 QUALITY ASSURANCE

A. FABRICATOR QUALIFICATIONS: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
B. PROFESSIONAL ENGINEER QUALIFICATIONS: Legally qualified to practice in jurisdiction where Project is located, experienced in providing engineering services of the kind indicated, with Professional Liability Insurance as required in Supplementary Conditions.
C. QUALIFY WELDING PROCEDURES AND PERSONNEL according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."
3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.06 PERFORMANCE REQUIREMENTS

A. LEED PERFORMANCE REQUIREMENTS

1. Recycled Content: Provide materials with at least 25% recycled or reused content
2. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material must be within 100 miles of project site for credit. (if applicable)

B. STRUCTURAL PERFORMANCE OF METAL STAIRS: Provide metal stairs capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each component of metal stairs.

1. Treads and Platforms of Metal Stairs: Capable of withstanding a uniform load of 100 lbf/sq. ft. or a concentrated load of 300 lbf on an area of 4 sq. in., whichever produces the greater stress.
2. Stair Framing: Capable of withstanding stresses resulting from loads specified above in addition to stresses resulting from railing system loads.
3. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

1.07 PROJECT CONDITIONS

A. FIELD MEASUREMENTS: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
B. ESTABLISHED DIMENSIONS: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to
C. ENSURE that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

D. COORDINATE INSTALLATION OF ANCHORAGES for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 EXPOSED METAL SURFACES: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 RECYCLED CONTENT OF STEEL PRODUCTS: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.03 FERROUS METAL MATERIALS:

A. Steel Plates, Shapes, and Bars: ASTM A 36.
B. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500.
C. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
D. Rolled-Steel floor Plate: ASTM A 786, rolled from plate complying with ASTM A 36 or ASTM A 283, Grade C or D.
E. Steel Bars for Gratings: ASTM A 36.
F. Wire Rod for Grating Crossbars: ASTM A 510.
G. Uncoated, Cold-Rolled Steel Sheet: Commercial quality, complying with ASTM A 366; or structural quality, complying with ASTM A 611, Grade A, unless another grade is required by design loads.
H. Uncoated, Hot-Rolled Steel Sheet: Commercial quality, complying with ASTM A 569; or structural quality, complying with ASTM A 570, Grade 30, unless another grade is required by design loads.
I. Galvanized Steel Sheet: ASTM A 653, G90 coating, either commercial quality or structural quality, Grade 33, unless another grade is required for design loads.

2.04 WELDING RODS AND BARE ELECTRODES: Select according to AWS specifications for metal alloy welded.

2.05 ROUGH HARDWARE: Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing, supporting or anchoring.

2.06 FASTENERS: zinc-coated fasteners for interior use, or galvanized for exterior use or when built into exterior walls:

A. Bolts and Nuts: Regular hexagon head type, ASTM A-307, Grade A.
B. Lag Bolts: Square Heat type, FS FF-B-561.
C. Machine Screws: Cadmium plated steel, FS FF-S-92.
D. Plain Washers: Round Carbon Steel FS FF-W-92.
E. Toggle Bolts: Tumble wing type, FS FF-B-588, Type, class and style as required.
F. Lock Washers: Helical spring type carbon Steel, FS FF--W-84.

2.07 CAST-IN-PLACE (CIP) ANCHORS: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency. Provide threaded or wedge type; galvanized ferrous castings, of either ASTM A 47 malleable iron or ASTM A 27 cast steel, with bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153.

2.08 EXPANSION ANCHORS: Drilled-in anchor bolt and sleeve assembly complying with FS FF-S-325, Group VIII (anchors, expansion, nondrilling), Type I (internally threaded tubular expansion anchor); and machine bolts complying with FS FF-B-575, Grade 5) with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

A. INTERIOR LOCATIONS: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
B. AT LOCATIONS EXPOSED TO WEATHER: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594 at locations exposed to weather.

2.09 MANUFACTURERED METAL PRODUCTS:

A. DOWNSPOUT BOOT: “Zurn” # Z199-DC (Downspout Cover) stainless steel unit with inlet,and outlet sized to fit drain pipe as specified in plumbing drawings. Depth to be ordered so face of drain is minimum 1 inch proud of surrounding finished material.
B. CONCEALED COUNTERTOP SUPPORTS: 2.5 inch wide by 1/2 inch thick units fabricated from ASTM A36 hot rolled steel with four (4) pre-drilled mounting holes, in length as required to securely anchor to support framing and to extend to within one (1) inch of edge of countertop overhang, with 35 degree “safe edge” on front of bracket, in black electrostatic powder-coat finish:
    1. BASIS-OF-DESIGN: “CenterlineBrackets Floating Countertop Support Bracket” Series FWM as manufacturered by Centerline Steel LLC., P: 888-960-3854, www.countertopbracket.com
C. CONCEALED SHELF SUPPORTS: 2.5 inch wide by 1/2 inch thick steel unit fabricated from ASTM A36 hot rolled steel with six (6) pre-drilled mounting holes to anchor to support framing and to extend to within one (1) inch of edge of countertop, with 35 degree “safe edge” on front of bracket (for silicone mounting on flat surface), in black electrostatic powder-coat finish:
    1. BASIS-OF-DESIGN: “Wall Mount Shelf Supports” (No. 283.33.941) w/ “Extrusion Rail” (No. 833.74.894) by Hafele America Co., P: 800.423.3531, www.hafele.com/us
D. ABRASIVE METAL NOSINGS (provide typically at stair treads and at exterior formed site steps unless otherwise indicated on the Drawings): Provide extruded aluminum units with solid abrasive-type filler (without ribs) consisting

of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions, and as follows:

1. At exterior site steps, fabricate in length three (3) inches less than full width of tread when abutting adjacent formed surfaces, centered in tread surface.
    a. Embedded Nosing Units: 3/4 to one (1) inch wide, with lip designed to fit at formed edge of steel pan.
    b. Epoxy Filler Color: As selected by Architect from manufacturer's full range of available options.
2. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
3. Apply clear lacquer to concealed surfaces of extruded units set into concrete before installation
4. BASIS OF DESIGN PRODUCT / MANUFACTURER: Spectra Type WP1A; Wooster Products, Inc.
    a. www.wooster-products.com
5. Approved Manufacturers: Subject to compliance with requirements, provide equal products by one of the following:
    a. ACL Industries, Inc.
    b. American Safety Tread Co., Inc.
    c. Amstep Products.
    d. Armstrong Products, Inc.
    e. Balco Inc.
    f. Granite State Casting Co.
    g. Wooster Products Inc.

E. WIRE SECURITY MESH (only in partitions above 10' AFF): ASTM A-185 welded steel wire mesh sheet (not rolled) - 6 x 6 - W2.9 x 2.9 (#8 gage wire) minimum.
F. EXPANDED-STEEL SECURITY MESH: Flattened expanded steel mesh fabricated from .042 inch (18 gage) steel with 1/2" spacing of perforated openings: "Ametco" flattened 1/2" x # 18 (.039 inch thick after flattening) or approved equal.
G. MAXIMUM SECURITY MESH: .070 inch thick (14 gage) flattened, expanded steel mesh, 1.40 lbs/SF minimum with 1/2" spacing of perforated openings of .265 x 1.0 inch maximum: "Amico" flattened ASM-.50-13F with "Amico" Secura Clips at all fasteners to be spaced at 8" vertical x 16" horizontal (at stud framing) or approved equal.
H. CHANNEL-SUSPENSION SYSTEM: Pre-engineered assemblies of 0.093 inch thick (12 gage) minimum pre-punched channels and shapes, with accessory hanger-rods (1/2 inch diameter min), beam-clamps, washers, nuts, inserts, fittings and other components in electro- or hot-dipped-galvanized finish typically.
    1. APPROVED MANUFACTURERS / SYSTEMS: Cooper B-Line, Kindorf by Thomas & Betts, Hohmann & Barnard, Unistrut, Versabar or equivalent system in compliance with requirements herein.
    2. CAST-IN-PLACE (CIP) SUSPENSION CHANNEL INSERTS: Galvanized, slotted-type "U" shaped galvanized steel channel inserts or continuous channels (as indicated on the Drawings) for minimum 3,400 pound per LF uniform load per foot, with maximum height of 1-3/16 inch
        a. Basis-of-Design: Unistrut # P3760 series heavy-duty concrete inserts
    3. HANGER RODS: Mild low carbon steel, fully threaded or threaded each end, with nuts as required to position and lock rod in place, in manufacturer's standard electro- or hot-dipped galvanized finish.
    4. INTERIOR, DRY AREA FINISH: Any manufacturer's standard phosephate and baked enamel/epoxy, electro-galvanized, or 15 mil minimum thickness polyvinyl chloride (PVC) finish
    5. EXTERIOR OR DAMP AREA FINISH: Hot-dipped galvanized (other finishes not permitted)

2.10 FABRICATION OF MISCELLANEOUS METALWORK - GENERAL

A. SHOP ASSEMBLY: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
B. SHEAR AND PUNCH METALS cleanly and accurately. Remove burrs.
C. EASE EXPOSED EDGES to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
D. WELD CORNERS AND SEAMS CONTINUOUSLY to comply with the following:
    1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    2. Obtain fusion without undercut or overlap.
    3. Remove welding flux immediately.
    4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
E. PROVIDE FOR ANCHORAGE of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
F. CUT, REINFORCE, DRILL, AND TAP METAL FABRICATIONS to receive finish hardware, screws, and similar items.
G. FABRICATE JOINTS that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
H. ALLOW FOR THERMAL MOVEMENT resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

I. FORM EXPOSED WORK TRUE TO LINE AND LEVEL with accurate angles and surfaces and straight sharp edges.
J. REMOVE SHARP OR ROUGH AREAS on exposed traffic surfaces.
K. FORM EXPOSED CONNECTIONS WITH HAIRLINE JOINTS, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.11 MISCELLANEOUS STEEL FRAMING AND SUPPORTS: Provide steel framing and supports that are not a part of structural-steel framing as necessary to complete the Work. Fabricate from structural-steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

A. GALVANIZE exterior miscellaneous framing and supports and when installed in exterior walls, and where indicated.
B. CAST-IN-PLACE (CIP) UNITS: When units will be cast into concrete or built into masonry, fabricate with integrally welded steel strap anchors 1-1/4 inches wide by 1/4 inch thick by 8 inches long at 24 inches o.c., unless otherwise indicated. Furnish inserts if units must be installed after concrete is placed.
C. LOOSE BEARING AND LEVELING PLATES: Provide at steel items bearing on masonry or concrete Work. Drill plates to receive anchor bolts and for to facilitate grouting. Galvanize after fabrication.
D. LOOSE STEEL MASONRY LINTELS: Fabricate from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 8 inches, unless otherwise indicated.
E. SHELF ANGLES: Fabricate from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete. Align expansion joints in angles with indicated control and expansion joints in cavity-wall exterior wythe. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.
F. ROOFTOP UNIT SUPPORT-FRAMES: Provide continuous steel-angle frame supports under all rooftop HVAC units, roof scuttles, roof smoke vents, skylights, exhaust fans and similar rooftop mounted equipment.
   1. Minimum angle size shall be 4" x 4" x 3/8" unless otherwise indicated.
   2. Field weld angle frames to the adjacent bar joists with horizontal leg flush with top of joists.
G. ANGLE-FRAME AT ROOFTOP OPENINGS: Provide continuous, four (4) sided steel-angle frame at all openings in the roof deck larger than 9" round or square, field welded to the adjacent bar joists.
   1. Provide 3" x 3" x 3/8" minimum angle size unless otherwise indicated.
H. BURGLAR BARS: Provide 5/8" diameter smooth bars at 6" OC each way for installation at all angle framed roof openings including mechanical equipment and ductwork penetrations. Weld bars at intersections and to the perimeter of the angle frame.
I. STEEL OVERHEAD-DOOR FRAMES: Fabricate frames from minimum 3/8” thick steel plate and/or shapes, fully welded. Plug-weld built-up members and continuously weld all exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware. Provide integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry. Extend bottom of frames to floor with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts. Galvanize exterior steel frames.
J. STEEL SUPPORTS FOR OVERHEAD DOORS & GRILLES: Fabricate from steel pipe, tube or channel sections as indicated on the Drawings or as recommended by manufacturer of door/grille unit.
K. EMBEDDED PIT-ANGLES /CHANNEL FRAMES: Provide galvanized perimeter steel angles and channel assemblies with welded studs for concrete embedment at dock leveler pits, edge of docks, and similar elements. Galvanize after fabrication at both interior and exterior conditions.

2.12 MISCELLANEOUS STEEL FABRICATIONS & TRIM: Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches from each end, 6 inches from corners, and 24 inches OC, unless otherwise indicated. Galvanize exterior miscellaneous steel trim and in exterior walls, and where indicated.

A. PIPE BOLLARDS: Fabricate from Schedule 80 steel pipe. Anchor bollards in place with concrete footings. Support and brace bollards in position in footing excavations until concrete has been placed and cured
B. PIPE GUARDS: Fabricate from 3/8-inch-thick by 12-inch-wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard unit minimum. Drill each end for two 3/4-inch anchor bolts.

2.13 STEEL LADDERS: Fabricate for locations shown, with dimensions, fabrication details and anchorages as follows:

A. COMPLY WITH ANSI A14.3, unless otherwise indicated.
B. SIDERAILS:
   1. Flat Bar Design: Continuous, 1/4 x 3 - inch steel flat bars, with eased edges, spaced 18 inches apart
   2. Steel Pipe Design: Continuous steel pipe with maximum clear 16” spacing
      a. Sizing to be delegated to ladder fabricator and must meet all specification requirements.

C. SAFETY POST EXTENSION: provide on one side of ladder to extend not less than 42 inches above roof edges.
D. ABRASIVE BAR RUNGS: 3/4 inch diameter round abrasive surfaced rungs spaced 12 inches OC. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces. Abrasive surface may be provided by coating rung with aluminum-oxide granules set in epoxy-resin adhesive, or by using a manufactured rung filled with aluminum-oxide grout, at fabricators option.
E. SUPPORT EACH LADDER at top and bottom and not more than 60 inches OC with welded or bolted bent-steel or hot-formed angle steel brackets of minimum 1/4" thickness x 3” H x 3” wide (at support) x 5” high, providing a minimum 3” clearance between rungs and supporting substrate. Size brackets to support design loads specified in ANSI A14.3.

2.14 LADDER SAFETY CAGES: Provide safety cage around ladder whenever the top of the ladder is eighteen (18) feet or more above finish floor (AFF), and when so provided, start ladder cage at 12 feet AFF continuously to the roof. Fabricate as follows:

A. HOOPS: 1/4-by-4-inch flat bar hoops at four (4) feet centers maximum, creating a round shaped cage not less than 27 inches or more than 30 inches from the centerline of the rungs, and not less than 27 inches wide overall. Attach hoops to back side of ladder so that continuous three (3) inch hand grip clearance at ladder siderails is maintained.
B. VERTICAL BARS: 3/16-by-1-1/2-inch flat bars secured to each hoop, centered 9.5 inch maximum around hoop perimeter.

2.15 METAL SHIPS' LADDERS: Provide where indicate, fabricated of open-type construction with steel channel or plate stringers, pipe and tube railings, and bar grating treads, unless otherwise indicated. Provide brackets and fittings for installation. Comply with applicable requirements of Division-05 Section "Decorative Metal Railings” for railings.

2.16 STEEL STAIRS (INTERIOR AND EXTERIOR):

A. PROVIDE COMPLETE STAIR ASSEMBLIES, including metal framing, hangers, struts, handrails, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure. Join components by welding, unless otherwise indicated. Use connections that maintain structural value of joined pieces. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.
B. PREASSEMBLE STAIRS IN SHOP to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
C. STAIR FRAMING: Fabricate stringers of structural-steel channels, plates, or a combination of both, as indicated. Provide closures for exposed ends of stringers. Construct platforms of structural-steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to stringers; bolt or weld framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
D. INTERIOR CONCRETE-FILLED METAL-PAN STAIR TREADS AND PLATFORMS: Form risers, sub-tread pans, and sub-platforms from uncoated cold-rolled steel sheet of thickness needed to comply with performance requirements - but not less than 0.067 inch (14 gage). Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers. Shape metal pans to include nosing integral with riser, unless nosings are indicated otherwise. Attach abrasive nosings to risers, when indicated.

2.17 EXTERIOR METAL BAR-GRATING STAIR & PLATFORMS:

A. PRODUCE metal bar gratings per NAAMM marking system that comply with the Metal Bar Grating Standard "Standard Specifications for Metal Bar Grating and Metal Bar Grating Treads" published in ANSI/NAAMM A202.1 "Metal Bar Grating Manual."
B. WELDED STEEL GRATINGS: Mark/Size: W 15 4 (welded with bearing bars at 15/16 inch OC and cross bars at 4 inch OC) of 1-1/2 inch deep bars min as required by indicated loads, with serrated traffic surface. Hot dip galvanize finish with coating weight of not less than 1.8 oz. PSF of coated surface.
C. FABRICATE REMOVABLE GRATING SECTIONS with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners which are tamper proof, for attachment to supports. Furnish threaded bolts with nuts and washers for each clip required. Furnish self-drilling fasteners with washers for each clip required.
D. ATTACH TOE PLATES to grating by welding, unless otherwise indicated. Provide toe plate height of 4 inches, unless a greater height is indicated.
E. FABRICATE CUTOUTS in grating sections for penetrations indicated. Arrange layout of cutouts to permit grating removal without disturbing items penetrating gratings. Edge band openings in grating that interrupt 4 or more bearing bars with bars of same size and material as bearing bars. Connect and fully weld to adjacent bearing bars so that structural capacity is not affected.
F. DO NOT NOTCH BEARING BARS at supports to maintain elevation.
G. AVAILABLE MANUFACTURERS: Subject to compliance with requirements, manufacturers offering metal bar gratings that may be incorporated in the Work include, but are not limited to, Alabama Metal Industries Corp.; Barnett/Bates Corp.; Blaw Knox Grating Div., Blaw Knox Corp.; IKG Industries; Klemp Corp.; McNichols Co., Ohio Gratings, Inc., Reliance Steel Products, Inc.; and Trueweld, Inc.

2.18 FINISHES:

A. COMPLY WITH NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal fabrications after assembly.
B. PREPARATION FOR SHOP PRIMING: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. APPLY SHOP PRIMER to uncoated surfaces of metal fabrications, except those that are shop finished, units with galvanized finishes, at units intended to be embedded in concrete or masonry, or covered with sprayed-on fireproofing, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Stripe paint corners, crevices, bolts, welds, and sharp edges.

D. HOT-DIP GALVANIZED FINISH: Apply zinc coating by the hot-dip process to comply with ASTM A 123, for steel and iron products, or ASTM A 153 for steel and iron hardware. Fill vent holes and grind smooth after galvanizing.

1. Galvanize all exterior steel assemblies, including associated attachments and brackets.

PART 3 - EXECUTION:

3.01 FASTENING TO IN-PLACE CONSTRUCTION: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.

3.02 CUTTING, FITTING, AND PLACEMENT: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.03 FIT EXPOSED CONNECTIONS accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

3.04 FIELD WELDING: Comply with the following requirements:

A. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
B. Obtain fusion without undercut or overlap.
C. Remove welding flux immediately.
D. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.05 SETTING BEARING AND LEVELING PLATES: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout. Use non-shrink, non-metallic grout unless otherwise indicated. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.06 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings, if any. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns. Where grout space under bearing plates is indicated at girders supported on concrete or masonry, install as specified above for setting and grouting bearing and leveling plates.

3.07 INSTALL PIPE COLUMNS on concrete footings with grouted baseplates. Position and grout column baseplates as specified above for setting and grouting bearing and leveling plates. Do not grout baseplates of columns supporting steel girders until girders are installed and leveled.

3.08 FILL BOLLARDS solidly with concrete, mounding top surface and finishing smooth.

3.09 INSTALLATION OF DOWNSPOUT BOOT: Mount to substrate securely through dual mounting straps. Install with top set 18" above grade unless indicated otherwise. Connect bottom to storm-drainage system piping. Apply sealant in color to match boot finish, all around gap between downspout and boot, sloping top surface away from downspout for water-tight seal.

3.10 INSTALL METAL STAIRS by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

3.11 FIELD WELDING: Comply with applicable AWS specification for procedures of manual shielded metal arc welding, for appearance and quality of welds, and for methods used in correcting welding work. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind exposed welded joints smooth and restore finish to match finish of adjacent surfaces.

3.12 CLEANING & PROTECTION:

A. TOUCHUP PAINTING: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
B. GALVANIZED SURFACES: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
C. PROTECT finishes of metalwork during construction period by use of temporary protective coverings. Remove protective covering at time of Substantial Completion. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.13 ADJUSTING AND CLEANING

A. TOUCHUP PAINTING: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting (but with low VOC in field) to

comply with SSPC-PA 1 for touching up shop-painted surfaces. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. GALVANIZED SURFACES: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780, using low VOC galvanizing repair finish material.

END OF SECTION 05 50 00

SECTION 05 70 00 – DECORATIVE METAL

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide ornamental, exposed decorative metal, where indicated on the Drawings, as specified herein, and as necessary for complete installation. Types of applications include but are not limited to the following:

A. Exterior Metal Canopies
B. Interior decorative metal with blackened finish

1.02 DESIGN/BUILD: provide Professional Engineering Design Services for the following:

A. Design of exterior Metal Canopies

1.03 RELATED SECTIONS: The following include requirements for the Work of this Section:

A. Refer to Division-05 “Metal Fabrications” Section for other requirements of steel work, including submittals, field measurement, shop priming and general installation requirements.

1.04 REFERENCED STANDARDS: American Institute of Steel Construction (AISC)’s “Code of Standard Practice”, as follows:

A. AISC Section 10.2.1: Tolerances – one-half of standard
B. AISC Section 10.2.3: Weld show through minimized
C. AISC Section 10.2.4: Joint Gap Tolerances Minimized
D. AISC Section 10.2.5: Welds Ground Smooth
E. AISC Section 10.2.6: Piece Marks Hidden
F. AISC Section 10.2.7: Mill Marks Removed
G. AISC Section 10.2.8: Surface Defects Minimized
H. AISC Section 10.4.1: Special Care in Processing AESS
I. AISC Section 10.4.2: Tolerances – one-half of standard

1.05 STRUCTURAL PERFORMANCE OF DECORATIVE METAL FABRICATIONS: Provide units capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each component:

A. Deflection Limits: Design awning framing systems to withstand design loads without deflections greater than 1/180 of the span with the following applied loads.
B. Gravity loads: Unit self-weight plus local code-required loads as indicated on the structural drawings.
C. Wind / Seismic loads: Per requirements of applicable local building code.

1.06 SUBMITTALS

A. PRODUCT DATA: For each type of product indicated, including finishing materials.
B. SHOP DRAWINGS: Include plans, elevations, component details, and attachments to other work of decorative metal. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items. Clearly indicate which components are decorative metalwork members, and include details addressing special requirements for fabrication and erection required.
   (1) Indicate oversized weld size, length and type – and identify special grinding, finish and profile of welds required.
   (2) Indicate to which direction bolt heads will be oriented.
   (3) Clearly indicate which surfaces or edges are exposed and what class of surface preparation will be used.
   (4) Indicate special tolerances and erection requirements for decorative metalwork.
C. PROVIDE TEMPLATES for anchors and bolts specified for installation under other Sections.

1.07 QUALITY ASSURANCE

A. FABRICATOR QUALIFICATIONS: A firm experienced in producing decorative metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
B. PROFESSIONAL ENGINEER QUALIFICATIONS: Legally qualified to practice in jurisdiction where Project is located, experienced in providing engineering services of the kind indicated, with Professional Liability Insurance as required in Supplementary Conditions.
   (1) WELDING: Qualify procedures and personnel according to the following:
      (a) AWS D1.1, "Structural Welding Code--Steel."
      (b) AWS D1.2, "Structural Welding Code--Aluminum."
C. CONSTRUCT MOCKUPS to demonstrate aesthetic effects and qualities of materials and execution not less than four (4) weeks before fabrication of decorative metalwork. Build mockups to comply with the following, using materials indicated for the final Work required.
   (1) Locate on-site or in the fabricator’s shop as directed by the Architect. Mockups must be full-size pieces unless the Architect approves smaller, representative units to be provided.
   (2) Notify the Architect one (1) week in advance of the dates and times when mockups will be available for review.
   (3) Demonstrate the proposed range of aesthetic effects regarding each element.
   (4) Provide complete, finished surfaces, including surface preparation and finishing systems indicated.
   (5) Obtain Architect’s approval of mockups before starting fabrication of Work.
   (6) Maintain mockups during construction undisturbed as a standard for judging completed Work. Approved mockups in undisturbed condition at time of Substantial Completion may become part of the completed Work.

1.08 DELIVERY, STORAGE, AND HANDLING

A. STORE DECORATIVE METAL INSIDE a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
B. DELIVER AND STORE CAST-METAL PRODUCTS in wooden crates surrounded by sufficient packing material to ensure that products will not be cracked or otherwise damaged.

1.09 PROJECT CONDITIONS

A. FIELD MEASUREMENTS: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.
B. ESTABLISHED DIMENSIONS: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions. If practical, provide allowance for trimming and fitting at site.

1.10 COORDINATION - COORDINATE INSTALLATION OF ANCHORAGES for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.11 PRE-INSTALLATION CONFERENCE: Schedule and conduct a conference at the project site per requirements of Division-01 requirements. Include representatives of the Contractor, fabricator, erector, and the finish applicator. Review and coordinate requirements for shipping, special handling, attachment of safety cables and temporary erection bracing, touch-up finishing and other requirements of decorative metalwork.

PART 2 - PRODUCTS

2.01 PROVIDE MATERIALS with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.02 ALUMINUM

A. Provide aluminum materials of alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
B. Extruded Bars and Shapes: ASTM B 221, Alloy 6063-T5/T52.
C. Drawn Seamless Tubing: ASTM B 210 or ASTM B 483, Alloy 6063-T832.
D. Plate and Sheet: ASTM B 209 Alloy 5005-H32.
E. Die and Hand Forgings: ASTM B 247, Alloy 6061-T6.
F. Castings: ASTM B 26, Alloy A356.0-T6.

2.03 STEEL AND IRON

A. Castings: Either gray or malleable iron, unless otherwise indicated.
B. Gray Iron: ASTM A 48, Class 30, unless another class is indicated or required by structural loads.
C. Malleable Iron: ASTM A 47.
D. Weathering Steel: US Steel's "CorTen" corrosion retarding steel, meeting ASTM A 588 (Cor-Ten B") with a yield strength of at least 50 KSI, and thin-steel sheet meeting ASTM A 606.

2.04 STAINLESS STEEL:

A. Stainless-Steel Sheet, Strip, Plate, and flat Bars: ASTM A 666, Type 304 unless noted otherwise
B. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 unless noted otherwise

2.05 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:
B. Aluminum Items: Type 304 stainless-steel fasteners.
C. Uncoated Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless-steel fasteners where exposed.
D. Dissimilar Metals: Type 304 stainless-steel fasteners.
E. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
F. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work, unless otherwise indicated.
G. Anchors: Provide anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed.

2.06 FABRICATION OF DECORATIVE METAL – GENERAL:

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
B. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces:
C. Form decorative metalwork elements to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces.
D. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
E. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Form simple and compound curves in bars and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
G. Cut, drill, and punch metals cleanly and accurately.
H. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
I. Mill joints to a tight, hairline fit. Cope or miter corner joints.
J. Fabricate connections that will be exposed to weather in a manner to exclude water.
K. Provide weep holes where water may accumulate.
L. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items, unless otherwise indicated.
M. Comply with AWS for recommended practices in shop welding. Weld behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.
N. Galvanize all exterior decorative fabrications, including associated brackets and fasteners.

2.07 SPECIAL FABRICATION REQUIREMENTS FOR DECORATIVE METAL: Locate field joints at concealed locations or as approved by the Architect. Detail decorative metal assemblies to minimize field handling and to expedite erection. Fabricate decorative metal with exposed surfaces smooth, square and of surface quality consistent with the approved mock up(s). Use special care in handling and shipping decorative metal both before and after shop finishing. In addition to special care used to handle and fabricate decorative metal, employ the following special fabrication techniques, as applicable:

A. Reduce fabrication tolerance to half of the normal tolerance required in the Code of Standard Practice Section 10.
B. Grind all exposed welds smooth. At groove welds, make welds flush with the surfaces on each side and within +1/16 to -0 inch of the plate thickness.
C. Oversize exposed fillet welds and ground-contour or blend to provide a smooth transition and to match the profile on approved mock-up(s).
D. Provide continuous welds typically of uniform size and profile, where welding is indicated
E. Minimize weld “show-through” on the far side of an exposed connection by grinding distortions and markings to a smooth profile with the adjacent material.
F. Maintain a uniform gap of 1/8 inch (+/- 1/32 inch) at all copings, blocking and joint gaps.
G. Fabricate to hide piece marks in the final structure, or make with media to permit full removal after erection.
H. Deliver decorative metal without mill marks (stenciled, stamped raised etc) in exposed locations. Mill marks may be omitted by cutting of mill material to appropriate lengths where possible. Where not possible, fill and/or grind to a surface finish consistent with the approved mock up.
I. Grind all exposed edges of sheared, punched or flame-cut steel to match approved mockup.
J. Weld-seal open ends of round and rectangular hollow structural sections with 3/8 inch thick closure plates. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AESS is exposed to weather.

2.08 DECORATIVE METAL CANOPY FABRICATION:

A. FABRICATE UNITS in conformance to general design indicated on the Drawings, from extruded shapes and tubes. Miter frame members at exposed corners and connect with concealed splice plates, as applicable. Provide weep-holes on bottom sides of exterior members at regular spacing.
B. WELDING: Interconnect members with full-length, full-penetration welds, unless otherwise indicated. Use welding method appropriate for metal and finish indicated and that develops full strength of members joined. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces.
C. BRACKETS, FITTINGS, AND ANCHORS: Provide wall brackets, fittings, and anchors to connect units to other work, unless otherwise indicated. Furnish inserts and other anchorage devices to connect units to substrate. Coordinate anchorage devices with supporting structure.

2.09 SHOP CONNECTIONS: Provide bolt type, finish, and alignment of bolt heads as indicated on the approved Shop Drawings. Appearance and quality of welds must be consistent with the approved mockup. Assemble and weld built-up sections by methods that will maintain alignment of members without warp exceeding the tolerance indicated.

2.10 SPECIAL DECORATIVE METAL FINISHES

A. ALUMINUM FINISHES: Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
B. Class II, Anodic Finish: AA-M12C22A31 clear anodized coating or AA-M12C22A32/A34 colored anodized coating (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Architectural Class II, clear or integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.
C. Color: As indicated on the Drawings, or if not indicated, as selected by Architect from full-range of available colors.

2.11 SHOP-FINISHED STEEL:

A. NATURAL STEEL (CLEAR) FINISH: Where indicated in the Drawings as “NATURAL FINISHED” or “CLEAR STEEL FINISH”, provide the following shop-applied finish on steel sheet or shapes to match the Architect’s finish sample, including surface sheen and texture.
   (1) MATERIALS:
      (a) ABRASIVE PADS: general purpose pad equal to Scotch-Brite # 7447 - “Maroon” colored
   (2) CLEAR POWDER-COAT: Cross-linked baked-enamel of TGIC polyester powder intended for application by electrostatic or tribo-charged spraying.

(3) SURFACE PREPARATION: After cutting, forming, welding and other fabrication is complete, and welds have been ground smooth, degrease residual mill oil or grease, cutting compounds and other soluble contaminates with denatured alcohol per SSPC-SP1 “solvent cleaning” requirements. After degreasing, hand sand with abrasive pad to remove loose mill scale, loose rust, paint and other detrimental foreign material per SSPC-SP2 “Hand Tool Cleaning” requirements. Repeat until residual rust is completely removed.
(4) TORCH SURFACES after cleaning to remove all residual moisture from the surface.
(5) APPLY POWDER COAT FINISH until a consistent clear, natural steel finish is achieved. Do not apply in thickness that will appear milky or hazy when dry.

2.12 COLORED POWDER-COAT FINISH: Provide minimum 1.5 mil thick continuous, cross-linked baked-enamel powder-coat finish, consisting of TGIC polyester power applied by electrostatic or tribo-charged spraying, then baked in a curing oven to fuse the deposited powder to the metal substrate, in full compliance with coating manufacturer’s written instructions for pretreatment, application, minimum dry-mil thickness (if thicker) and baking procedures.

2.13 BLACKENED FINISH (POWDER-COAT): Where indicated in the Drawings as “blackened” or blackened steel finish, provide the following shop-applied powder-coat finish on steel sheet or steel shapes to match the Architect’s blackened steel finish sample, including color, surface sheen and texture.

A. POWDER-COAT MATERIAL: TGIC polyester powder coating of the “Super Durable TGIC” class, with a blended colored and/ or finish application necessary to simulate the appearance of black-oxide on steel. The power coated finish must meet or exceed the following:

(1) ASTM D3359, Measuring Adhesion by Tape Test, Method B, coating retention of not less than 95%.
(2) ASTM D2794, Impact Resistance, minimum resistance to impact not less than 120 in. /lb.
(3) ASTM D3363, Film Hardness by Pencil Test, minimum hardness: 2H.
(4) THICKNESS: Minimum finish film thickness of 2-3 mils as measured by manufacturer’s standard powder coat measurement and inspection procedures.

B. PRETREATMENT: Prepare metal surfaces with a pre-treatment cleaning system to remove foreign material and to properly prepare the surface to achieve the coating system requirements specified above.
C. CURING: Heat cure in accordance with powder-coat finish manufacturer’s prescribed curing schedule to permanently bond the finish to the metal substrate.

PART 3 - EXECUTION

3.01 EXAMINATION

A. EXAMINE SUBSTRATES AND CONDITIONS, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.
B. PROCEED WITH INSTALLATION only after unsatisfactory conditions have been corrected.
C. EXAMINATION OF MATERIALS: Check decorative metal members upon delivery for twist, kinks, gouges or other imperfections which might result in rejection of the appearance of the member. Coordinate remedial actions with fabricator prior to erection.

3.02 PREPARATON: Provide connections for temporary shoring, bracing and supports only where noted on the approved Erection Drawings. Temporary connections not shown must be made at locations not exposed to view in the final structure or as approved by the Architect.

A. HANDLE, LIFT AND ALIGN PIECES using padded slings and/or other protection required to maintain the appearance of the decorative metal through the process of erection.

3.03 ERECTION: Set decorative metalwork accurately in locations and to elevations indicated, and according to AISC specifications referenced herein. In addition to the special care used to handle and erect decorative metalwork, employ the following erection techniques:

A. Erection Tolerances must meet the requirements of Chapter 10 of the AISC Code of Standard Practice.

3.04 INSTALLATION, GENERAL

A. PROVIDE ANCHORAGE DEVICES and fasteners where needed to secure decorative metal to in-place construction.
B. PERFORM CUTTING, DRILLING, AND FITTING REQUIRED to install decorative metal. Set products accurately in location, alignment, and elevation; measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
C. FIT EXPOSED CONNECTIONS ACCURATELY TOGETHER to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.
D. DO NOT CUT OR ABRADE FINISHES that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

(1) Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

E. RESTORE PROTECTIVE COVERINGS that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
F. CORROSION PROTECTION: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
G. GRIND FIELD WELDS SMOOTH in the connections of decorative metal members. Comply with requirements for “fabrication of AESS” above for field connections, and as follows:

(1) Bolt Head Orientation: all bolt heads in a connection must be oriented to one side
(2) Remove run-out tabs, erection bolts, and other steel members added to connections for alignment, fit-up, or welding in the field must be fully removed.

(3) Install field groove welds to eliminate the need for backing bars and to permit their removal after welding.
(4) Remove welds at run-out tabs to match adjacent surfaces and grind smooth.
(5) Plug weld holes for erection bolts and grind smooth.
(6) Field-fill all welding access holes cut into the web at intersections with flanges or W shapes and at structural tees for field welding of the flanges. Perform filling with proper procedures to minimize restraint and address thermal stresses in Group 4 and 5 shapes. Weld profile, quality and finish mist be consistent with mockup(s).

3.05 INSTALLING ORNAMENTAL AWNINGS: Mount units at heights and in positions indicated. Secure to framing and blocking with specified fasteners.

3.06 CLEANING

A. CLEAN METALS BY WASHING THOROUGHLY with clean water and soap, rinsing with clean water, and drying with soft cloths, unless otherwise recommended by the fabricator or metal finish manufacturer.
B. TOUCHUP PAINTING: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material.
C. GALVANIZED SURFACES: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.07 AESTHETIC ACCEPTANCE: The Architect will observe installed decorative metalwork to determine acceptability, based on conformance with the Approved mockup(s).

3.08 ADJUSTING AND CLEANING: Clean and touchup paint or finish field welds, bolted connections, and abraded areas of shop paint to blend with adjacent surfaces of decorative metalwork. Clean field welds, bolted connections and abraded areas of galvanized surfaces to comply with ASTM A780. Perform touch-up work in accordance with applicable Division-09 requirements

3.09 PROTECTION

A. PROTECT FINISHES OF ORNAMENTAL METAL from damage during construction period with temporary protective coverings approved by ornamental metal fabricator. Remove protective covering at time of Substantial Completion.

3.10 RESTORE FINISHES DAMAGED DURING INSTALLATION and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 70 00

SECTION 05 73 00 – DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide metal handrails, guards, and integrated railings systems, where indicated on the Drawings, as specified herein, and as necessary for complete installation.

1.02 RELATED SECTIONS: The following include requirements for the Work of this Section:

A. Section 018113 Certification Requirements.
B. Refer to Division-05 “Metal Fabrications” Section for general metal materials and installation requirements
C. Refer to Division-09 “Glazing” Section for glass materials and installation requirements

1.03 DESIGN/BUILD: provide Professional Engineering Design Services for design of metal railings.

1.04 PERFORMANCE REQUIREMENTS

A. LEED PERFORMANCE REQUIREMENTS

1. Recycled Content: Provide materials with at least 25% recycled or reused content
2. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material must be within 100 miles of project site for credit. (if applicable)
3. VOC Emissions Evaluation:Site applied paints and primers must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
4. VOC content requirements for wet-applied products: For site applied paints and primers, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Paints and Coatings Applications, as per the California Air Resource Board (CARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings or South Coast Air Quality Management District (SCAQMD) Rule 1113, effective February 5, 2016. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints and coatings.

B. STRUCTURAL PERFORMANCE OF GUARD RAILINGS & HANDRAILS: Provide guards and handrails complying with requirements in ASTM E 985 for structural performance, based on testing performed according to ASTM E 894 and ASTM E 935, and capable of withstanding the following structural loads without exceeding the allowable design working stress of materials involved:

1. Top Rail of Guards: Concentrated load of 300 pounds applied at any point and in any direction, and a uniform load of 50 lbs/ft. applied horizontally and concurrently with uniform load of 100 lbs/ft. applied vertically downward. Concentrated and uniform loads need not be assumed to act concurrently.
2. Handrails Not Serving as Top Rails: Concentrated load of 200 pounds applied at any point and in any direction, and a uniform load of 50 LBS/FT. applied in any direction. Concentrated and uniform loads need not be assumed to act concurrently.
3. Infill Area of Guards: Horizontal concentrated point load of 200 pounds applied to 1 sq. ft at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area. Load on infill area need not be assumed to act concurrently with loads on top rails.

C. THERMAL MOVEMENTS: Provide units that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects of temperature. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 140 deg F, ambient; 180 deg F, on material surfaces.

D. CONTROL OF CORROSION: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.05 QUALITY ASSURANCE

A. FABRICATOR QUALIFICATIONS: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
B. INSTALLER QUALIFICATIONS: Entity with no less than three (3) years of successful experience in installation of Work similar to the requirements for this project, acceptable to the manufacturer of the primary products specified, as verifiable by a current written statement from the manufacturer.
C. QUALIFY WELDING PROCEDURES AND PERSONNEL according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."
3. CERTIFY that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

D. SOURCE LIMITATIONS: Obtain each type of railing system component through one source from a single manufacturer.
E. PRODUCT OPTIONS: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Do not

modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

F. GUARDRAIL MOCKUP: Build mockup of guardrail to verify selections made under sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation. Build mockup for each form and finish of guard railing consisting of not less than two posts or glazed panel supports (as applicable), the top rail (if exists), infill area, handrail, and anchorage system components that are full height and are not less than 72 inches in overall width. Approved guardrail mockup may remain as part of the Work if acceptable to Architect.

1.06 SUBMITTALS

A. LEED SUBMITTAL REQUIREMENTS

1. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
2. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.
3. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material (this includes components of the mix design). Include distance to Project and cost for each regional material. (if applicable)
4. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
5. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealants.

B. SUBMIT PRODUCT DATA of pre-engineered railing systems to include assembly details, connection, and anchorage to adjacent supporting construction as appropriate. Include installation instructions for each type and size of systems to be provided. Include manufacturer's maintenance data.

C. SUBMIT SHOP DRAWINGS to include plans, elevations, sections, details, and attachments to other work. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. SUBMIT MATERIAL SAMPLES for initial selection of products involving color or texture, including mechanical finishes, submit samples of the following:

1. Custom wood picket with metal support picket (at Atrium areas)
2. All other railings as indicated in Drawings
3. Mounting fittings, brackets and accessories.

E. SUBMIT ASSEMBLED MOCKUP SECTION of railing system after approval of materials above, made from full-size components, Show method of finishing members at intersections.

F. QUALITY ASSURANCE REQUIREMENTS

1. Comply with applicable provisions of AWS D1.1 “Structural Welding Code – Aluminum”, AWS D1.3 “Structural Welding Code – Steel”, and AWS 1.6 “Structural Welding Code – Stainless Steel”
2. Welder qualifications: AWS certified for type of welding required.
3. Weld and braze joints in accordance with National Ornamental & Miscellaneous Metals Association (NOMMA) “Voluntary Joint Finish Standards”:

    a. Finish 1: No evidence of a welded joint.

1.07 DELIVERY STORAGE AND HANDLING

A. DELIVER MATERIALS in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. STORE MATERIALS inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack materials flat to prevent sagging.

1.08 PROJECT CONDITIONS

A. FIELD MEASUREMENTS: Where railings are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. ESTABLISHED DIMENSIONS: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.09 COORDINATION

A. COORDINATE FABRICATION SCHEDULE with construction progress to avoid delaying the Work.

B. COORDINATE INSTALLATION OF ANCHORAGES for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
C. SCHEDULE INSTALLATION so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.01 STEEL HANDRAILS AND GUARDRAILS AT EGRESS STAIRS: Fabricate from steel shapes or tube typically (not pipe) to comply with design, dimensions, profiles and details as indicated on the Drawings – and if not indicated, per the following requirements - but not less than that required to withstand the required performance loads. At guardrails, fabricate with not more than four (4) inch clearance at all internal openings and to adjacent floor or wall surfaces:

A. GUARDRAIL FRAMEWORK SUPPORTS: Fabricate from 2 x ¾" inch rectangular tube or solid square steel plate supports at four (4) feet maximum spacing unless otherwise indicated
B. TOP RAIL OF GUARDRAIL: 2 inch wide x 3/4 inch high rectangular tube or solid steel with eased edges. Fabricate with top of rail not less than 42 inches above finished floor (AFF) unless otherwise indicated.
C. BOTTOM RAIL OF GUARDRAILS: 2inch wide x 3/4 inch high tube or solid steel with eased edges, matching depth of guardrail support posts, with minimum two (2) inch clearance to floor unless otherwise indicated
D. BOTTOM RAIL OF GUARDRAILS: Match size and profile of top railing unless otherwise indicated, with minimum two (2) inch clearance to floor unless otherwise indicated
E. GUARDRAIL PICKETS: 2 x ¾" inch solid steel plate between top and bottom rails of guardrails.
F. GUARDRAIL PICKETS: 1/2 inch square tubes between top and bottom rails of guardrails unless otherwise indicated
G. INFILL PANELS: Three (3) inch square welded mesh of 0.25 inch diameter steel wire, with perimeter edge U-channel trim welded to mesh and with welded steel tabs for attachment to railing supports as needed and where called for in Drawings
H. HANDRAILS: Locate top of handrails at 36 inches above nosing line of stairs, placed on both sides of stairs (unless otherwise indicated at "private" stair with less than 10 occupant load) - extending not less than 12 inches beyond top and bottom stair risers.
    1. Support from brackets mounted to guardrail supports or from wall brackets to provide minimum 2-1/4 inch clearance from railing per NFPA Life-Safety Code requirement, and with 1-1/2 inch clear minimum below railing to support members.
    2. Fabricate handrails with wall returns at ends of wall-mounted handrails typically, and interconnect handrailings on inside of stairs to be continuous throughout. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.
    3. Handrail Material: 1-1/2 x ¾" inch square tubing with supports at five (5) feet maximum
I. FABRICATE GUARDRAILS AND HANDRAILS by inter-connecting members using butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated. At tee and cross intersections, cope ends of intersecting members to fit contour of tube to which end is joined, and weld all around. Form changes in direction of handrails and rails as follows:
    1. By inserting prefabricated concealed sleeves or fittings, and mitering railings members flush.
    2. Close exposed ends of handrail and railing members with prefabricated end fittings.
    3. Grind interconnected surfaces to be flush, and ease all fabricated edges typically.
J. PROVIDE MISCELLANEOUS FITTINGS, brackets, end closures, flanges, and anchors for interconnecting railings and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work. Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.
K. CONNECT RAILING POSTS to stair framing by direct welding, unless otherwise indicated in Drawings.
L. TYPICAL FINISH of handrails, guard railings, and fittings:
    1. Galvanize and prime paint handrails and guardrails when located at exterior conditions
    2. Prime paint units only at interior locations, for field finishing per Division-09 Painting Section.
    3. Provide handrails and guards of stainless-steel materials throughout

2.02 FASTENERS: Provide the following:

A. Aluminum Components: Type 304 stainless-steel fasteners.
B. Stainless-Steel Components: Type 304 stainless-steel fasteners.
C. Uncoated Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed; Type 304 stainless-steel fasteners where exposed.
D. Dissimilar Metals: Type 304 stainless-steel fasteners.
E. Provide tamper-resistant flat-head machine screws for exposed fasteners, unless otherwise indicated.

2.03 ANCHORS: Provide cast-in-place or torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.04 HARDWOOD AND STEEL RAILING

A. As Indicated in Drawings and Schedules.

2.05 FABRICATION

A. FABRICATE RAILINGS TO COMPLY WITH REQUIREMENTS indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
B. ASSEMBLE units to minimize splicing and assembly. Use connections that maintain structural value of joined pieces.
C. CUT, DRILL, AND PUNCH METALS cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
D. FORM WORK TRUE TO LINE and level with accurate angles and surfaces. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

2.06 FINISHES

A. APPEARANCE OF FINISHED WORK: Variations in appearance of abutting or adjacent pieces are acceptable if they are within less than the range indicated with the approved mockup. Noticeable variations in same plane are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINE adjacent Work for verification of installation tolerances and for compliance with other requirements and conditions affecting installation. Verify critical dimensions, and examine supporting structure and other conditions under which the Work of this Section is to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALL units where indicated on the Drawings, using mounting methods and fasteners appropriate to substrate as recommended by system manufacturer, in compliance with the manufacturer's instructions, and in compliance with the sealed engineered shop drawings. Install units plumb and level, firmly anchored in locations and at position indicated.

3.03 FASTENING TO IN-PLACE CONSTRUCTION: Provide anchorages and fasteners where necessary for securing the Work of this Section to in-place construction. Provide threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as appropriate.

3.04 CUTTING, FITTING, AND PLACEMENT: Perform cutting, drilling, and fitting required for installing the work of this Section. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting. Set units accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.05 ADJUST HANDRAILS AND RAILING SYSTEMS before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:

A. Anchor posts to steel by welding directly to steel supporting members.
B. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with post installed anchors and bolts.

3.06 ATTACH HANDRAILS TO WALL with wall brackets. Provide bracket with 2-1/4 inch clearance minimum (per NFPA's "Life Safety Code") from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:

A. Use type of bracket with predrilled hole for exposed bolt anchorage.
B. For steel-framed gypsum board assemblies, use hanger or lag bolts set into wood backing/blocking between studs. Coordinate with stud installation to locate backing/blocking members.

3.07 INSTALLATION TOLERANCE:

3.08 ADJUST RAILINGS BEFORE ANCHORING to ensure matching alignment at abutting joints.

3.09 CLEANING & PROTECTION

A. CLEAN ALL EXPOSED SURFACES according to manufacturer's recommendations after removing temporary labels and protective coatings. Clean aluminum by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
B. PROTECT RAILINGS FROM DAMAGE during construction period with temporary protective coverings approved by guardrail manufacturer. Remove protective coverings at time of Substantial Completion.

3.10 RESTORE FINISHES DAMAGED during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 00

End of Division 05

DIVISION 06 – WOOD, PLASTICS & COMPOSITES

SECTION 06 10 00 – SHEATHING

SECTION 06 40 00 – ARCHITECTURAL WOODWORK

SECTION 06 41 00 – ARCHITECTURAL CASEWORK

SECTION 06 41 16 – PLASTIC LAMINATE-CLAD ARCHITECTURAL CABINETS

SECTION 06 64 13 – FIBERGLASS REINFORCED PLASTIC (FRP) PANELING

SECTION 06 10 00 – ROUGH CARPENTRY

PART 1 - GENERAL

1.01 PROVIDE nailers, blocking, backing, and plywood which is generally not exposed to view, as required for completion of the Work, where noted on the Drawings, and as specified herein.

A. All rough carpentry inside the existing building must be fire-retardant treated (FRT)

1.02 LUMBER STANDARD: American. Softwood Lumber Std. PS 20 (U.S. Dept. Comm.), S4S, 19% moisture at time of dressing, except as otherwise indicated.

PART 2 - PRODUCTS

2.01 WOOD BLOCKING for support or attachment of other construction, including rooftop equipment bases and support curbs, blocking, cants, nailers, furring and grounds: provide dimension lumber of Construction, Stud, or No. 2 grade with 19 percent maximum moisture content and of any of the following species:

A. Mixed southern pine; SPIB.
B. Hem-fir or Hem-fir (north); NLGA, WCLIB, or WWPA.
C. Spruce-pine-fir (south) or Spruce-pine-fir; NELMA, NLGA, WCLIB, or WWPA.
D. Eastern softwoods; NELMA.
E. Northern species; NLGA.
F. Western woods; WCLIB or WWPA.

2.02 WOOD FURRING: Provide strips for installing plywood or paneling, select boards with no knots capable of producing bent-over nails and damage to panels.

2.03 ENGINEERED WOOD PRODUCTS

A. WOOD BLOCKING OR BACKING PANELS: For concealed wall backing in drywall partitions (including but not limited to application at grab-bars, wall-mounted cabinets, and wall-mounted door stops), provide APA C-D PLUGGED INT plywood with fire-retardant treatment, 3/4" thick minimum, or 2 x 6 fire-retardant treated lumber.
B. ELECTRICAL / PHONE PANELS: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4 inch thick.

2.04 WOOD-PRESERVATIVE-TREATED MATERIALS

A. PRESERVATIVE TREATMENT BY PRESSURE PROCESS: Comply with AWPA U1, and as follows:

(1) For interior construction not in contact with the ground: Use Category UC2
(2) For exterior construction not in contact with the ground: Use Category UC3b
(3) For items in contact with the ground: Use Category UC4a
(4) For items in contact with the ground in sever climates: Use Category UC4b
(5) For items in contact with the ground in climates with high potential for deterioration: Use Category UC4c
(6) For items in continuous contact with water: Use Category UC5 Marine

B. PRESERVATIVE CHEMICALS: Provide materials acceptable to authorities having jurisdiction and containing no arsenic or chromium.
C. FOR EXPOSED ITEMS PRESERVATIVE ITEMS that are noted to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
D. TREAT ITEMS INDICATED on Drawings, and the following:

(1) Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
(2) Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.
(3) Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
(4) Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
(5) Wood floor plates that are installed over concrete slabs-on-grade.

2.05 FIRE RETARDANT TREATED (FRT) WOOD MATERIALS (typical interior wood blocking except where preservative treated): Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

A. FIRE-RETARDANT-TREATED LUMBER AND PLYWOOD BY PRESSURE PROCESS: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test. Use treatment that does not promote corrosion of metal fasteners.

(1) Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

B. IDENTIFY FIRE-RETARDANT TREATED WOOD with appropriate classification marking of qualified testing agency.

2.06 KILN-DRY WOOD MATERIALS AFTER TREATMENT to a maximum moisture content of 19 percent for lumber and 15 percent for plywood. Do not use material that is warped or does not comply with requirements for untreated material. Mark

each treated item with the treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.

2.07 PROVIDE FASTENERS of size and type indicated and that comply with requirements for material and manufacture.

A. Nails, Brads, and Staples: ASTM F 1667.
B. Power-Driven Fasteners: CABO NER-272.
C. Wood Screws: ASME B18.6.1.
D. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
E. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
F. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153.

PART 3 - EXECUTION

3.01 WOOD SLEEPER, BLOCKING, AND NAILER INSTALLATION:

A. INSTALL WHERE INDICATED and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
B. ATTACH ITEMS TO SUBSTRATES to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build anchor bolts into masonry during installation of masonry work. Where possible, secure anchor bolts to formwork before concrete placement.
C. PROVIDE PERMANENT GROUNDS of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.02 INSTALL PLYWOOD BACKING PANELS by fastening to studs. Coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

3.03 INSTALLATION OF WOOD BLOCKING AT ROOF AREAS: Typically, provide not less than 2 x 6 inch nominal preservative treated wood blocking members at roof and roof edges – spaced when necessary with solid shims or plywood, as appropriate. Connect blocking members in accordance with FM Global's Property Loss Prevention Data Sheet # 1-49 – "Perimeter flashing", and as follows:

A. BLOCKING TO CMU'S: Provide 12 inch long x 3/8 inch diameter (minimum – or as otherwise noted) galvanized steel anchor bolts spaced at 32 inch centers typically, and at 16 inch centers when within eight (8) feet (or 10% of total wall length - whichever is greater) of intersection with other walls. Embed bolt with a galvanized steel nut and washer at bottom into solid-filled cores of the CMU. Stagger bolts to either side of blocking members wider than 6 inches.
B. BLOCKING TO ROOF DECKING: Provide two (2) rows staggered of minimum # 10 galvanized sheet metal screws, with spacing in each row not to exceed 24 inches typically, and at 12 inch centers when within eight (8) feet (or 10% of total wall length – whichever is greater) of intersection with other walls. Penetrate screws into decking with not less than 3 full screw-threads clear, and provide a 5/8 inch diameter galvanized steel washer at top of blocking penetration.
C. BLOCKING TO OTHER BLOCKING: Provide galvanized wood screws with minimum 100 pound withdrawal resistance or lag screws of equivalent strength, in length to penetrate into secured member not less than 1-1/4 inch. Install fasteners in two (2) rows staggered, with spacing in each row not to exceed 24 inches typically, and at 12 inch centers when within eight (8) feet (or 10% of total wall length - whichever is greater) of intersection with other walls.

3.04 PROTECTION

A. PROTECT WOOD THAT HAS BEEN TREATED with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
B. PROTECT ROUGH CARPENTRY from weather. If, despite protection, rough carpentry becomes sufficiently wet that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00

SECTION 06 16 00 – SHEATHING (DENSELEMENT SYSTEM)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work of this section includes coated fiberglass-mat gypsum sheathing board system with integral weather-resistant barrier (WRB) and air barrier (AB) features, and all accessory materials required for covering sheathing joints, fasteners, penetrations, rough openings, and material transitions, for use under exterior wall claddings.
B. Fluid-applied membrane air barrier

1.02 RELATED SECTIONS

A. Section 014000 Quality Requirements; Section 014500 Code-Required Special Inspections and Procedures; coordination with owners' independent testing and inspection agency
B. Section 054000 Cold-Formed Metal Framing
C. Section 061000 Rough Carpentry
D. Section 079200 Joint Sealants; sealant materials and installation techniques
E. Section 092116 Gypsum Board Assemblies
F. Exterior wall claddings

1.03 DEFINITIONS

A. Air Barrier (AB): Air tight barrier made of material that is relatively air impermeable but moisture vapor permeable, with sealed joints and penetrations, and with terminations sealed to adjacent surfaces.
B. Weather-Resistant Barrier (WRB): Water-shedding barrier made of material that is moisture-resistant, installed to shed water, with sealed joints and penetrations, and with terminations sealed to adjacent surfaces.
C. Rough Openings: Openings in the wall to accommodate windows and doors.
D. Material Transitions: Areas where the WRB / AB coated fiberglass-mat gypsum sheathing connects to beams, columns, slabs, parapets, foundation walls, roofing systems, and at the interface of dissimilar materials.

1.04 REFERENCE STANDARDS

A. ASTM C473 Standard Test Method for Physical Testing of Gypsum Panel Products.
B. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
C. ASTM C1280 Standard Specification for Application of Gypsum Sheathing.
D. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
E. ASTM E72 Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
F. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
G. ASTM E119 Standard Test Method for Fire Tests of Building Construction and Materials.
H. ASTM E136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 C.
I. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
J. ASTM E2178 Standard Test Method for Air Permeance of Building Materials.
K. ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
L. ICC ES AC212 Acceptance Criteria for Water-Resistive Coatings Used as Water-Resistive Barriers over Exterior Sheathing.
M. AAMA 714 Voluntary Specification for Liquid Applied Flashing Used to Create a Water Resistive Seal Around Exterior Wall Openings in Buildings.

1.05 SUBMITTALS

A. Submittals: Submit in accordance with Division 1 requirements.
B. Product Data and Installation Instructions: Submit manufacturer's product data including sheathing and accessory material types, composition, descriptions and properties, installation instructions and substrate preparation recommendations.
C. Shop Drawings: Submit shop drawings indicating locations and extent of WRB / AB system, including details of typical conditions, special joint conditions, intersections with other building envelope systems and materials; counter flashings and details showing bridging of envelope at substrate changes, details of sealing penetrations, and detailed flashing around windows and doors
D. Test Reports: Submit test reports indicating compliance with specified performance characteristics and requirements
E. Sample warranty: Submit a sample warranty identifying the terms and conditions of the warranty as herein specified.
F. Evaluation reports: Accredited laboratory testing for materials

1.06 WARRANTY

A. Provide manufacturer's standard warranty against in-place exposure damage (delamination, deterioration) for 12 (twelve) months of exposure to normal weather conditions beginning with the date of installation of the product.
B. Provide manufacturer's standard warranty for sheathing to be free of manufacturing defects that make it unsuitable for its intended use. Warranty period shall be Ten (10) years from the date of purchase of the product.
C. Provide manufacturer's standard warranty for use as a drainage plane when the cladding systems are properly designed and installed, with a warranty period of 10 years from the date of purchase of the product or, when used as a substrate in architecturally specified drainage EIFS, 12 years from the date of purchase of the product.
D. Material Warranty: Provide material manufacturer's standard product warranty, for a minimum three (3) years from date of Substantial Completion.

1.07 QUALITY ASSURANCE- MOCK UP

A. Install WRB / AB sheathing with sealed joints and penetrations in mock-up as specified in Section 014339 Mock-Ups.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store WRB / AB coated fiberglass mat gypsum sheathing under cover and keep dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack sheathing flat and supported on risers on a flat platform to prevent sagging.
B. Protect fluid applied material, primers and accessory materials from damage, weather, excessive temperatures and construction traffic.
C. Store fluid applied material and primers at temperatures of 40 degrees F or above.
D. Apply fluid applied material to clean surfaces free of contaminants. Chemical residues, surface coatings or films may adversely affect adhesion. Pressure-treated wood and other contaminated surfaces should be cleaned with a solvent wipe before application.

1.09 FIELD CONDITIONS

A. Application standards where applicable are in accordance with Gypsum Association Publication GA-253 for gypsum sheathing and ASTM C1280.
B. Do not install sheathing that is moisture damaged. Indications that panels are moisture damaged include, but not limited to, discoloration, sagging, or irregular shape.
C. Allow installed sheathing to be dry to the touch before sealing joints, penetrations, rough openings, and material transitions.
D. Do not attempt to seal joints, corners, penetrations, rough openings, and material transitions when installed sheathing surface is frozen or has frost on the surface.
E. Do not apply sealing materials to sheathing when air or surface temperature is below 25F for fluid applied materials.
F. Sequencing. Do not install air barrier material before the roof assembly has been sufficiently installed to prevent a buildup of water in the interior of the building.
G. Compatibility. Do not allow air barrier materials to come in contact with chemically incompatible materials.
H. Ultra-violet exposure. Do not expose air barrier materials to sunlight longer than as recommended by the material manufacturer.

PART 2 - PRODUCTS

2.01 WEATHER BARRIER ASSEMBLIES

A. Acceptable products: DensElement Barrier System as manufactured by Georgia-Pacific Gypsum LLC.
   (1) Sheathing: DensElement Sheathing.
   (2) Fluid-applied flashing materials: Fluid-applied flashing as approved by Georgia-Pacific Gypsum LLC.
   (3) Primers, backer rods and accessory materials: As approved by Georgia-Pacific Gypsum LLC.
B. System Description: Weather-Resistant Barrier and Air Barrier assembly installed at exterior stud walls under exterior cladding, consisting of the following components as herein specified:
   (1) Sheathing: WRB / AB coated fiberglass mat gypsum sheathing.
   (2) Fluid-applied flashing to seal sheathing joints, inside and outside corners, penetrations, rough openings, and material transitions.
   (3) Backer rods and accessory materials.

2.02 WEATHER-RESISTANT BARRIER (WRB) AND AIR BARRIER (AB) GYPSUM SHEATHING

A. Description: Coated fiberglass mat gypsum sheathing with integral weather-resistant barrier (WRB) and air barrier (AB) complying with applicable requirements of ICC-ES AC212, ASTM E2178, ASTM E2357.
B. Vapor Permeability: When tested as system in accordance with ASTM E96
   (1) (water method) the WRB and AB system has a minimum vapor permeance of 20 perms with sealed joints and fasteners.
C. The WRB and Air Barrier Gypsum Sheathing has a moisture absorption rate < 6%
D. Air Barrier performance requirements:
   (1) Air permeance of sheathing: Sheathing with an air permeability not greater than 0.001 cfm/ft2 (0.02L/s/m2) when tested in accordance with ASTM E2178.
   (2) Air permeance of assembly: Assembly of sheathing and sealing components with an average air leakage not greater than 0.04 cfm/ft2 (0.2L/s/m2) when tested in accordance with ASTM E2357.

2.03 FLUID-APPLIED FLASHING AND ACCESSORY MATERIALS FOR JOINTS, INSIDE AND OUTSIDE CORNERS, FASTENERS, ROUGH OPENINGS, AND MATERIAL TRANSITIONS

A. Substrate requirements:
   (1) Sheathing panels should be trimmed to obtain neat fitting joints.
   (2) Gaps that are more than 1/4” and less than 1” shall be filled with a backer rod to support the fluid applied flashing at the transition joint.
   (3) For gaps larger than 1" use transition membrane flashing as approved by Georgia-Pacific Gypsum LLC.
B. Fluid applied flashing for panel joints, inside and outside corners, and penetrations
   (1) Description: STP-based fluid applied flashing.
   (2) Properties:
      (a) Acceptable substrate: Georgia-Pacific Gypsum LLC DensElement Sheathing.
      (b) Adhesion to fiberglass mat faced sheathing: No delamination from face of sheathing.
      (c) Applied wet film thickness: 16 mils.

(d) Air permeance: meets 0.004 cubic feet per minute per square foot (0.02L/s/sq m), maximum, when tested in accordance with ASTM E2178.
(e) Water vapor permeance: >10 perms (287 ng/(Pa s sq m)), minimum, when tested in accordance with ASTM E96/E96M.
(f) Ultraviolet and weathering resistance: Approved for 12 months weather exposure.
(g) Comply with applicable requirements of AAMA 714

(3) Primer: Provide primer in accordance with air barrier manufacturer's written instructions for exposed gypsum core edges.

C. Fluid applied flashing for sealing fasteners:

(1) Description: STP-based fluid applied flashing.
(2) Properties:

(a) Acceptable substrate: Georgia-Pacific Gypsum LLC DensElement Sheathing.
(b) Adhesion to fiberglass mat faced sheathing: No delamination from face of sheathing.
(c) Applied wet film thickness: 16 mils.
(d) Air permeance: meets 0.004 cubic feet per minute per square foot (0.02 L/s/sq m), maximum, when tested in accordance with ASTM E2178.
(e) Water vapor permeance: >10 perms (287 ng/(Pa s sq m)), minimum, when tested in accordance with ASTM E96/E96M.
(f) Ultraviolet and weathering resistance: Approved for 12 months weather exposure.
(g) Comply with applicable requirements of AAMA 714.

D. Fluid applied flashing for sealing rough openings

(1) Fluid applied flashing: STP-based fluid applied flashing.
(2) Primer: Liquid primer in accordance with air barrier manufacturer's written instructions for exposed gypsum core edges. Apply primer to raw gypsum board edges by brushing on a thin, uniform coat.
(3) Properties:

(a) Acceptable substrate: Georgia-Pacific Gypsum LLC DensElement Sheathing.
(b) Flashing adhesion to fiberglass mat faced sheathing: No delamination from face of sheathing.
(c) Applied wet film thickness: 16 mils.
(d) Flashing air permeance: meets 0.004 cubic feet per minute per square foot (0.02 L/s/sq m), maximum, when tested in accordance with ASTM E2178.
(e) Flashing water vapor permeance: >10 perms (287 ng/(Pa s sq m)), minimum, when tested in accordance with ASTM E96/E96M.
(f) Ultraviolet and weathering resistance: Approved for 12 months weather exposure.
(g) Flashing comply with applicable requirements of AAMA 714.

E. Material transitions using fluid applied flashing:

(1) Refer to substrate requirements for treatment of gaps as specified herein. Gaps that are more than 1/4” and less than 1” shall be filled with a backer rod to support the fluid applied flashing at the transition joint. For gaps larger than 1" use transition membrane flashing as approved by Georgia-Pacific Gypsum LLC
(2) Fluid applied flashing for material transitions:
(3) Properties:

(a) Acceptable substrate: Georgia-Pacific Gypsum LLC DensElement Sheathing.
(b) Adhesion to fiberglass mat faced sheathing: No delamination from face of sheathing.
(c) Applied wet film thickness: 16 mils
(d) Air permeance: 0.004 cubic feet per minute per square foot (0.02L/s/sq m), maximum, when tested in accordance with ASTM E2178
(e) Water vapor permeance: >10 perms (287 ng/(Pa s sq m)), minimum, when tested in accordance with ASTM E96/E96M
(f) Ultraviolet and weathering resistance: Approved for 12 months weather exposure
(g) Comply with applicable requirements of AAMA 714

PART 3 - EXECUTION

3.01 PREPARATION

A. Remove projections, protruding fasteners, loose or damaged sheathing material at edges of panel that might interfere with proper installation to seal joints, corners, fasteners, penetrations, openings, or material transitions.
B. Wipe down the sheathing surface to receive sealing materials with a clean cloth.
C. Ensure field conditions are met as outlined in Part 1 – General Requirements.

3.02 INSTALLATION OF WEATHER-RESISTANT BARRIER (WRB) AND AIR BARRIER (AB) SHEATHING

A. WRB / AB Coated fiberglass mat sheathing:

(1) Install and fasten DensElement Sheathing according to manufacturer’s detailed installation instructions
(2) Fastener and penetration treatment: Treat all sheathing fasteners with specified fluid applied flashing used for sealing joints.

3.03 FLUID APPLIED FLASHING FOR SEALING SHEATHING JOINTS, INSIDE AND OUTSIDE CORNERS, FASTENERS, ROUGH OPENINGS, AND MATERIAL TRANSITIONS

A. Sealing DensElement Sheathing Joints using specified Fluid Applied Flashing

(1) Apply fluid applied flashing over the joint in a zigzag or ribbon pattern. Cover a minimum of 1” on both sides of the joint.
(2) With a straight edge tool, spread evenly over the sheathing joint.
(3) Apply at a rate to achieve a minimum wet mil thickness of 16 mils over the entire joint area.

B. Sealing DensElement Sheathing Vertical Corners using specified Fluid Applied Flashing

(1) Apply fluid applied flashing over the inside and/or outside corner in a zigzag or ribbon pattern. Cover a minimum of 2” on both sides of the corner.
(2) With a straight edge tool, spread evenly over the sheathing corner.
(3) Apply at a rate to achieve a minimum wet mil thickness of 16 mils over the corner area.

C. Sealing DensElement Sheathing Fasteners using specified Fluid Applied Flashing: Apply the fluid applied flashing material to fasteners and wipe down with a straight edge tool; provide a minimum 16 mil thick coating over the fastener.

D. Sealing DensElement Sheathing Rough Openings using specified Fluid Applied Flashing

(1) Apply a bead of DensDefy™ Liquid Flashing into all inside corners of the opening.
(2) Apply DensDefy™ Liquid Flashing in the opening sill, jamb and header in a zig-zag or ribbon pattern.
(3) Apply DensDefy™ Liquid Flashing over the DensElement Sheathing adjacent to the opening sill, jamb and header in a zig-zag or ribbon pattern.
(4) Use a straight edge tool to spread the DensDefy™ Liquid Flashing to a pinhole void free application achieving a minimum 16 wet mils
(5) Spread the DensDefy™ Liquid Flashing a minimum of 2” into the rough opening and a minimum 1” past the interior air seal of the window unit. Refer to the project details and specifications to determine window placement and minimum requirement for rough opening treatment.
(6) Ensure a minimum 2” of DensDefy™ Liquid Flashing is applied onto the sheathing surface adjacent to the opening.

E. Sealing DensElement sheathing material transitions using specified Fluid Applied Flashing

(1) Sheathing joint and transition gaps to receive fluid-applied flashing shall be less than 1/4" (6.4 mm).
(2) For gaps larger than 1/4" use shall be sealed with fluid-applied flashing as approved by Georgia-Pacific Gypsum, LLC
(3) Gaps that are more than 1/4” and less than 1” shall be filled with a backer rod to support the fluid applied flashing at the transition joint.
(4) If necessary, prime the adjacent material with primer per the material manufacturer’s recommendations.
(5) Apply fluid applied flashing over the sheathing and adjacent material in a zigzag or ribbon pattern. Ensure the flashing is a minimum of 2” on each substrate material surface.
(6) With a straight edge tool, spread fluid applied flashing over material transition joint.
(7) Apply at a rate to achieve a minimum wet mil thickness of 16 mils.

3.04 SEALING EXTERIOR WALL PENETRATIONS

A. Exterior wall penetration shall be sealed to prevent air and water infiltration. Penetrations may be sealed with fluid applied flashing.
B. For round or square pipe/duct penetrations use specified fluid applied flashing, refer to DensElement Barrier System Technical Guide for instructions for proper sealing.

3.05 FIELD QUALITY CONTROL

A. Do not cover installed WRB / AB assembly until required inspections have been completed and installation has been accepted.
B. Where applicable, allow for owner’s inspection and air barrier testing and reporting.

3.06 PROTECTION

A. Protect WRB / AB assembly from damage during installation and during the construction period.

END OF SECTION 06 16 00

SECTION 06 40 00 – ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide Architectural woodwork requiring quality, expert craftsmanship and joinery skills, where indicated on the Drawings, as specified herein, and as necessary for complete installation. This Section includes:

A. Exterior Architectural Woodwork and finish carpentry
B. Interior Architectural Woodwork and finish carpentry, including:
   1. Interior trim, including non-fire-rated interior door frames.
   2. Interior wood door frames.
   3. Shelving and clothes rods.
   4. Interior stairs and railings.

1.02 PRIMING & FINISHING: Note that all interior and exterior woodwork must be sealed on all surfaces before installation - including the back-or mounting side, the joining edges, and at all field-cut ends, without exception. Refer to Division-09 “Painting” Section for materials and application of shop and/or field applied finishes.

1.03 RELATED SECTIONS:

A. Section 018113 – Product Reporting Form
B. Division-06 “Rough Carpentry” for furring, blocking, backing panels and other carpentry work not exposed to view and for framing exposed to view.
C. Division-09 “Painting” Section for priming and back priming of Architectural Woodwork.

1.04 DEFINITIONS

A. MDF: Medium-density fiberboard.
B. MDO: Plywood with a medium-density overlay on the face.

1.05 LEED PERFORMANCE REQURIEMENTS

A. Provide products that meets meet one of the following requirements: EPA TSCA Title VI for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins, California Air Resources Board (CARB) ATCM for formaldehyde requirements for ultra-low emitting formaldehyde (ULEF) resins, EPA TSCA Title VI formaldehyde requirements for no added formaldehyde resins (NAF), or CARB ATCM formaldehyde requirements for no added formaldehyde resin (NAF).
B. Provide documentation for all wood showing that it is SFI, FSC, ATES, CSA, or PERC Certified. For FSC Certified wood: Lumber and plywood shall be certified as "FSC Pure" or "FSC Mixed Credit" according to Standard for Chain of Custody Certification.
C. VOC Emissions Evaluation: For adhesives and sealants, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers’ or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
D. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the VOC limits, as per the applicable SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.06 STRUCTURAL PERFORMANCE OF WOOD GUARD RAILINGS & HANDRAILS: Provide guards and handrails capable of withstanding the following loads without exceeding the allowable design working stress of materials involved:

A. Top Rail of Guards: Concentrated load of 200 lbf applied at any point and in any direction, and a uniform load of 50 lbf/ft. applied horizontally and concurrently with uniform load of 100 lbf/ft. applied vertically downward. Concentrated and uniform loads need not be assumed to act concurrently.
B. Handrails Not Serving as Top Rails: Concentrated load of 200 lbf applied at any point and in any direction, and a uniform load of 50 LBS/FT. applied in any direction. Concentrated and uniform loads need not be assumed to act concurrently.
C. Infill Area of Guards: Horizontal concentrated load of 200 lbf applied to 1 sq. ft at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area. Load on infill area need not be assumed to act concurrently with loads on top rails.

1.07 SUBMITTALS

A. LEED SUBMITTAL REQURIEMENTS:
   1. COMPLETE PROVIDED PRODUCT DATA REPORTING FORM IN SPEC SECTION 01 81 13 AND PROVIDE THE FOLLOWING:
   2. PROVIDE THIRD-PARTY CERTIFICATE CONFIRMING PRODUCTS MEET ONE OF THE FOLLOWING REQUIREMENTS: EPA TSCA TITLE VI FOR FORMALDEHYDE REQUIREMENTS FOR ULTRA-LOW-EMITTING FORMALDEHYDE (ULEF) RESINS, CALIFORNIA AIR RESOURCES BOARD (CARB) ATCM FOR FORMALDEHYDE REQUIREMENTS FOR ULTRA-LOW EMITTING FORMALDEHYDE (ULEF) RESINS, EPA TSCA TITLE VI FORMALDEHYDE REQUIREMENTS FOR NO ADDED FORMALDEHYDE RESINS (NAF), OR CARB ATCM FORMALDEHYDE REQUIREMENTS FOR NO ADDED FORMALDEHYDE RESIN (NAF). NOTE

MANUFACTURER'S CLAIMS FOR MEETING ABOVE-MENTIONED REQUIREMENTS DO NOT MEET LEED STANDARDS.

3. PROVIDE DOCUMENTATION FOR ALL WOOD SHOWING THAT IT IS SFI, FSC, ATES, CSA, OR PERC CERTIFIED. FOR FSC CERTIFIED WOOD: LUMBER AND PLYWOOD SHALL BE CERTIFIED AS "FSC PURE" OR "FSC MIXED CREDIT" ACCORDING TO FSC STD-01-001 , "FSC PRINCIPLES AND CRITERIA FOR FOREST STEWARDSHEIP," AND TO FSC STD-40-004, "FSC STANDARD FOR CHAIN OF CUSTODY CERTIFICATION."
4. VOC EMISSIONS EVALUATION: PROVIDE DOCUMENTATION THAT PRODUCT COMPLIES WITH ONE OF THE FOLLOWING: SCS INDOOR ADVANTAGE GOLD, FLOORSCORE, MAS CERTIFIED GREEN, UL GREENGUARD GOLD OR CRI GREEN LABEL PLUS. THE THIRD-PARTY CERTIFICATION MUST STATE THE EXPOSURE SCENARIO USED TO DETERMINE COMPLIANCE. CLAIMS OF COMPLIANCE FOR WET-APPLIED PRODUCTS MUST STATE THE AMOUNT APPLIED IN MASS PER SURFACE AREA. THE CLAIMS OF COMPLIANCE MUST ALSO STATE THE RANGE OF TOTAL VOCS AFTER 14 DAYS, MEASURED AS SPECIFIED IN CDPH STANDARD METHOD V1.1 OR CDPH STANDARD METHOD V1.2-2017.
5. VOC CONTENT REQUIREMENTS FOR WET-APPLIED PRODUCTS: PROVIDE MSDS OR MANUFACTURERS CUTSHEET SHOWING VOC REQUIREMENTS TESTING AND COMPLIANT ACCORDING TO SCAQMD RULE 1168, OCTOBER 6, 2017, OR CANADIAN VOC CONCENTRATION LIMITS FOR ARCHITECTURAL COATINGS (SOR/2009-264) OR THE CARB 2007 SCM FOR ARCHITECTURAL COATINGS, SCAQMD RULE 1113, FEBRUARY 5, 2016, OR EUROPEAN DECOPAINT DIRECTIVE (2004/42/EC). IF A PRODUCT CANNOT BE REASONABLY BE TESTED AS SPECIFIED ABOVE, TESTING OF VOC CONTENT MUST COMPLY WITH ASTM D2369-10; ISO 11890, PART 1; ASTM D6886-03; OR ISO 11890-2. METHYLENE CHLORIDE AND PERCHLOROETHYLENE MAY NOT BE INTENTIONALLY ADDED IN PAINTS, COATINGS, ADHESIVES, OR SEALANT

B. PRODUCT DATA: For each type of product and process specified and incorporated into items of Architectural woodwork during fabrication, finishing, and installation.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

C. SHOP DRAWINGS: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components. Show details full size. Show locations and sizes of blocking and nailers, including concealed blocking and reinforcement specified in other Sections.

D. LIST OF MOCKUP MATERIALS: List generic product names together with manufacturers, manufacturers' product names, model numbers, and other information as required to identify materials used. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents, unless such deviations are specifically brought to the attention of the Architect and approved in writing.

E. SAMPLES FOR VERIFICATION: Submit full-size units or Samples of sizes indicated, prepared from the same material to be used for the Work, with shop-applied transparent finish, that show full range of color and texture variations expected for the following:
   1. (WD-__) Hardwood with Transparent Finish. Submit set of at least three units exhibiting approximate limits of variations in color, pattern, texture, or other characteristics inherent in material or product. Apply finish to all faces and edges.
      a. Solid Hardwood with 3" wide by 12" long
      b. Hardwood Veneer: 12" by 12", representative of and selected from actual flitches to be usd for Project.
   2. (WD FAB-__) Hardwood Veneered Paneling with Transparent Finish: 24 inches by 24 inches with veneers representative of and selected from actual flitches to be used for Project. Include at least one face-veneer seam and finish as specified.
   3. (WDB) Wood Wall Bases: 3 inch long segments for each base type.
   4. Other Wood and Surfacing Samples: Submit 4 by 4 inch sample for each type, color and finish, with one edge treatment or profile as specified.
      a. (WD-5) Woodwork with Opaque Finish
      b. (PLAM) Plastic Laminates
      c. (SSF) Solid Surfacing

F. PRODUCT CERTIFICATES: Signed by manufacturers of woodwork certifying that products furnished comply with requirements.

1.08 QUALITY STANDARD COMPLIANCE CERTIFICATES: AWI Quality Certification Program certificates

A. QUALIFICATION DATA: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.09 QUALITY ASSURANCE

A. SOURCE LIMITATIONS FOR FABRICATION AND INSTALLATION: Engage a qualified woodworking firm to assume undivided responsibility for fabricating and installing woodwork specified in this Section.

B. QUALITY STANDARD: Comply with AWI's "Architectural Woodwork Quality Standards" for grades of architectural woodwork, construction, finishes, and other requirements as applicable to the Work.

C. MOCKUP: Provide materials for construction of a field mockup of each different woodwork material and color indicated, showing the full range of exposed textures, and dimensions to be expected in the completed construction.

1. BEFORE INSTALLING ARCHITECTURAL WOODWORK, build mockup to verify selections made under sample Submittals and to demonstrate aesthetic effects. Refer to Division-01 for general requirements of Mockup.

1.10 DELIVERY, STORAGE, AND HANDLING: Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.11 PROJECT CONDITIONS

A. DO NOT INSTALL ARCHITECTURAL WOODWORK MATERIALS THAT ARE WET, MOISTURE DAMAGED, OR MOLD DAMAGED. INDICATIONS THAT MATERIALS ARE WET OR MOISTURE DAMAGED INCLUDE, BUT ARE NOT LIMITED TO, DISCOLORATION, SAGGING, OR IRREGULAR SHAPE. INDICATIONS THAT MATERIALS ARE MOLD DAMAGED INCLUDE, BUT ARE NOT LIMITED TO, FUZZY OR SPLOTCHY SURFACE CONTAMINATION AND DISCOLORATION.

B. WEATHER LIMITATIONS: Proceed with installation of exterior woodwork only when existing and forecasted weather conditions permit work to be performed and at least one coat of specified finish to be applied without exposure to rain, snow, or dampness.

C. ENVIRONMENTAL LIMITATIONS: Do not deliver or install interior woodwork materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

D. FIELD MEASUREMENTS: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

1. Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

E. COORDINATE sizes and locations of framing, blocking, reinforcements, and other related units of Work specified in other Sections to ensure that exterior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.01 LUMBER: FACTORY MARK EACH PIECE OF LUMBER WITH GRADE STAMP OF APPLICABLE INSPECTION AGENCY INDICATING GRADE, SPECIES, MOISTURE CONTENT AT TIME OF SURFACING, AND MILL. FOR EXPOSED LUMBER, MARK GRADE STAMP ON END OR BACK OF EACH PIECE OR OMIT GRADE STAMP AND PROVIDE CERTIFICATES OF GRADE COMPLIANCE ISSUED BY INSPECTION AGENCY. Comply with DOC PS 20 typically, and the following grading rules:

A. NeLMA: Northeastern Lumber Manufacturers' Association, "Standard Grading Rules for Northeastern Lumber."
B. NHLA: National Hardwood Lumber Association, "Rules for the Measurement and Inspection of Hardwood & Cypress."
C. NLGA: National Lumber Grades Authority, "Standard Grading Rules for Canadian Lumber."
D. SPIB: The Southern Pine Inspection Bureau, "Standard Grading Rules for Southern Pine Lumber."
E. WCLIB: West Coast Lumber Inspection Bureau, Standard No. 17, "Grading Rules for West CoastLumber."
F. WWPA: Western Wood Products Association, "Western Lumber Grading Rules."

2.02 WOOD GRADING & APPEARANCE REQUIREMENTS: Natural characteristics are acceptable, but face knots and knot holes, chipped edge knots, short end splits, stains, and planer burns are not acceptable, even if permitted by referenced standards.

2.03 FABRICATED WOODWORK MATERIALS: Provide units that comply with requirements of the referenced AWI quality standard for each type of woodwork/quality grade indicated and with requirements of the following referenced standards:

A. SOFTWOOD PLYWOOD: DOC PS 1.
B. HARDBOARD: AHA A135.4.
C. MDF: ANSI A208.2, Grade 130 made with binder containing no urea-formaldehyde resin.
D. PARTICLEBOARD (PBD): ANSI A208.1, Grade M-2, made with binder containing no urea-formaldehyde resin.
E. PREFINISHED (MELAMINE-FACED) PARTICLEBOARD: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10. Provide in color indicated on the Drawings, or if not indicated: White.
F. HARDWOOD PLYWOOD AND FACE VENEERS: HPVA HP-1.
G. EXTERIOR APPLICATIONS:

1. EXTERIOR SOFTWOOD PLYWOOD: DOC PS 1, - Marine grade - Exterior type.
2. EXTERIOR MDO PLYWOOD: Exterior softwood plywood with MDO surface both sides

3. EXTERIOR MDF PANEL: “Extira” (www.extira.com) moisture, rot and termite resistant wood panel with phenolic resins and zinc borate, and with 5-year warranty, in size and thickness as indicated on the Drawings, for field-painted opaque finish.

2.04 EXTERIOR TRIM FOR OPAQUE FINISH: Provide engineered exterior trim units in width(s) as indicated in the Drawings, in maximum lengths available to minimize field joints and splices, and as manufactured by one of the following:

A. Thickness: 3/4 inch (4/4) or 1.0 inch (5/4) inch thick trim boards in size indicated on the Drawings
B. Finish Surface Texture: Smooth
C. CEMENT FIBER TRIM: Acceptable Manufacturers:
   1. “HardieTrim”, www.jameshardie.com
   2. Color: Primed for field-painting
   3. Color: As selected by Architect from manufacturer’s full range of available pre-finished color options
D. CELLULAR PVC for field-finishing - Acceptable Manufacturers:
   1. “Azek Trimboards”, www.azek.com
   2. “Fypon Cellular PVC Trim”, www.fypon.com
   3. “Kleer” by Kleer Products, www.kleerlumber.com
   4. “Koma Trim” by Kommerling USA, www.komatrimboards.com
   5. “Versatex Trimboards” by Wolfpac Technologies, www.versatex.com

2.05 WOOD SPECIES AND CUT FOR NATURAL (TRANSPARENT) FINISHED WOODWORK: Refer to the Drawings – provide smooth surfaced finish typically on all sides unless otherwise noted to be “rough” or “textured” on the exposed face surface.

2.06 WOOD SPECIES AND CUT FOR NATURAL (TRANSPARENT) FINISH (except as otherwise indicated):

A. REFER TO FINISH SCHEDULE.

2.07 PRESERVATIVE TREATED WOOD: Pressure treat per AWPA U1; Use Category UC2. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 18 percent respectively. Use preservative chemicals acceptable to AHJ representatives and that contain no arsenic or chromium. For exposed, exterior items to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes. Mark lumber or plywood with treatment-quality mark of an inspection agency acceptable to the AHJ and approved by the American Lumber Standard Committee's Board of Review. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.

A. Application: Exterior Architectural woodwork without inherent insect or weather decay resistance

2.08 FIRE-RETARDANT-TREATED LUMBER AND PLYWOOD: Pressure process to provide a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent respectively. Do not use material that does not comply with requirements for untreated material or is warped or discolored. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to AHJ representatives. For exposed lumber or plywood indicated to receive a stained or natural finish, mark end or back of each piece.

A. Application: Concealed wood within non-combustible buildings – not required for exposed woodwork finishes, or in combustible building construction type (Interior of Construciton Type III, or Type V Buildings).

2.09 STANDING AND RUNNING TRIM:

A. NATURAL-FINISHED WOOD TRIM: Comply with AWI Section 300, Custom grade. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work. Assemble casings in plant except where shipping limitations require field assembly.

2.10 EXTERIOR HORIZONTAL WOOD SCREENING for natural, transparent finish:

A. WOOD SPECIES & GRADE: Western Red Cedar - Select grade per NLGA 204a or WCLIB 111-e, kiln-dried
B. PATTERN: Spaced, rectangular 2 x 6 nominal (1-1/2 x 5-1/2 inch) boards with eased edges, maximum length feasible
C. SURFACE FINISH: smooth, sawn exposed face all sides (S4S)

2.11 PAINTED (OPAQUE) FINISHED INTERIOR WOOD TRIM:

A. SPECIES: Yellow Poplar, or other closed-grain hardwood, including alder, aspen, basswood, cottonwood, gum, magnolia, soft maple, sycamore, or tupelo.
B. Grade: NHLA
C. MAXIMUM MOISTURE CONTENT: 15 percent
D. Finger Jointing: Not allowed.
E. Face Surface: Surfaced (smooth)

2.12 PAINTED (OPAQUE) FINISHED INTERIOR WOODWORK MOLDINGS: Provide units of hardwood as indicated above for wood trim, but with maximum moisture content of 9 percent, and in profile / pattern as indicated on the Drawings, typically in compliance with WMMPA WM 12 standard profiles, and as follows:

A. (WD-5) Wood Base: **REFER TO FINISH SCHEDULE**

2.13 HIGH-GLOSS PAINTED (AUTOMOTIVE-LIKE) INTERIOR WOODWORK FINISH: Water-proof MDF equal to “Medex” by Roseburg

2.14 SHELVING AND CLOSET WOODWORK & COMPONENTS:

A. EXPOSED OR CLOSET SHELVING: fabricate from one of the following – in 3/4 inch minimum thickness:

1. Closet shelf: 3/4 inch thick prefinished white Melamine-faced particleboard (both sides) with applied PVC edges
2. Particleboard with solid-hardwood front edge (particleboard to be painted both sides).
3. MDF or MDO softwood plywood with solid-wood front edge (MDF or MDO to be painted both sides).
4. Wood boards complying with painted finished interior wood trim requirements above.

B. WOOD SHELF CLEATS: 3/4-by-3-1/2-inch boards as indicated above for shelving hardwood lumber trim for opaque finish to match adjacent wall color.

C. SHELF BRACKETS WITHOUT ROD SUPPORTS: BHMA A156.16, B04041; powder-coat-finished formed steel.

D. STANDARDS FOR ADJUSTABLE SHELF BRACKETS: BHMA A156.9, B04102; powder-coat-finished steel.

E. ADJUSTABLE SHELF BRACKETS: BHMA A156.9, B04112; powder-coat-finished steel.

F. STANDARDS FOR ADJUSTABLE SHELF SUPPORTS: BHMA A156.9, B04071; powder-coat-finished steel.

G. ADJUSTABLE SHELF SUPPORTS: BHMA A156.9, B04081 or B04091; powder-coat-finished steel.

H. CLOTHES RODS: 1-5/16-inch diameter, chrome-plated-steel tubes.

I. ROD FLANGES: Chrome-plated steel.

2.15 WOOD STAIRS:

A. CLT Stringer, Treads and Riser supports Designed by Structural Engineer. Refer to Structural Drawings.

B. HARDWOOD TREADS: As indicated on Drawings with WD-1 Finish.

C. RISERS: As indicated on drawings with WD-1 Finish.

D. HARDWOOD RAILINGS: Provide units in pattern or profile indicated on the Drawings, in clear, kiln-dried hardwood with steel spine shapes.

2.16 MISCELLANEOUS WOODWORK MATERIALS

A. EXTERIOR NAILS OR SCREWS: Type 304 stainless steel

1. At metal framing supports, provide self-drilling screws as recommended by metal-framing manufacturer.

B. ANCHORS: Select material, type, size, and finish required for each substrate for secure anchorage, penetrating a minimum of 1-1/4 inch into wood substrate materials. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors. Power nailing systems are permitted using fasteners with equal or greater performance characteristics (including but not limited to withdrawal and bending strength and corrosion resistance) of typical nails.

C. FLUSH Z-CLIP OR CONCEALED PANEL MOUNTS: 1.875 inch high metal units each with minimum two (2) each compatible fasteners, designed to engage matching reversed units when concealed behind panels. Select units and fasteners per substrate and materials to be connected, with minimum two (2) clips per panel, with a holding capability of not less than five (5) times calculated loads:

1. Basis-of-Design Manufacturer: Monarch Metal Fabrication, or equal:
2. Interior 3/16 inch deep Aluminum: Monarch # MF-625 w/ 5/8 inch lift-off – min. clip size of 1.5 inch wide
3. Interior 1/4 inch deep Aluminum: Monarch # MF-375 w/ 3/8 inch lift-off – min. clip size of 2.0 inch wide
4. Exterior 1/4 inch deep stainless-steel: Monarch # MFSS w/ 3/4 inch lift-off – min. clip size of 1.5 inch wide

D. FASTENERS FOR EXTERIOR WOOD DECKING: Type 305 stainless-steel deck screws with painted head color to match installed, finish color of decking.

E. FASTENERS FOR INTERIOR FINISH CARPENTRY: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

F. GLUE: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use. Wood glue shall have a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. PANELING ADHESIVE: Comply with paneling manufacturer's written recommendations for adhesives. Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. MULTIPURPOSE CONSTRUCTION ADHESIVE: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer. Adhesive shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.17 FABRICATION, GENERAL: Provide and maintain units with 7 to 12 percent moisture content typically. Comply with AWI Section 300, Custom grade except as otherwise indicated, or other AWI requirements as applicable:

A. Fabricate woodwork to dimensions, profiles, and details indicated.

B. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except at ends exposed in finished work.

C. At exterior trim members, provide a minimum 10 degree positive slope (100 degree from vertical) on horizontal surfaces to provide positive drainage and to prevent moisture accumulation on trim members.

D. At transparent finished frames or jambs wider than available lumber, use veneered construction - do not glue units for required width.

E. Ease edges of lumber less than 1 inch in nominal thickness to 1/16-inch radius and edges of lumber 1 inch or more in nominal thickness to 1/8-inch radius.

F. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation.

G. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

2.18 FABRICATION OF NATURAL-FINISHED WOOD PANELING & WAINSCOTS: Comply with AWI Section 500- Custom Grade requirements, with solid-wood lumber trimmed edges:

A. Matching of Adjacent Veneer Leaves: Book match.
B. Vertical Matching of Adjacent Veneer Leaves: End match.
C. Veneer Matching within Panel Face: Center match.
D. Panel-Matching Method: Match panels within each separate area using pre-manufactured sets used full width

2.19 HARDWOOD SHELVES: 3/4 inch thick hardwood veneered plywood (both sides), with an exposed, 1-1/2 inch high hardwood edge trim on the exposed face.

2.20 PLAM / HDWD EDGED SHELVES: 3/4 inch thick thermoset decorative panel exposed to bottom surface with NEMA LD-3 grade high-pressure plastic laminate (PLAM) finish on top surface, and with 3/4 x 1-1/2 inch high hardwood face trim.

2.21 PLAM SHELVES: 3/4 inch thick thermoset decorative panel exposed to bottom surface with NEMA LD-3 grade high-pressure plastic laminate (PLAM) finish on top surface – self-edged with 3-mil PVC tape matching PLAM.

2.22 SHOP PRIMING

A. WOODWORK FOR TRANSPARENT FINISH: Shop seal woodwork for transparent finish with stain (if required), other required pretreatments, and first coat of finish as specified in Division-09 Section "Painting."
B. PREPARATIONS FOR FINISHING: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
C. BACKPRIMING: Apply one coat of sealer or primer, compatible with finish coats, to all concealed surfaces of woodwork.

PART 3 - EXECUTION

3.01 EXAMINE SUBSTRATES with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION: Condition woodwork to average prevailing humidity conditions in installation areas before installation. Deliver concrete inserts and similar anchoring devices to be built into substrates well in advance of time substrates are to be built. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.03 INSTALL WOODWORK TRUE AND STRAIGHT with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.

3.04 DISCARD units of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned or too small to fabricate work with minimum of joints or optimum jointing arrangements, or which are of defective manufacturer with respect to surfaces, sizes or patterns.

3.05 CONDITION INTERIOR WOODWORK to average prevailing humidity conditions in installation areas before installation.

3.06 INSTALL STANDING AND RUNNING TRIM with minimum number of joints possible, using full- length pieces to the greatest extent possible. Do not use pieces less than 24 inches long, except where necessary. Cut into the exposed face of the trim-board material. Do not route-out over 5/16 inch of trim material unless otherwise indicated. Locate all joints over a solid framing member, and double-nail each side of joint. Stagger joints in adjacent and related members. Cope at returns, miter at corners, and use scarf joints for end to end joints, to provide tight fitting joints with full surface contact throughout length of joint. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.

A. Install trim after gypsum-board joint finishing operations are completed.
B. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting.
C. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

3.07 DO NOT APPLY EXTERIOR WOOD TRIM over wet sheathing, or closer than 6 inches from finished grade, unless material is preservative treated. Do not apply wood directly over concrete or masonry – separate with a 28 gage metal flashing or 15-mil polyethylene film.

3.08 ANCHOR WOODWORK TO ANCHORS OR BLOCKING built in or directly attached to substrates. Do not use staples, or T-nails. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing. Use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork. Double nail all trim at 16 inches maximum on-center, with an additional nail on boards over 12 inch nominal thickness. Do not nail into a cut edge of trim material. Anchor between 1/2 min. to 2 inches maximum from the edge - penetrating 1-1/4 inch minimum into wood substrate, or not less than three (3) screw-threads through metal framing. Anchor trim from one end to the other – do not nail towards the ends from the center.

3.09 SEAL ALL EXTERIOR TRIM members to prevent water intrusion. Do not allow water to stand or to leak behind trim units. Seal all butt-joints and where trim abuts siding, window frames, door frames or similar conditions.

3.10 SHELVING AND CLOTHES ROD INSTALLATION

A. Cut shelf cleats at ends of shelves about 1/2 inch less than width of shelves and sand exposed ends smooth.
B. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches OC. Apply a bead of multipurpose construction adhesive to back of shelf cleats before installing. Remove adhesive that is squeezed out after fastening shelf cleats in place.
C. Install shelf brackets according to manufacturer's written instructions, spaced not more than 32 inches OC. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.

D. Install standards for adjustable shelf supports according to manufacturer's written instructions. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Space fasteners not more than 12 inches OC.
E. Install standards for adjustable shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches o.c. and within 6 inches of end of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
F. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports. Fasten shelves to cleats with finish nails or trim screws, set flush. Fasten shelves to brackets to comply with bracket manufacturer's written instructions.
G. Install rod flanges for rods as indicated. Fasten to shelf cleats, framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Install rods in rod flanges.

3.11 STAIR AND RAILING INSTALLATION: Secure treads and risers as indicated in Drawings.

3.12 COMPLETE FINISHING WORK specified in this Section to the extent not completed at shop or before installation of woodwork.

A. At both interior and exterior applications, verify that all edges and backs of members are sealed, and if not, field-apply sealer before installation.
B. Field-apply sealer to all field-cut wood surfaces before installation, so that all edges of wood members will be protected from moisture infiltration and damage.
C. Where exposed, fill nail and screw holes with filler that will finish in color similar to adjacent woodwork.
D. Refer to Division-09 Section for final finishing of installed Woodwork.

3.13 REPAIR DAMAGED AND DEFECTIVE WOODWORK, where possible, to eliminate functional and visual defects. When not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

3.14 CLEAN WOODWORK on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 40 00

SECTION 06 41 00 – ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.01 PROVIDE CUSTOM-FABRICATED ARCHITECTURAL WOOD CASEWORK requiring quality craftsmanship and joinery, where indicated in the Drawings and as specified herein.

1.02 QUALITY ASSURANCE: Except as otherwise indicated by the Drawings or these Specifications, provide Architectural Woodwork in compliance with The Architectural Woodwork Institute's "Quality Standards" Section 400 – Custom Grade.

1.03 SUBMITTALS

A. SUBMIT PRODUCT DATA for each type of product indicated. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. SUBMIT SHOP DRAWINGS showing location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections. Show locations and sizes of holes and cutouts installed in architectural woodwork.

C. SUBMIT SAMPLES FOR INITIAL SELECTION, to include Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.

(1) Shop-applied transparent finishes.
(2) Plastic laminates.
(3) Countertop materials

1.04 DO NOT DELIVER WOODWORK until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.05 PROJECT CONDITIONS

A. ENVIRONMENTAL LIMITATIONS: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. FIELD MEASUREMENTS: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

(1) Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements.
(2) Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.01 GENERAL

A. PROVIDE MATERIALS THAT COMPLY with requirements of the AWI quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. TYPICAL SUBSTRATE MATERIAL: 3/4 inch thick minimum medium-density fiberboard (MDF) material complying with ANSI A208.1 Grade M-2 (except for density) with no added urea formaldehyde (NAUF).

C. WATERPROOF MDF: For countertop substrate and at door, drawer end and other exposed components of opaque painted cabinets, provide water-proof formaldehyde-free medium density fiberboard (MDF) as follows:

(1) APPROVED MANUFACTURER: “Medex” by Roseburg, P: 800-245-1115, www.roseburg.com

D. CONFIGURATION:

(1) Refer to drawings for all cabinet sizes, door sizes, and configuration.
(2) Provide frameless “European” box construction unless otherwise indicated on drawings.
(3) Provide full overlay doors unless otherwise indicated on drawings.

2.02 THERMOSET DECORATIVE OVERLAY PANELS (typical finish of cabinet interiors): Particleboard complying with ANSI A208.1, Grade M-2, or medium-density fiberboard complying with ANSI A208.2, Grade MD, with surface of thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1. Provide material with no added urea formaldehyde (NAUF).

A. Provide material / color as indicated on the Drawings – if not indicated - provide color as selected by Architect from Manufacturer’s full range of available color options.

2.03 PLASTIC LAMINATE (PLAM): High-pressure, decorative laminate meeting NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.

A. APPROVED MANUFACTURER: Provide Manufacturer and color/series (solid-color core) and finish as indicated on the Drawings. Other manufacturers must be submitted as a substitution for approval by the Architect per Division-01 Requirements.

2.04 DECORATIVE PRE-FINISHED PANELS: high-density particleboard panels with dimensional textured thermofused finish in 3/4 inch thickness typically. Provide manufacturer’s matching 1.0 mm thick ABS edge-banding at all exposed edges, Refer to Drawings for manufacturer, style, and color required, as selected by the Architect.

2.05 HARDWOOD Species and Cut for Transparent Finish:

A. Oak, American White (Quercus alba) USA – to match veneer, Refer to Finish Legend

2.06 HARDWOOD VENEER PLYWOOD: Minimum 3/4 inch thick hardwood veneer plywood, with minimum 1/4" matching hardwood edging typically – in species and cut matching typical hardwood species / cut indicated above unless otherwise indicated.

2.07 NATURAL-WOOD VENEER LAMINATE: Provide “natural-finished wood” composite veneered laminate material manufactured with real wood:

A. Basis-of-Design Product / Manufacturer: Unless noted otherwise in the Drawings, provide White-oak straight grain # 60204 by Treefrog Veneer (www.treefrogveneer.com) or approved equal

2.08 WOOD SPECIES FOR OPAQUE FINISH: Poplar, or any other equivalent closed-grain hardwood

2.09 THERMOSET DECORATIVE OVERLAY PANELS: Particleboard complying with ANSI A208.1, Grade M-2, or medium-density fiberboard complying with ANSI A208.2, Grade MD, with surface of thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1. Provide material with no added urea formaldehyde (NAUF). Provide panels prefinished in color, size and overlay indicated on the Drawings – if not indicated, provide color as selected by Architect from Manufacturer’s full range of available color options. Provide full overlay if not indicated.

2.10 WOOD COUNTERTOP MATERIALS:

A. BUTCHER-BLOCK COUNTERTOP: Manufacturer pre-finished units in maximum length feasible to minimize countertop joints, prefinished in either varnish or oil finish, as selected by the Architect, and as follows:

(1) EDGE & UNIT THICKNESS: 1-1/2 inch

B. WOOD SPECIES: American Hard Maple (Acer saccharum), American Cherry (Prunus serotina), Appalachian Red Oak, American Black Walnut (Juglans nigra)
C. GRAIN PATTERN: Blended - running block pattern, edge-grain strips, end-grain blocks
D. APPROVED MANUFACTURER: John Boos & Company – other manufacturers must be submitted as a substitution per requirements of Division-01 for the Architect’s approval

2.11 WOOD COMPOSITE COUNTERTOP: Flat sheet of 1/2 inch thickness base material, with exposed edges laminated to required countertop thickness as indicated on the Drawings, or minimum 1-1/2” thick at countertop edges if not indicated. Cracked, chipped, broken, stained, or defective material will not be acceptable. Minimize color differences across joints. Provide matching joint adhesive approved for use by manufacturer. Fabrication must be in strict compliance with manufacturer's instructions. Check color match before proceeding with fabrication. Route and shape exposed edges for a homogeneous integral surfaced appearance. All surfaces must be of uniform gloss, with edges eased and polished smooth Provide the following:

A. APPROVED PRODUCTS / MANUFACTURERS: “Richlite - Black Diamond” – Northwest Series, (www.richlite.com), or “EcoTop – Jet Black” by Klip BioTechnologies, Inc (www.KLIPTECH.com)

2.12 MISCELLANEOUS WOOD MATERIALS:

A. Hardboard: AHA A135.4.
B. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade MD.
C. Particleboard (PBD): ANSI A208.1, Grade M-2
D. Softwood Plywood: DOC PS 1, Medium Density Overlay.
E. Hardwood Plywood And Face Veneers: HPVA HP-1.

2.13 ADHESIVE

A. for Bonding Plastic Laminate: contact cement.
B. for Bonding Edges: Hot-melt adhesive.

2.14 INSTALLATION MATERIALS

A. FURRING, BLOCKING, SHIMS, AND HANGING STRIPS: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
B. ANCHORS: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.15 MISCELLANEOUS WOOD PRODUCTS:

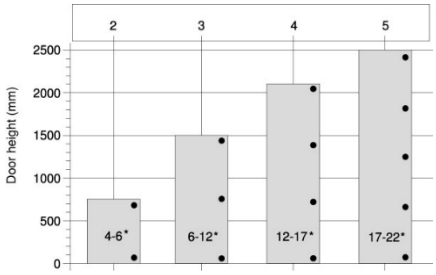
A. Hardboard AHA A135.4.
B. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade MD.
C. Particleboard (PBD): ANSI A208.1, Grade M-2
D. Softwood Plywood: DOC PS 1, Medium Density Overlay.
E. Hardwood Plywood And Face Veneers: HPVA HP-1.

2.16 CABINET HARDWARE AND ACCESSORIES

A. HARDWARE STANDARD: Comply with BHMA A156.9 for items indicated by referencing BHMA numbers or items referenced to this standard.
B. PROVIDE CABINET HARDWARE AND ACCESSORY MATERIALS associated with architectural cabinets as indicated in the Drawings, except for items specified in Division-08 "Door Hardware" Section:

(1) Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees (minimum) of opening, soft-closing. BLUM -73B3590 110deg+ Clip Top Blumotion / soft close

(a) Provide appropriate Blumotion specifications for thick doors, blind corner, metal frame, angled or wide angle applications.
(b) Follow manufacturer guidelines on number of hinges per weight, or as follows
(i) 2 hinges for doors weight 4-6kg, 3 hinges for door weights of 6-12 kg, 4 hinges for weights of 12-17 kg, and 5 hinges for 17-22 kg.



(2) Back-Mounted Pulls: Provide typical cabinet pull units and in finish as indicated on the Drawings – if not indicated, provide # 8071 as manufactured by Richelieu – in brushed nickel finish or equivalent as selected by Architect.
(3) Adjustable Shelf Standards and Clip-type supports (for mounting at ends of shelves): BHMA A156.9, B04071; with shelf rests, B04081
(4) Adjustable Shelf Standards and brackets (for mounting at rear of shelves): BHMA A156.9, B04102; with shelf brackets, B04112.
(5) Shelf Rests for drilled holes: BHMA A156.9, B04013.
(6) Soft-closing Drawer Slides: Side-mounted, full-extension – soft-closing units extending under bottom edge of drawer, epoxy-coated steel with polymer rollers and rated for the following loads: Blum Tandem Undermounts – 563H – w/ Blumotion soft close
(a) For drawers not more than 3 inches high or 24 inches wide: Grade 2
(b) For drawers more than 3 inches high but not more than 6 inches high and not more than 24 inches wide, provide Grade 1HD-100.
(c) For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-200.
(d) For computer keyboard shelves, provide Grade 1HD-100.
(e) For trash bins not more than 20 inches high and 16 inches wide, provide Grade 1HD-200.
(7) Waste Container system – soft-close bottom mount waste container unit. Include two waste containers. Hailo US Cargo FL Series w/ soft close by Hafele
(8) Door and Drawer Silencers: BHMA A156.16, L03011
(9) Hidden Countertop Supports: 24 inch long units fabricated from hot rolled steel, in 1-1/2 inch width x 1/4 inch high flat solid bar extending under countertop projection, with a four (4) inch long cold-formed L-angled mounting flange with extended oval holes for up to 1/4 inch diameter fasteners to mount into vertical cabinet frame components, in black electrostatic powder-coat finish:
(a) Basis-of-Design: Outwater Plastic's "Harmony Floating Hidden countertop Support"
(10) Hidden Countertop Supports: 2.5 inch wide by 1/2 inch thick units fabricated from ASTM A36 hot rolled steel with four (4) pre-drilled mounting holes, in length as required to securely anchor to support framing and to extend to within one (1) inch of edge of countertop overhang, with 35 degree "safe edge" on front of bracket, in black electrostatic powder-coat finish:
(a) BASIS-OF-DESIGN: "CenterlineBrackets Standard Granite Bracket" Series CSP as manufactured by Centerline Steel LLC., P: 888-960-3854, www.countertopbracket.com
(11) Concealed Hardware Finish: Provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

C. Exposed Hardware Finishes: Provide finish that complies with BHMA A156.18 for BHMA finish number indicated:
(1) Typical unless otherwise indicated: Bright Chromium Plated - BHMA 625 for brass or bronze base; BHMA 651 for steel base.

D. DOOR & DRAWER LOCKS Disk tumbler cylinder cam locks for doors and drawers with lipped/overlay construction (straignt cam) or flush construction (formed cam) as required. Provide units with cam size and type as required by cabinet construction:
(1) BASIS-OF-DESIGN: "CompX National" # C8053-19 series (black finished unless indicated otherwise)
(2) Keying: 2 keys/door – all units keyed alike unless otherwise indicated.

2.17 FABRICATION:

A. TYPICAL FABRICATION OF WOOD CABINETS FOR TRANSPARENT FINISH
(1) Quality Standard: Comply with AWI Section 400, Custom Grade, and as follows:
(2) AWI Type of Cabinet Construction: Frameless Style, flush overlay or as otherwise indicated.
(3) Grain Matching: Run and match grain vertically for drawer fronts, doors, and fixed panels or as otherwise indicated.
(a) Matching of Veneer Leaves: Random match.

(b) Vertical Matching of Veneer Leaves: End match.

B. TYPICAL FABRICATION OF WOOD CABINETS FOR OPAQUE FINISH

(1) Quality Standard: Comply with AWI Section 400, Custom Grade requirements for wood cabinets, and as follows:

(a) AWI Type of Cabinet Construction: Frameless (face frame) with flush overlay or as otherwise indicated.
(b) WOOD PANELS for doors, drawers, cabinet sides and other exposed surfaces: Waterproof MDF

C. PLASTIC-LAMINATE CABINETS

(1) Quality Standard: Comply with AWI Section 400 – Custom Grade requirements for laminate cabinets.
(2) AWI Type of Cabinet Construction: frameless with flush overlay
(3) Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following:

(a) Horizontal Surfaces Other Than Tops: HGL.
(b) Post formed Surfaces: HGP.
(c) Vertical Surfaces: VGS.
(d) Edges: Self-edged with PVC tape, 0.018-inch minimum thickness, matching laminate in color, pattern, and finish.

(4) Materials for Semi-exposed Surfaces: Provide surface materials indicated below:

(a) Surfaces Other Than Drawer Bodies: Thermoset decorative overlay.
(b) Drawer Sides and Backs: Thermoset decorative overlay.
(c) Drawer Bottoms: Hardwood plywood – or decorative pre-finished panels .

(5) Colors, Patterns, and Finishes: Provide materials and products as indicated on the Drawings. Other manufacturers must be submitted as a substitution per of Division-01 requirements. If color is not indicated, provide from Architect approved plastic laminate manufacturer, in manufacturer's full range of colors and finishes in the both solid colors, and solid colors with the core the same color as the surface.

D. PLASTIC-LAMINATE (PLAM) COUNTERTOPS

(1) Quality Standard: Comply with AWI Section 400 – Custom Grade
(2) Core material: MDF, or waterproof MDF at countertops with sinks.
(3) High-Pressure Decorative Laminate Grade: HGS (HGP at post-formed countertops).
(4) Colors, Patterns, and Finishes: Provide materials and products as indicated on the Drawings. Other manufacturers must be submitted as a substitution per of Division-01 requirements. If color is not indicated, provide from Architect approved plastic laminate manufacturer, in manufacturer's full range of colors and finishes in both solid colors, and in solid colors with the core the same color as the surface.
(5) Edge Treatment: Self-edged in same material as horizontal laminate cladding

E. PLASTIC-LAMINATE (PLAM) WINDOW STOOLS

(1) Quality Standard: Comply with AWI Section 400 – Custom Grade
(2) Profile / assembly: 3/4 inch thick waterproof MDF top with 1-1/2 inch high edge trim. Provide 1/2 inch thick marine plywood or waterproof MDF sub-base screwed to substrate wall material, and anchor stool with adhesive to sub-base.
(3) High-Pressure Decorative Laminate Grade: HGS.
(4) Colors, Patterns, and Finishes: Provide materials and products as indicated on the Drawings. Other manufacturers must be submitted as a substitution per of Division-01 requirements. If color is not indicated, provide from Architect approved plastic laminate manufacturer, in manufacturer's full range of colors and finishes in both solid colors, and in solid colors with the core the same color as the surface.
(5) Edge Treatment: Self-edged in same material as horizontal laminate cladding

2.18 FABRICATION, GENERAL

A. WOOD MOISTURE CONTENT: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
B. FABRICATE WOODWORK to dimensions, profiles, and details indicated. Ease edges to 1/16 inch radius at corners of cabinets and edges of solid-wood (lumber) members and rails.
C. COMPLETE FABRICATION, including assembly, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
D. SHOP CUT OPENINGS, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs. Seal edges of openings in countertops with a coat of varnish.
E. SHOP FABRICATE casework to dimensions, profiles, and details indicated on Shop Drawings. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting. Complete fabrication, finishing, hardware application and other Work before shipment to project site to maximum extent possible.
F. SHOP ASSEMBLY OF CASEWORK: Completely assemble casework in shop prior to shipment to project site. Mark individual items in sequence with removable materials to facilitate field assembly. Shop fit glass in casework, remove and package to protect from breakage, clearly marked to facilitate field installation.
G. COUNTERTOP CUTOUTS: To the greatest extent possible, make countertop cutouts in the factory, with all exposed edges completely sealed against potential water penetration between finish surface and substrate, and substrate and web frame, as applicable.

PART 3 - INSTALLATION:

3.01 DELIVER inserts and other anchoring devices to be built into substrates, well in advance of time substrates are to be built. Condition wood materials to average prevailing humidity conditions in installation areas prior to installation.

3.02 DISCARD units of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned or too small to fabricate work with minimum of joints or optimum jointing arrangements, or which are of defective manufacturer with respect to surfaces, sizes or patterns.

3.03 INSTALL the Work plumb, level, true and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8 inch in 8'-0" for plumb and level, and with 1/16" maximum offset in flush adjoining surfaces and 1/8" maximum offsets in revealed adjoining surfaces.

3.04 SCRIBE AND CUT to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.

3.05 ANCHOR to anchors or blocking built-in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fastener heads are required, use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork, and matching final finish where transparent finish is indicated.

3.06 INSTALL CABINETS without distortion so that cabinet doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors in openings and to provide free operation. Complete installation of hardware and accessory items indicated.

3.07 COUNTERTOPS: Anchor securely to base units and other support systems.

3.08 REPAIR DAMAGED and defective casework to eliminate defects functionally and visually, or where not possible, replace casework. Adjust joinery for uniform appearance. Clean, lubricate and adjust hardware for smooth operation. Rehang or replace doors which do not swing or operate freely, as directed by Owner. Clean casework on exposed and semi-exposed surfaces. Touch-up shop applied finishes to restore damaged or soiled areas.

3.09 TOUCH-UP FINISHING as required by installation. Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing of concealed surfaces and similar items.

3.10 PROTECTION: Provide final protection and maintain conditions, in a manner acceptable to Fabricator and Installer, which ensures architectural woodwork being without damage or deterioration at time of substantial completion.

END OF SECTION 06 41 00

SECTION 06 41 16 – PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.01 SUMMARY:

A. Section Includes:

(1) Plastic-laminate-clad architectural cabinets.
(2) Cabinet hardware and accessories.
(3) Miscellaneous materials.

B. Related Requirements:

(1) Section 06 10 00 “Rough Carpentry” for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.
(2) Section 12 36 61 “Solid Surface Countertops”.

1.02 COORDINATION:

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.03 ACTION SUBMITTALS:

A. Product Data:

(1) Plastic-laminate-clad architectural cabinets.
(2) Cabinet hardware and accessories.
(3) Miscellaneous materials.

B. Product Data Submittals: For each product.
C. Shop Drawings:

(1) Include plans, elevations, sections, and attachment details.
(2) Show large-scale details.
(3) Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
(4) Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.

D. Samples for Initial Selection: For each type of exposed finish.
E. Samples for Verification: For the following:

(1) Plastic Laminates: 4 by 4 inches, for each type, color, pattern, and surface finish required.

(a) Provide one sample applied to core material with specified edge material applied to one edge.
(b) Provide edge banding on one edge.

(2) Corner Pieces:

(a) Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
(b) Miter joints for standing trim.

(3) Exposed Cabinet Hardware and accessories: One full-size for each type and finish.

1.04 INFORMATIONAL SUBMITTALS:

A. Qualification Data: For Installer.
B. Product Certificates: For each type of product.

1.05 QUALITY ASSURANCE:

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
B. Installer Qualifications: Fabricator of products.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.07 FIELD CONDITIONS:

A. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

(1) Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction and indicate measurements on Shop Drawings.

C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.01 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS:

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.

(1) Provide inspections of fabrication and installation together with labels and certificates from AWI certification program indicating that woodwork and installation complies with requirements of grades specified.
(2) The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

B. Architectural Woodworks Standards Grade: Custom.
C. Type of Construction: Frameless.
D. Door and Drawer-Front Style: Frameless with Flush overlay.
E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
F. Exposed Surfaces:

(1) Horizonal Surfaces: Grade HGS.
(2) Postformed Surfaces: Grade HGP.
(3) Vertical Surfaces: VGS.
(4) Edges: Grade VGS.
(5) Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.

G. Semi Exposed Surfaces:

(1) Surfaces Other Than Drawer Bodies: Thermally fused laminate panels.

(a) Edges of Plastic-Laminate Shelves: PVS edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish.
(b) Edges of Thermally Fused Laminate Panel Shelves: PVC and polyester edge banding.
(c) For semi exposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD3, Grade CLS.

(2) Drawer Sides and Backs: Solid-hardwood lumber.
(3) Drawer Bottoms: Hardwood plywood.

H. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, ISO 4583-3, grade to match exposed surface.
I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior body.

(1) Join subfronts, back, and sides with glued rabbeted joints supplemented by mechanical fasteners.

J. Colors, Patterns, and Finishes: Refer to Finish Legend on Drawings. Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

(1) To be selected by Architect from laminate manufacturer's full range in the following categories:

(a) Solid colors, matte finish.
(b) Wood grains, matte finish.
(c) Patterns, matte finish.

2.02 WOOD MATERIALS:

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

(1) Wood Moisture Content: 5 to 10 percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

(1) Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
(2) Particleboard (Medium Density): ANSI A208.1, Grade M-2.
(3) Softwood Plywood: DOC PS 1, medium-density overlay.
(4) Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.03 CABINET HARDWARE AND ACCESSORIES:

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

(1) Accuride International.
(2) Blum, Julius & Co., Inc.
(3) Grass America, Inc.
(4) Knape & Vogt Manufacturing Company.

B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 135 degrees of opening and soft close feature.

C. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.
D. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.
E. Catches: Push-in magnetic catches, ANSI/BHMA A156.9, B03131.
F. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04071; with shelf rests, B04081.
G. Shelf Rests: Metal.
H. Drawer Slides: ANSI/BHMA A156.9.
   (1) Standard Duty (Grade 1 and Grade 2):
      (a) Type: extension.
      (b) Material: Zinc-plated steel with polymer rollers.
   (2) Grad 1HD-100 and Grad 1HD-200: Side mounted; full-extension type; zin c-plated-steel ball-bearing slides.
   (3) For drawers not more than 3 inches(75 mm) high and not more than 24 inches(600 mm) wide, provide Grade 1.
   (4) For drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide Grade 1HD-100.
   (5) For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-100.
I. Door Locks: ANSI/BHMA A156.11, E07121.
J. Drawer Locks: ANSI/BHMA A156.11, E07041.
K. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
L. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
   (1) Refer to Finish Legend on Drawings.
M. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.04 MISCELLANEOUS MATERIALS:

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
C. Adhesive for Bonding Plastic Laminate: Type II water-resistant type as selected by fabricator to comply with requirements.
   (1) Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.05 FABRICATION:

A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.
B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   (1) Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
   (2) Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
   (3) Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.02 INSTALLATION:

A. Grade: Install cabinets to comply with quality standard grade of item to be installed.
B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
   (1) Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
   (2) Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   (3) Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish or toggle bolts through metal backing or metal framing behind wall finish.

3.03 ADJUSTING:

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets, Adjust joinery for uniform appearance.

3.04 CLEANING:

A. Clean, lubricate, and adjust hardware.
B. Clean cabinets on exposed and semi exposed surfaces.

END OF SECTION 06 41 16

SECTION 06 64 13 – FIBERGLASS REINFORCED PLASTIC (FRP) PANELING

PART 1 - GENERAL

1.01 WORK INCLUDES surface preparation of wall surfaces and installation of Fiberglass Reinforced Plastic (FRP) paneling, as specified herein and as needed for a complete and proper installation.

1.02 PROVIDE FRP paneling on all wall surfaces adjacent to or within two (2) feet of a service (mop) sink, up to 48 inches above finished floor (FFE), unless another wall finish is indicated to be provided on the Drawings.

PART 2 - PRODUCTS

2.01 (STANDARD) FRP PANELS: .090 inch thick x 4 feet wide 4 x 8, 10 or 12 ft high USDA accepted panels of semi-rigid fiberglass reinforced plastic panels, with color-matched one-piece trim and panel moldings at all joints between panels, and at top and bottom edges of panels:

A. Basis-of-Design Product / Manufacturer: “Marlite FRP", # S-100/2/S White - Class III/C per ASTM E-84, smooth surfaced units, or equal

PART 3 - INSTALLATION

3.01 EXAMINE AREAS and conditions in which FRP will be installed. Complete all finishing operations, including prime coat of paint, before beginning installation of wall surface protection materials.

3.02 PREPARATION: Acclimate panels in temperature and humidity conditions approximating those at the project site for not less than 24 hours before application. Lay panels flat. Do not stack on fresh conc. floors or other surfaces that emit moisture. Walls must be dry and free from dirt, dust and grease. Remove switchplates, wall plates, and surface- mounted fixtures in areas where panels are to be applied.

3.03 PANEL FITTING: Position panels with 1/4" gap at ceiling and floor, and 1/8' gap between each panel and division bar of moldings to allow for normal expansion and contraction. Allow not less than 1/8" gap around pipes, electrical fittings, and other projections. Use carbide-tipped power saws to cut panels. Prefit each panel before installing.

3.04 INSTALL PANELS by using manufacturer’s recommended adhesive applied to back of panels for 100% coverage, with a notched trowel. Before adhesive skins over, set panels in position and press against wall. Pull entire panel back away from wall 8" to 10" to flash off any solvents, if applicable. Press back in place. Apply adequate pressure to make full contact between panel and wall.

3.05 PANEL MOLDINGS: Install one-piece matching trim and panel moldings at all joints between panels, and at top and bottom edges of panels. Install moldings with continuous bead of silicone sealant during installation of panels. Seal joints between moldings and between molding and adjacent finish material. Remove excess sealant immediately.

3.06 CLEAN-UP: Remove excess adhesive and sealant while it is still wet. Replace removed plates and fixtures. Remove surplus materials and debris resulting from panel installation upon completion of Work, and leave areas of installation in clean condition.

END OF SECTION 06 64 13

END OF DIVISION 6

DIVISION-07 – THERMAL & MOISTURE PROTECTION

SECTION 07 08 00 – COMMISSIONING OF BUILDING EXTERIOR ENCLOSURE

SECTION 07 11 00 – DAMPPROOFING

SECTION 07 13 00 – FOUNDATION WATERPROOFING SYSTEM

SECTION 07 21 00 – THERMAL INSULATION

SECTION 07 21 19 – FOAMED-IN-PLACE INSULATION

SECTION 07 25 00 – WATER RESISTIVE BARRIER (WRB)

SECTION 07 25 10 – FLUID-APPLIED WATER-RESISTIVE BARRIER (WRB)

SECTION 07 27 00 – AIR BARRIER REQUIREMENTS

SECTION 07 50 00 – MEMBRANE ROOFING SYSTEM

SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM

SECTION 07 72 00 – ROOF ACCESSORIES

SECTION 07 81 00 – APPLIED FIREPROOFING

SECTION 07 84 00 – FIRESTOPPING

SECTION 07 92 00 – JOINT SEALANTS

SECTION 07 08 00 – BUILDING ENCLOSURE COMMISSIONING

PART 1 - GENERAL

A. DESCRIPTION

1. The requirements of this Section apply to all sections of Division 07 and Division 08.

B. RELATED WORK

1. Section 01 75 00 – Operation and Maintenance Data Integration
2. Section 01 79 00 – Commissioning Demonstration and Training
3. Section 01 81 13 – LEED Certification Requirements
4. Section 01 81 19 – Indoor Air Quality Management
5. Section 07 27 00 – Air Barrier Requirements

C. SUMMARY

1. This Section includes requirements for commissioning the Facility exterior closure, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 13 General Commissioning Requirements.
2. The commissioning activities have been developed to support the Owner requirements and to meet the enclosure commissioning requirements of the LEED (Leadership in Energy and Environmental Design) Rating System.

D. DEFINITIONS

The following terms as they apply to this section:

1. Refer to Section 01 91 13 General Commissioning Requirements for definitions.
2. Air Barrier Accessory - Products designated to maintain air tightness between air barrier materials, air barrier assemblies and air barrier components, to fasten them to the structure of the building, or both (e.g., sealants, tapes, backer rods, transition membranes, fasteners, strapping, primers).
3. Air Barrier Assembly - The combination of air barrier materials and air barrier accessories that are designated and designed within the environmental separator to act as a continuous barrier to the movement of air through the environmental separator.
4. Air Barrier Component - Pre-manufactured elements such as windows, doors, dampers and service elements that are installed in the environmental separator.
5. Air Barrier Envelope - The combination of air barrier assemblies and air barrier components, connected by air barrier accessories that are designed to provide a continuous barrier to the movement of air through an environmental separator. There may be more than one air barrier envelope in a single building. Also known as Air Barrier System.
6. Air Barrier Material - A building material that is designed and constructed to provide the primary resistance to airflow through an air barrier assembly.
7. Air Barrier System - Same as AIR BARRIER ENVELOPE.
8. Air Leakage Rate - The rate of airflow (CFM) driven through a unit surface area (sq.ft.) of an assembly or system by a unit static pressure difference (Pa) across the assembly. (example: 0.25 CFM/sq.ft. @ 75 Pa)
9. Air Leakage - The total airflow (CFM) driven through the air barrier system by a unit static pressure difference (Pa) across the air barrier envelope. (example:6500 CFM @ 75 Pa)
10. Air Permeance - The rate of airflow (CFM) through a unit area (sq.ft.) of a material driven by unit static pressure difference (Pa) across the material (example: 0.004CFM/sq.ft. @ 75 Pa).
11. Environmental Separator - The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments. Also known as the Control Layer.

E. COMMISSIONED SYSTEMS

1. Commissioning of a system or systems specified in Division 07 and Division 08 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 and the BECxA.
2. The following Facility exterior closure systems will be commissioned:
    a. Roofs (Asphalt shingles, slate shingles, wood shingles, clay roof tiles, built-up bituminous, modified bituminous, EPDM, PVC, fluid-applied, sprayed polyurethane, flashing & sheet metal, metal roofing, roof specialties, and roof accessories)
    b. Exterior Insulation and Finish Systems (EIFS)
    c. Curtain Wall Systems (Mullions, glazing, and sealing)
    d. Exterior Doors (Revolving, glass leaf, emergency exit, and service)
    e. Exterior Windows (Aluminum, steel, glazing, storm)
    f. Louvers and Vents
    g. Sealants (Caulking, mechanical seals, and wind and vapor barriers)

F. QUALIFICATIONS

1. The Building Enclosure Commissioning Agent (BECxA) shall be contracted with the University of Arkansas directly through the Commissioning Agent (CxA). All building testing associated with the building enclosure, underfloor plenum, water resistance of exterior assemblies, etc., are the responsibility of the contractor unless otherwise noted in the contract documents. The BECxA performs building envelope commissioning in

accordance with the most current University of Arkansas' Commissioning Standards. Design Review, oversees quality control testing specified in these specifications, performs quality control air barrier inspection as specified, interfaces with the designer and product manufacturer's representatives to assure all installation requirements are met, and coordinates efforts between all workers installing or penetrating the air barrier materials.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

A. DESIGN REVIEW

1. The BECxA shall review the Contract Plans and Specifications and advise the Design Team and General Contractor of any deficiencies that would prevent the construction of an effective air barrier system. The BECxA shall provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for a proper air barrier system.

B. SUBMITTAL REVIEW

1. The commissioning process requires review of selected Submittals. The BECxA will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will forwarded to the Contractor.
2. The commissioning process requires Submittal review simultaneously with architect review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 13 General Commissioning Requirements.

C. PRE-CONSTRUCTION COORDINATION

1. The Commissioning Agent shall coordinate and schedule a building enclosure pre-construction meeting. The enclosure architectural details, enclosure components, sequencing of trades, and testing requirements will be covered in the meeting. Any potential changes to the construction details or materials will be identified in this meeting. The meeting should be scheduled before installation of any of the building enclosure components and after the construction of the mock-up.

D. CONTRACTORS TESTS

1. Contractor tests as required by other sections of Division 07 (07 27 00) or Division 08 shall be scheduled and documented in accordance with Section 01 00 00 General Requirements. The BECxA will have the option to witness selected Contractor tests.

E. QUALITIY CONTROL INSPECTION

1. The BECxA shall conduct the following inspections as applicable during installation of the air barrier system, and submit quality control reports as indicated below:
    a. Inspect to assure continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.
    b. Inspect to assure structural support of the air barrier system to withstand design air pressures.
    c. Inspect to assure masonry surfaces receiving air barrier materials are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortor joints struck flush or as
    d. Inspect and test to assure site conditions for application temperature, and dryness of substrates are within guidelines.
    e. Inspect to assure substrate surfaces are properly primed if applicable and in accordance with manufacturer's instructions. Priming must extend at least 2 inches beyond the air barrier material to make it obvious that the primer was applied to the substrate before the air barrier material.
    f. Inspect to assure laps in materials are at least a 2-inch minimum, shingled in the correct direction or mastic applied in accordance with manufacturer's recommendations, and with no fishmouths.
    g. Inspect to assure that a roller has been used to enhance adhesion. Identify any defects such as fishmouths, wrinkles, areas of lost adhesion, and improper curing. Note the intended remedy for the deficiencies.
    h. Inspect to assure that the correct materials are installed for compatibility.
    i. Inspect to assure proper transitions for change in direction and structural support at gaps.
    j. Inspect to assure proper connection between assemblies (membranes and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

END OF SECTION 07 08 00

SECTION 07 11 00 – DAMPROOFING AND WATERPROOFING

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide bituminous dampproofing, in accordance with requirements contained herein, applied to the following surfaces:

A. Exterior concrete “slab-edge” surfaces, extending to footing below
B. Foundation walls at basements and crawlspaces.

1.02 RELATED SECTIONS

A. Division 03: Concrete
B. Division 07: Insulation

1.03 DAMPPROOFING: Provide cold-applied, emulsified-asphalt meeting one of the following:

A. ASTM D 1227, Type II, Class 1, for troweled coats: or
B. ASTM D 1227 Type II, Class 1 for fibered brush and spray coats, or
C. ASTM D 1227, Type III, Class 1for brush and spray coats.

1.04 WATERPROOFING: Provide self-adhering waterproofing membrane meeting the following:

A. Flexible, bituminous, roll-type waterproofing membrane.
B. Composed of a nominally 56 mil thick layer of polymeric waterproofing membrane on a heavy duty, four-mil thick, cross-laminated polyethylene carrier film.

1.05 SUBMITTALS

A. Product Data

1.06 QUALITY CONTROL

A. Obtain all products from one manufacturer as a “system”.
B. Store and install according to manufacturer’s specifications.

PART 2 - PRODUCTS

2.01 DAMPPROOFING: Installed ONLY at below grade conditions that are NOT crawlspace or basement.

A. EMULSIFIED-ASPHALT PRIMER: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.
B. ASPHALT-COATED GLASS FABRIC: ASTM D 1668, Type I.

2.02 WATERPROOFING MEMBRANE: Installed at ALL crawlspace and basement conditions.

A. Basis of Design: W.R. Meadows; Mel-Rol.
B. Testing Criteria
   (1) ASTM D412:
      (a) Tensile Strength Film: 5900 psi min
      (b) Tensile Strength Membrane: 460 psi min
      (c) Elongation: 971.3% min
   (2) ASTM C836: Low Temp Crack Bridging 100 Cycle @ -25dF: Pass
   (3) ASTM D903: Peel Adhesion: 11.8 lb/in min
   (4) ASTM D1876: Lap Adhesion: 8.62 lbf/in. min
   (5) ASTM E-96,B: Water Vapor Permeability: 0.1 Perms max
   (6) ASTM D 570: Water Absorption: 0.1%, 72 hrs. max
   (7) ASTM D5385: Hydrostatic Resistance: Equiv. to 200 ft of water. Min.
   (8) ASTM E 154: Puncture Resistance: 50 lbf min
   (9) ASTM D1970: Flexibility @ -20dF: Pass
C. Accessories: Install above membrane as part of a system with associated:
   (1) Primer adhesive
   (2) Detail Strips
   (3) Termination bar
   (4) Mastic beads
   (5) Catalytic Bonding Asphalt
   (6) Protection Course
   (7) Drainage Board. System shall include dimpled drainage mat over waterproofing system if backfill is native soil. Drainage board may be excluded only if backfill is clean gravel with silt barrier between backfill and soil.
      (a) Basis of Design: W.R. Meadows; Mel-Drain.

PART 3 - EXECUTION

3.01 DAMPPROOFING:

A. MASK OR OTHERWISE PROTECT ADJOINING EXPOSED SURFACES from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
B. CLEAN SUBSTRATES OF PROJECTIONS and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.

C. COMPLY WITH MANUFACTURER'S WRITTEN RECOMMENDATIONS unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing. Apply additional coats if recommended by manufacturer or required to achieve coverages indicated. Allow each coat of dampproofing to cure 24 hours before applying subsequent coats.
D. AT INTERNAL AND EXTERNAL CORNERS, changes in plane, construction joints, and cracks, install embed an 8-inch-wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat required for embedding fabric is in addition to other coats required.
E. APPLY TWO (2) BRUSH OR SPRAY COATS at a rate of 1.5 to 2.5 gal./100 sq. ft per coat depending on substrate texture, to produce a uniform, dry-film thickness of not less than 15 mils. Apply in two (2) coats to obtain required thickness, allowing time for complete drying between coats.
F. REMOVE DAMPPROOFING MATERIALS from surfaces not intended to receive dampproofing.

3.02 WATERPROOFING MEMBRANE:

A. Temperature … Apply in dry, fair weather when the air and surface temperatures are above 40° F (4° C). Do not apply to frozen concrete.
B. MEL-ROL LOW TEMP can be used when air and surface temperatures are between 20° F (-7° C) and 60° F (16° C).
C. Surface Conditioning … Apply MEL-PRIME adhesive to surfaces that will be covered within one working day. If left exposed overnight, additional adhesive must be applied. Follow all instructions and precautions on containers.
D. REMOVE release paper from MEL-ROL from the top edge of the roll and firmly press exposed area to the wall. Remove the release paper from the rolls in a downward direction, pressing MEL-ROL into place on the wall.
E. Footing Details … Use DETAIL STRIP for impaction sheet coverage. First, fold strips lengthwise and then cut at the fold. Material is then ready to install as 4 ½" (114.3 mm) strips on either side of the rebar. Any excess can be turned down on the face of the footing. Next, fill the voids around rebars in the keyway with CATALYTIC BONDING ASPHALT. Pour the walls. Install DETAIL STRIP horizontally along the wall where it meets the footing, placing half the material up the wall and the other half onto the footing. Extend the material 4 ½" (114.3 mm) beyond outside corners. Slit extended portion of DETAIL STRIP lengthwise. Place the horizontal flap out onto the footing and bend the vertical flap around the wall. Repeat this procedure in the opposite direction.
F. MEL-ROL can be applied to concrete, masonry surfaces, wood, insulated wall systems, and metal. All substrates must be clean, dry, and free of all surface irregularities.
G. Horizontal Application … Remove release paper on edge, then position the MEL-ROL membrane. Pull balance of release paper off, running the roll from low to high points so that all laps will shed water. Stagger end laps and overlap all seams at least 2 ½" (63.5 mm). Apply a double-thickness of the MEL-ROL membrane over construction, control, and all expansion joints and cracks greater than 1/16″ (1.59 mm) wide.
H. Vertical Wall Application … Masonry walls may require the application of a cementitious parge-coat. Allow the parge-coat to dry before priming and applying MEL-ROL. When applied, the parge-coat will produce a smooth, uniform, and well-bonded surface. Remove release paper, then apply vertically in lengths approximately 8′ (2.44 m) long over the top of the horizontal DETAIL STRIP at the footing. Overlap seams at least 2 ½" (63.5 mm). Tightly butt edges of membrane and apply POINTING MASTIC in corner applications.
I. To the top terminations, apply POINTING MASTIC at least 1/8″ (3.18 mm) thick and 1″ (25.4 mm) wide. As an option, TERMINATION BAR may be used to fasten the membrane mechanically.
J. Hand-Rub and Roll Press … Once positioned, immediately hand-rub the MEL-ROL membrane firmly to the surface, removing any bubbles or wrinkles, then pressure roll the complete surface to assure positive adhesion.
K. Inside Corners … Before MEL-ROL is applied, place a vertical DETAIL STRIP on inside corners extending the material 4 ½" (114.3 mm) beyond each side of the corner. Terminate at the footing and finish the corner with POINTING MASTIC.
L. Outside Corners … Bend DETAIL STRIP vertically over the outside corner and extend 4 ½" (114.3 mm) beyond each side of the corner. Terminate the material at the footing. Finish the corner with POINTING MASTIC. (See Diagram C.)
M. Drains and Protrusions … All protrusions should be sealed with two layers of membrane applied at least 6″ (152.4 mm) in all directions. Seal all terminations with POINTING MASTIC. Around drains, apply two layers of MEL-ROL and put a bead of POINTING MASTIC between the membrane and clamping rings and at all terminations, drains, and protrusions. See ASTM D 5898
N. Inspect and Repair … A thorough inspection should be made before covering and all necessary repairs made immediately. Tears and inadequate overlaps should be covered with MEL-ROL … slit fish mouths and patch. Seal edges of all patches with POINTING MASTIC. Where applicable, horizontal applications can be flood-tested for 24 hours. All leaks should be marked and repaired when membrane dries.
O. Protect the Membrane … on all vertical and horizontal installations with the immediate application of PROTECTION COURSE if no drainage system is used, or MEL-DRAIN. To secure PROTECTION COURSE, use POINTING MASTIC as an adhesive, and/or physically attach at the top edge using TERMINATION BAR. Backfilling should be done immediately, using care and caution to avoid damaging the waterproofing application.
P. PRECAUTIONS: Avoid the use of products that contain tars, solvents, pitches, polysulfide polymers, or PVC materials that may come into contact with MEL-ROL. The use of MEL-ROL does not negate the need for relief of hydrostatic heads. A complete drain tile system should be placed around the exterior of footing and under slabs, as required.
Q. Dispose of all debris off site. Do NOT leave debris to be covered by backfill.

END OF SECTION 07 11 00

SECTION 07 13 00 – FOUNDATION WATERPROOFING SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide waterproofing membrane with protection course in accordance with requirements contained herein. Waterproofing include all sheet materials applied with sealed joints and flashings as needed to form the concealed waterproofing membrane. Waterproofing includes but is not limited to the following:

A. Provide waterproof membrane and waterstops on concrete and in concrete joints below-grade at all conditions where the exterior finished grade is above the interior finished floor elevation of occupied spaces, basements and crawl spaces.

1.02 INTENT: It is the intent of this Section that the building structure be absolutely watertight from below grade moisture.

1.03 INSTALLER QUALIFICATIONS: An entity with not less than five (5) years of successful experience in installation of waterproofing sheets similar to requirements for this project and which is acceptable to and licensed by the manufacturer of primary waterproofing materials.

1.04 PRODUCT DATA SUBMITTALS: Submit specifications, installation instructions, and general recommendations from the waterproofing materials manufacturer.

1.05 JOB CONDITIONS:

A. SUBSTRATE: Proceed with work of this section only after substrate construction, openings, and penetrating work have been completed.
B. WEATHER: Proceed with waterproofing and associated work only when existing and forecasted weather conditions will permit work to be performed in accordance with manufacturers' recommendations and warranty requirements.

1.06 SPECIAL INSTALLER'S WARRANTY: Provide installation warranty, signed by Installer, covering Work of this Section, including removal and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks, as applicable.

A. Warranty Period: Two (2) years from date of Substantial Completion

PART 2 - MATERIALS

2.01 MANUFACTURER: Obtain primary waterproofing materials from a single manufacturer, to the greatest extent possible. Provide secondary materials only as recommended by the manufacturer of the primary materials.

2.02 WATERPROOFING SYSTEM: At existing and new foundation walls with basement or crawlspace behind. Provide a system from a single manufacturer that includes membrane, drainage and insulation. Subject to compliance with requirements, products that may be incorporated into the Work include the following:

A. TUF-N-DRI + WARM-N-DRI WATERPROOFING SYSTEM by Tremco.

(1) Tuf-N-Dri elastic membrane (rubber-like) with 2,000% elongation and min. 15 year warranty at ALL below grade walls.
(2) Warm-N-Dri Rigid Fiberglass Insulation Drainage Board: 2-3/8 inch thick, R-10 at ALL basement and crawlspace walls.

2.03 PROTECTION / DRAINAGE PANEL (at below-grade walls without space or perimeter insulation): Panels consisting of a nonwoven, needle-punched geotextile facing laminated to one side with a polymeric film bonded to the other side of a nonbiodegradable, molded-composite plastic-drainage core. Acceptable products include but are not limited to the following:

A. Tremco's DrainStar Wall Drain 90 – 0.25 inch thick
B. Carlisle's "CCW MiraDRAIN 6200" and "CCW MiraDRAIN 6200XL" – 0.040 inch thick
C. Grace's "Hydroduct 220" (vertical) or "Hydroduct 660" (horizontal) – 0.44 inch thick,

2.04 PROTECTION BOARD: Premolded, semirigid asphalt/fiber composition board, 1/4 inch thick, formed under heat and pressure, of standard sizes.

2.05 CONCRETE WATERSTOPS: "Volclay" Waterstop # RX 101, 1" wide by .75" high, self-adhering elastomeric/bentonite material as manufactured by the American Colloid Company (phone: 708-392-4600). Provide manufacturer's special adhesive and 2" concrete cut nails at all joints.

2.06 WATERPROOFING & FLASHING ACCESSORIES: Provide sealants, pourable sealers, cone and vent flashings, inside and outside corner flashings, termination reglets, and other accessories recommended by waterproofing manufacturer for intended use, and as follows:

A. PRIMERS: Provide concrete primer recommended by the manufacturer of sheet waterproofing material for applications required.
B. ADHESIVES: Adhesive compounds and tapes recommended by waterproofing sheet manufacturer, for waterproof sealing of seams in membrane, and for waterproof sealing of joints between membrane and flashings, adjoining surfaces and projections through membrane.
C. TERMINATION BARS: Manufacturer's standard aluminum or formed polymer bars, approximately 1 inch wide, prepunched for anchors, with non-corrosive stainless-steel anchors.

PART 3 - EXECUTION

3.01 ALLOW TIME for walls to properly cure before applying waterproofing membrane.

3.02 REMOVE all concrete fins, projections, burrs, concrete splatter, general surface dirt and other foreign materials so as to leave wall and flat surfaces in clean condition suitable for application of membrane. Clean surface with high pressure air to remove dust, loose stones and debris.

3.03 PATCH ALL VOIDS, cracks, spalled areas and areas where coarse aggregate is visible. Patching must be done with Portland Cement, grout or concrete.

3.04 INSTALL all components and Waterproofing System according to manufacturer's specifications.

3.05 INSTALL PROTECTION COURSE over completed membrane, complying with manufacturer's recommendations for both waterproofing sheet and protection course materials.

END OF SECTION 07 13 00

SECTION 07 21 00 – THERMAL INSULATION

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide insulation work, as shown on the drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents. Applications of insulation specified in this section include the following: blanket-type building insulation and rigid-type building insulation at wall furring

1.02 RELATED SECTIONS:

A. Section 018113 Certification Requirements.

1.03 THERMAL CONDUCTIVITY: Thicknesses indicated are for thermal conductivity (k-value at 75 degrees F or 24 degrees C) specified for each material. Provide adjusted thicknesses as directed for equivalent use of material having a different thermal conductivity. Where insulation is identified by "R" value, provide thickness required to achieve indicated value.

1.04 FIRE AND INSURANCE RATINGS: Comply with fire-resistance, flammability and insurance ratings indicated, and comply with regulations as interpreted by governing authorities.

1.05 SUBMITTALS

A. SUBMIT PRODUCT DATA including manufacturer's product specifications and installation instructions for each type of insulation and moisture protection material required.

1.06 LEED PERFORANCE REQUIREMENTS

A. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.
B. VOC Emissions Evaluation: For Thermal Insulation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
C. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope.
D. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.07 LEED DOCUMENTATION REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.
C. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
D. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope.
E. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable

1.08 QUALITY ASSURANCE

A. FIRE-TEST-RESPONSE CHARACTERISTICS: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to AHJ representatives. Identify materials with appropriate markings of applicable testing and inspecting agency.
    1. Surface-Burning Characteristics: ASTM E 84.
    2. Fire-Resistance Ratings: ASTM E 119.
    3. Combustion Characteristics: ASTM E 136.

1.09 DELIVERY, STORAGE, AND HANDLING

A. PROTECT INSULATION MATERIALS from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
B. PROTECT PLASTIC INSULATION as follows:
    1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
    2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
    3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 PROVIDE PREFORMED UNITS, sized to fit applications indicated; selected from manufacturer's standard thicknesses, widths, and lengths, as appropriate for conditions of use indicated.

2.02 HIGH-DENSITY ROCK-WOOL INSULATION BOARD: Typical at exterior continuous insulation. Formaldehyde free, unfaced, rock-wool-fiber boards of 6.0 PCF minimum, with R-value of 4.2 per inch thickness, meeting ASTM C 665, Type I (blankets without membrane facing); consisting of mineral fibers with a maximum flame-spread and smoke-developed indexes of 0 and 0 respectively; and rated as non-combustible per ASTM E 136 / NFPA Standard 220. Approved Products / Manufacturers include:

A. Owens Corning / Thermafiber RainBarrier HD
B. Roxul CavityROCK DD

2.03 EXTRUDED POLYSTYRENE (XPS) INSULATION:

A. EXTRUDED-POLYSTYRENE (XPS) INSULATION: ASTM C 578 – Type IV (1.60 PCF – compressive strength of 25 PSI) with insulation value of R-5 per inch, maximum flame-spread and smoke-developed indexes of 75 and 450, respectively. Acceptable Manufacturers include: DiversiFoam Products, Dow Chemical Company, Owens Corning, or Pactiv Building Products Division.

1. Provide drainage type insulation under all permeable finish materials including Cement Plaster “Stucco”: Foamular Insul-Drain XPS by Owens Corning, or equal.

2.04 EXPANDED POLYSTYRENE (EPS) INSULATION:

A. EXPANDED POLYSTYRENE (EPS) INSULATION: Rigid, cellular polystyrene thermal insulation formed by expansion of polystyrene resin beads or granules in a closed mold to comply with ASTM C 578 for Type I, (0.9 PCF), 10 PSI compressive strength, and with maximum flame-spread and smoke-developed indices of 75 and 450, respectively.
B. UNDER-SLAB EXPANDED POLYSTYRENE (EPS) INSULATION FILL: Rigid, cellular polystyrene thermal insulation formed by expansion of polystyrene resin beads or granules in a closed mold to comply with ASTM C 578 for Type IX, (2.0 PCF), 25 PSI compressive strength, and with maximum flame-spread and smoke-developed indices of 75 and 450, respectively.

2.05 UN-FACED BATT or BLANKET INSULATION: Provide formaldehyde free, un-faced batts or blankets (without kraft-paper facings) consisting of fiberglass, or rock-wool meeting ASTM C 665, Type I (blankets without membrane facing) with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics. Subject to compliance with requirements, available manufacturers include but are not limited to:

A. GLASS-FIBER INSULATION:

1. CertainTeed Corporation.
2. Guardian Building Products, Inc.
3. Johns Manville Corporation.
4. Knauf Fiber Glass.
5. Owens Corning.

B. ROCK-WOOL FIBER INSULATION:

1. Owens Corning / Thermafiber.
2. Roxul.

2.06 SILL SEALER (install below all bottom track or sill plates on concrete substrate): Glass fiber insulation in strip form, 1/4" nominal thickness compressible to 1/32"; selected from standard widths to suit width of sill members indicated.

2.07 PROTECTION BOARD: Premolded, semirigid asphalt/fiber composition board, 1/4 inch thick, formed under heat and pressure, of standard sizes.

2.08 AUXILIARY INSULATING MATERIALS

A. ADHESIVE FOR BONDING INSULATION: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.
B. MISCELLANEOUS INSULATION ANCHORS: Provide adhesively attached, spindle-type anchors (angle-shaped when required), insulation-retaining washers and insulation standoffs with suitable anchor adhesive with demonstrated capability to bond insulation anchors securely to substrates indicated where insulation is required in areas where metal framing or other insulation retention system is not indicated.

PART 3 - EXECUTION

3.01 EXAMINE SUBSTRATES AND CONDITIONS, with Installer present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. CLEAN SUBSTRATES OF SUBSTANCES harmful to insulations or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.
B. COMPLY WITH INSULATION MANUFACTURER'S WRITTEN INSTRUCTIONS applicable to products and application indicated. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice and snow.
C. EXTEND INSULATION IN THICKNESS INDICATED to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
D. WATER-PIPING COORDINATION: If water piping is located on inside of insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

E. APPLY SINGLE LAYER OF INSULATION to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

3.03 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

A. ON VERTICAL SURFACES, set units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer. If not indicated, extend insulation a minimum of 36 inches below exterior grade line.
B. PROTECT BELOW-GRADE INSULATION on vertical surfaces from damage during backfilling by applying protection board. Set in adhesive according to insulation manufacturer's written instructions.
C. PROTECT TOP SURFACE OF HORIZONTAL INSULATION from damage during concrete work by applying protection board.

3.04 INSTALLATION OF GENERAL BUILDING INSULATION

A. APPLY INSULATION UNITS TO SUBSTRATES by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
B. SEAL JOINTS BETWEEN CLOSED-CELL (NONBREATHING) INSULATION units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
C. INSTALL MINERAL-FIBER BLANKETS IN CAVITIES formed by framing members according to the following requirements:
    1. Use blanket widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
    2. Place blankets in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
    3. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping stapling flanges to flanges of metal studs.

3.05 INSTALL BOARD INSULATION ON CONCRETE OR CMU SUBSTRATES by adhesively attached, spindle-type insulation anchors as follows:

A. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
B. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
C. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
D. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.06 PLACE LOOSE-FILL INSULATION into spaces indicated, either by pouring or by machine blowing, to comply with ASTM C 1015. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively

3.07 PROTECT INSTALLED INSULATION FROM DAMAGE due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

SECTION 07 21 19 – FOAMED-IN-PLACE INSULATION

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide concealed, foamed-in-place insulation where indicated on the Drawings, as specified herein, and as necessary for complete installation. Apply in thickness(es) required to provide thermal resistance (R-values) as indicated on the Drawings. Provide a thermal barrier between foamed-in-place insulation and occupied spaces, per requirements of the building code as a part of the Work of this Section, unless a separate thermal barrier material is indicated on the Drawings.

1.02 RELATED SECTIONS

A. Section 018113 Certification Requirements.
B. Section 072100 Thermal Insulation

1.03 REFERENCES

A. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):
   1. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat flow Meter Apparatus.
   2. ASTM D 1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
   3. ASTM D 1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.
   4. ASTM D 1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
   5. ASTM D 2856 - Standard Test Method for Open-Cell Content of Rigid Cellular Plastics by the Air Pycnometer.
   6. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   7. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.
   8. ASTM E 283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

B. INTERNATIONAL CODE COUNCIL (ICC)'s INTERNATIONAL BUILDING CODE (IBC):
   1. Applicable Sections of the most recent locally adopted version, for the following:
      a. Alternate Materials, design and methods of construction
      b. Foam Plastic Insulation.
      c. Unvented Attic Assemblies.

1.04 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For Thermal Insulation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
B. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.
C. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.05 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
C. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope.If applicable, provide a a compliant embodied carbon optimization report or action plan.
D. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable.

1.06 SUBMIT PRODUCT DATA consisting of manufacturer's data sheets on each product to be used, including:

A. Preparation instructions and recommendations.
B. Storage and handling requirements and recommendations.
C. Installation methods

1.07 AHJ SUBMITTALS: Submit technical data sheets and samples as required by the local AHJ's upon their request. Include the technical data sheet from the manufacturer showing the test results from the ASTM E84 (Surface Burning Characteristics) and Appendix X, if applicable.

1.08 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by material manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements. A manufacturer's willingness to sell its sprayed fire-resistive materials to an entity does not in itself confer qualification on the installer.
B. Source Limitations: Obtain materials through one source from a single manufacturer. Components must be a matched set (system) as supplied by the manufacturer.
C. MOCK-UP: Provide a mock-up of the Work of this Section for evaluation of surface preparation techniques and application workmanship. Finish areas as designated by Architect. Do not proceed with remaining work until installation is approved by Architect. Rework mock-up area as required to produce acceptable work.
D. DELIVERY, STORAGE, AND HANDLING: Deliver in manufacturer's original containers clearly labeled with manufacturer's name, product identification, safety information, net weight of contents and expiration date. Store in a safe manner and where the temperatures are within the limits specified by the material manufacturer. Remove empty containers must be removed from site on a daily basis. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local AHJ.
    1. Use components as supplied with no site alterations or additions.
E. PROJECT CONDITIONS: Maintain environmental conditions (including temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits. Ventilate area to receive insulation to maintain safe working conditions. Protect workers as recommended by standards and manufacturer's recommendations. Protect adjacent surfaces, windows, equipment and site areas from damage of overspray.
F. PROTECT FOAM MATERIALS as follows:
    1. Component A and B: store between 60 and 90 degrees F.
    2. Component B can be frozen but must be protected from overheating over 120 degree F, and prolonged storage over 100 degree F.

1.09 WARRANTY

A. MANUFACTURER'S LIFETIME LIMITED WARRANTY: That materials when installed by manufacturer certified contractors using factory-trained applicators and applied in accordance with the Manufacturer's requirements will perform as stated in the Manufacturer's Technical Product Data sheet. This warranty will be effective from the date of substantial completion, throughout the life of the building with no additional action by the Owner (installer to prepare registration paperwork for execution by Owner and submittal by Installer). Manufacturer's responsibility under this limited materials warranty will be to repair or replace any defective material only, and will not be responsible for labor or other costs in connection with the removal or installation of either the original or replacement product.

PART 2 - PRODUCTS

2.01 SPRAY-FOAM INSULATION:

A. PROVIDE SPRAY-APPLIED FOAM INSULATION equal to or greater than the manufacturer's tested products and meeting or exceeding the indicated requirements herein for material composition and physical properties, as substantiated with independent 3rd party testing of materials equal to those intended to be provided. Materials must expand to insulate and seal cracks, gaps and joints with a single application, and cannot contain any CFCs, HCFC, or ozone-depleting chemicals.

2.02 PERFORMANCE CHARACTERISTICS

A. Air Leakage Rate: Maximum material air leakage rate of less than 0.004 CFM per SF under a pressure differential of 0.02 L/m2 at 75 Pa per ASTM E 2178 or E 282.
B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency, and as follows.
C. Flame-Spread Index: 25 or less.
D. Smoke-Development Index: 450 or less.
E. Sustainability Requirements: Provide spray polyurethane foam insulation meeting the following:
F. Low Emitting: Insulation tested according to CA/DPH/EHLB/v1.1-2010.
G. Resistant to fungal growth per ASTM C1338.
H. Containing no PBDE.

2.03 CLOSED-CELL FOAM INSULATION (requires a thermal barrier when exposed): Vapor impermeable 2-component polyurethane based spray-applied foam using water as a blowing agent, in minimum density of 2.1 PCF, and with a minimum aged R-value at 1-inch thickness of R-4.9 at 75 deg F. Acceptable products include the following: (submit other products as a substitution request for approval by Architect):

A. HeatLok XT, by Demilec (USA) P: 877-336-4532 – www.demilecusa.com
B. ProSeal Eco # MD-R-210, by Icynene Inc., P: 1-800-758-7325, www.icynene.com
C. ThermalGuard CC2 by Rhino Linings Corp. – P: 800-422-2603 www.rhinolinings.com
D. Quik-Shield # 112 or # 112 XC by SWD Urethane (R-6.6), P: 800-828-1394, www.swdurethane.com
E. Equivalent products of BASF Corporation or Dow Chemical Company are also acceptable.

2.04 CLOSED-CELL BIO-BASED FOAM INSULATION (requires a thermal barrier when exposed): Vapor impermeable 2-component polyurethane based spray-applied foam using water as a blowing agent, in minimum density of 2.1 PCF, and with a minimum 14% bio-based and 13.5 renewable material content, with a minimum aged R-value at 1-inch thickness of R-7.4 at 75 deg F. Acceptable products include the following: (submit other products as a substitution request for approval by Architect):

A. HeatLok Soy 200, by Demilec (USA) P: 877-336-4532 – www.demilecusa.com

2.05 THERMAL BARRIER COATING: Fire-tested, water-based fire-protective intumescent coating compatible with the spray foam material to completely encapsulate the foamed-in-place insulation after installation. Pending insulation material manufacturer's approval for use, acceptable products include but are not limited to:

A. Blazelock TBX – 11 dry mils minimum thickness, by Demilec (USA) – www.demilecusa.com
B. Paint-to-Protect # DC315 – 12 to 15 dry mils minimum thickness, by SWD Urethane, www.swdurethane.com.

PART 3 - EXECUTION

3.01 EXAMINE SUBSTRATES, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of work. A substrate is in satisfactory condition if it complies with the following:

A. Substrates are free of oil, grease, incompatible primers, dirt, or other foreign substances capable of impairing bond of materials with the substrates
B. Objects penetrating foamed-in-place material, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
C. Substrates are not obstructed by ducts, piping, equipment, and other suspended construction that will interfere with applying material.

3.02 PROCEED WITH INSTALLATION ONLY AFTER unsatisfactory conditions have been corrected.

3.03 PREPARATION: Cover other work subject to damage from overspray of materials during application. Clean substrates of substances that could impair bond, including dirt, oil, grease, release agents, and incompatible primers, paints, or other coatings.

3.04 COMPLY WITH MANUFACTURER'S WRITTEN INSTRUCTIONS for mixing materials, application procedures, and types of equipment used to mix, convey, and spray on material, as applicable to the particular conditions of installation and as required to achieve the insulation thicknesses as indicated on the Drawings. Use components within their labeled shelf-life. Mix components thoroughly prior to use.

3.05 EXTEND MATERIAL IN FULL THICKNESS over the entire area of each substrate. Unless otherwise recommended in writing by material manufacturer, install body of insulation in a single course.

A. Do not spray into rising foam.
B. At water pipes within the insulated exterior walls, coordinate location of piping to ensure that it is placed on the warm side of the insulation, and that the insulation will encapsulate the piping completely.
C. Do not apply insulation within three (3) inches of heat emitting devices, or where the temperature is in excess of 200 degrees F, as per ASTM C411 or in accordance with applicable codes.
D. Install into cavities formed by framing embers to achieve the thickness or thermal-resistance value as indicated on the Drawings.

3.06 REMOVE AND REPLACE APPLICATIONS of insulation material that does not comply with the manufacturer's installation requirements.

3.07 APPLY ADDITIONAL MATERIALS per manufacturer's written instructions where application thickness does not comply with specified requirements.

3.08 APPLICATION OF THERMAL BARRIER: Except when manufacturer's testing indicates that the spray-foam material passes ASTM E-84 "Appendix X" requirements, apply a sprayed, thermal barrier coating over the installed spray-foam insulation when the insulation is exposed to the atmosphere of occupied spaces - including areas above suspended ceilings, and within attics or crawl spaces not ventilated to the exterior. If insulation will be separated from occupied spaces by not less than 1/2 inch thick gypsum board or an equivalent approved thermal barrier (as typical at exterior, finished walls), application of a sprayed thermal barrier is not required.

3.09 CLEANING: Immediately after completing installation operations in each containable area of the Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.10 PROTECT installed spray foam insulation from damage due to harmful weather exposures, physical abuse, and other causes detrimental to the installed material.

END OF SECTION 07 21 19

SECTION 07 25 00 – FLUID-APPLIED WATER RESISTIVE BARRIER (WRB)

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide a fluid-applied, vapor-permeable, air, moisture and weather-resistive barrier (WRB) system where indicated on the Drawings, as specified herein, and as necessary for a complete installation. The Work of this Section includes the primary membrane, through-wall flashing membranes, related accessories and joint treatments to bridge and seal the following air leakage pathways and gaps throughout the Project:

A. Joints and gaps in substrate material(s), and between dissimilar building envelope materials
B. Connections of the walls to the roof air barrier.
C. Connections of the walls to the foundations.
D. Seismic, expansion and control joints in the substrate material
E. Openings and penetrations at window and door frames, store front and curtain wall
F. Piping, conduit, duct and similar penetrations through the substrate
G. Ties, screws, bolts, anchorages and similar penetrations for subsequent insulation and finishes
H. Other air-leakage pathways into the building envelope.

1.02 RELATED SECTIONS

A. Section 018113 Certification Requirements.

1.03 LEED REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and sealants, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the VOC limits, as per the applicable SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.04 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
    1. 1. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
    2. 2. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant

1.05 BARRIER PERFORMANCE REQUIREMENTS: Provide a system capable of performing as a continuous vapor-permeable weather barrier, and as a liquid-water drainage plane flashed to discharge to the exterior any incidental condensation or water penetration. The system must be capable of accommodating substrate movement and sealing substrate expansion and control joints, construction material changes, and transitions at perimeter conditions without deterioration or leakage, and as follows:

A. AIR PERMEABILITY: 0.0016 CFM/SF at 1.6 PSF per ASTM E2178 and ASTM E283 with no increased air leakage when subjected to a sustained wind load of 10.5 PSF for 1 hour and gust wind load pressure of 62.8 PSF for 10 seconds when tested at 1.6 PSF per ASTM E331
B. WATER VAPOR PERMEANCE: 11.6 perms per ASTM E96 Method B when tested at 58 mils dry film thickness.
C. NO FUNGAL GROWTH when tested per ASTM D 5590
D. SURFACE BURNING: NFPA Class A, UBC Class 1, flame Spread 25, Smoke Developed 85 per ASTM E84
E. UV RESISTANCE: Passes 73 Cycles to ASTM D4799 Cycle B (Q-UV)
F. LOW TEMPERATURE FLEXIBILITY and crack bridging: Pass -4 degrees F per ASTM C836
G. LONG TERM FLEXIBILITY: Pass to CGSB 71-GP-24M
H. PASSING WATERTIGHTNESS test CGSB 37-GP-56M

1.06 REFERENCES

A. ASTM E2357: Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
B. ASTM E2178: Standard Test Method for Air Permeance of Building Materials.

C. ASTM E283: Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
D. ASTM E1677 Specification for Air Retarder (AR) Material or System for Low-Rise Framed Building Walls.
E. ASTM E330: Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
F. ASTM E331: Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
G. ASTM E96: Water Vapor Transmission of Materials.
H. CGSB 37-GP-56M: Membrane, Modified, Bituminous, Prefabricated, and Reinforced.
I. AMMA 2400: Standard Practice for Installation of Windows with a Mounting flange in Stud Frame Construction.
J. ASTM E 2112: Standard Practice for Installation of Exterior Windows, Doors and Skylights.
K. ASTM D 5590: Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay

1.07 SUBMITTALS

A. SUBMIT PRODUCT DATA for each component of the barrier system.
B. LABORATORY TEST DATA from an approved independent testing laboratory certifying the air leakage and vapor permeance rates of the air barrier membranes, including primary membrane and transition sheets, exceed the requirements of the Massachusetts Energy Code and in accordance with ASTM E2178. Include test reports on porous substrate and include sustained wind load and gust load air leakage results.
C. SUBMIT INSTALLER QUALIFICATIONS indicating training, qualifications, competencies and written approval by the primary system manufacturer for execution of the Work of this Section.

1.08 QUALITY ASSURANCES:

A. PERFORM WORK in accordance with manufacturer's written instructions and this specification. Maintain one copy of manufacturer's written instructions on site. Allow access to Work site by the air barrier membrane manufacturer's representative. Ensure continuity of the weather barrier throughout the Project.
B. PROVIDE MATERIALS from a single manufacturer regularly engaged in the manufacturing of such weather resistant membrane systems, including sheet membrane, air barrier sealants, primers, mastics, and adhesives.
C. COMPLY with all federal, state and local regulations controlling the use of volatile organic compounds (VOCs).
D. MOCK-UP: Construct mock approximately 6 foot high x 6 foot wide, incorporating typical substrate(s) with attachment of subsequent materials to demonstrate barrier membrane application details that will be used. Allow seven (7) calendar days for inspection and approval of mock up by Owner and/or Architect before proceeding with air barrier work. Pending approval, the mock-up may remain as part of the Work.
E. PRE-INSTALLATION CONFERENCE: Organize and administer not less than one (1) week prior to commencement of the Work of this Section, in accordance with requirements of Division-01 Sections. Ensure that all entities responsible for creating and maintaining a continuous plane of weather tightness are present at the conference.

1.09 DELIVERY, STORAGE, AND HANDLING

A. DELIVER MATERIALS in original, unopened packages with manufacturers' labels intact and clearly identifying products.
B. STORE MATERIALS inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes. Complete installation as rapidly as possible in each area of construction.
C. WASTE MANAGEMENT AND DISPOSAL: Separate and recycle waste materials in accordance with requirements of Division-01 Sections and per the Construction Manager's Waste Reduction Work Plan. Verify compliance with VOC regulations and requirements herein for all products, and document to the Construction Manager.

1.10 PROJECT CONDITIONS - WEATHER LIMITATIONS: Maintain ambient temperatures above 40 deg F for a minimum of 24 hours before, during, and after coatings are applied. Do not apply air-moisture barrier coating during rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air and substrate temperatures permit materials to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

1.11 COORDINATE INSTALLATION of barrier components with other trades to provide a continuous air-tight membrane.

PART 2 - PRODUCTS

2.01 FLUID-APPLIED WEATHER RESISTANT BARRIER (WRB):

A. BASIS-OF-DESIGN PRODUCT / MANUFACTURER:
Grace Construction Products (GCP): Perm-A-Barrier VPL single component acrylic membrane – or equal

2.02 PROVIDE AUXILIARY MATERIALS recommended by the prime barrier manufacturer for the intended use and compatible with the barrier membrane. Liquid-type auxiliary materials shall comply with VOC limits of AHJ representatives.

2.03 PRIMER: Liquid waterborne or solvent-borne primer recommended for substrate by manufacturer of barrier material.

2.04 WRB MEMBRANE FLASHING: For use at perimeter of window or storefront framing (head jamb or sills), transitions and joint treatments in substrates, inside or outside substrate corners, and at anchorage locations for subsequent framing or cladding materials, provide a self-adhering UV-resistant SBS modified-bitumen sheet membrane with a metallic aluminum film with the following physical properties:

A. Peel Adhesion to Primed Steel 15.0 per ASTM D 1000

B. Vapor permeance: less than 0.05 perms per ASTM E 96
C. Membrane Thickness: 0.0443 inch (40 mils)
D. Low temperature flexibility: -15 degrees F per ASTM D146 min
E. Elongation: 40% per ASTM D412-modifed min
F. Basis-of-Design Product / Manufacturer:
Perm-A-Barrier Aluminum Flashing by GCP – or equal

2.05 ADHESIVE WITH LOW VOC CONTENT: For self-adhering membranes at all temperatures, provide a synthetic rubber based adhesive, quick setting, having the following physical properties:

A. VOC: less than 240 g per L,
B. Solids by weight: 40%,
C. Drying time (initial set): 30 minutes.
D. Basis-of-Design Product / Manufacturer:
Perm-A-Barrier Adhesive Primer by GCP -- equal

2.06 PENETRATION & TERMINATION SEALANT: moisture cured, medium modulus polymer modified sealing compound having the following physical properties:

A. Compatible with sheet air barrier, roofing and waterproofing membranes and substrate,
B. Complies with Fed. Spec. TT-S-00230C, Type II, Class A
C. Complies with ASTM C 920, Type S, Grade NS, Class 25
D. Elongation: 450 – 550%
E. Remains flexible with aging and seals construction joints up to 1 inch wide
F. Basis-of-Design Product / Manufacturer:
Perm-A-Barrier Universay Sealant by GCP

PART 3 - EXECUTION:

3.01 EXAMINE SUBSTRATES and conditions under which the Work of this Section is to be performed, and notify the Construction Manager in writing of unsatisfactory conditions. All surfaces must be sound, dry, clean and free of oil, grease, dirt, excess mortar or other contaminants. Fill voids, gaps and spalled areas in substrate to provide an even plane. Strike masonry joints flush.

3.02 EXAMINE ROOF EDGES, wall framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where materials will be installed.

3.03 VERIFY that concrete or masonry has cured and aged for minimum time period recommended by the barrier manufacturer. Verify that concrete or masonry surfaces are visibly dry and free of moisture.

3.04 VERIFY that masonry joints are flush and completely filled with mortar.

3.05 PROCEED WITH INSTALLATION only after unsatisfactory conditions have been corrected.

3.06 PROTECT CONTIGUOUS WORK from moisture deterioration and soiling caused by application of air-moisture barrier. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.

3.07 PROTECT SUBSTRATES AND WALL CONSTRUCTION behind them from inclement weather during installation. Prevent penetration of moisture behind sheathing and deterioration of substrates.

3.08 INSTALLTION OF BARRIER SYSTEM

A. JOINT TREATMENT

1. SEAL JOINTS 1/4 inch and less between panels of sheathing boards with joint treatment sealant. Fill joints with approved joint treatment sealant ensuring contact with all edges of substrate material. Strike flush any excess sealant over joint layer to form a continuous layer over the joint.
2. SEAL GAPS AND VOIDS or irregular joints greater than 1/4 inch between sheathing panels, and cracks over 1/16 inch in masonry or concrete with a strip of membrane flashing lapped a minimum of 1-1/2 inch on both sides of the joint. Prime surfaces per manufacturers' instructions and allow to dry. Align and position the flashing material, remove protective film and press firmly into place. Ensure minimum 2 inches overlap at all end and side laps of the flashing membrane joints. Roll all laps and membrane with a counter top roller to ensure a weather-tight seal.
3. SEAL INSIDE AND OUTSIDE CORNERS of substrate materials or sheathing boards with a strip of membrane flashing extending a minimum of three (3) inches on either side of the corner. Prime surfaces per manufacturers' instructions and allow to dry. Align and position membrane flashing, remove protective film and press firmly into place. Ensure minimum 2 inches overlap at all end and side laps of membrane flashing. Roll all laps and membrane with a counter top roller to ensure a weather-tight seal.
4. TRANSITON AREAS: At tie-in's to structural beams, columns, floor slabs and intermittent floors, parapet curbs, foundation walls, roofing systems and at the interface of dissimilar materials, provide the seal method as indicated above for corners.

3.09 ATTACHMENTS OF SUBSEQUENT BUILIDING MATERIALS: Provide membrane flashing material extending a minimum of three (3) inches on all sides of planned anchor locations of subsequent building systems or finishes (including rain-screen assemblies and siding). Coordinate with installer(s) of subsequent systems for accurate anchorage locations. Prime surfaces per manufacturers' instructions and allow to dry. Align and position membrane flashing, remove protective film and press firmly into place. Ensure minimum 2 inches overlap at all end and side laps of membrane flashing. Roll all laps and membrane with a counter top roller to ensure a weather-tight seal.

3.10 WINDOWS AND ROUGH OPENINGS: Wrap head and jamb of rough openings with membrane flashing. Place membrane flashing across sheet-metal flashings and end dam terminations. Prime surfaces as per manufacturers' instructions and allow to dry. Align and position membrane flashing, remove protective film and press firmly into place. Ensure minimum 2 inch overlap at all end and side laps of flashing membrane, and roll all laps and he membrane with a counter top roller to ensure a weather-tight seal. Extend barrier to connect to the vapor retarder barrier, if exists.

3.11 APPLICATION OF PRIMARY WEATHER BARRIER: Apply by spray or flat trowel a complete and continuous unbroken film of liquid barrier membrane. For temperatures above 40 degrees F and rising, apply one component water based elastomeric emulsion air barrier membrane at a rate of 16.7 SF / gallon to a uniform wet film thickness of 100 mils to achieve an average dry film thickness of 58 mils. Spray apply or trowel around all projections and penetrations ensuring a complete and continuous barrier membrane. Lap liquid applied membrane 1 inch over self-adhering membranes to seal their leading edges. Allow barrier membrane to dry per manufacturers recommendations prior to placement of exterior wall finish materials.

3.12 APPLICATION OF TERMINATION SEALANT: Seal membrane terminations, heads of mechanical fasteners, masonry tie fasteners, around penetrations, duct work, electrical and other apparatus extending through the primary water resistive air barrier membrane and around the perimeter edge of membrane terminations at window and door frames with penetration and termination sealant.

3.13 FIELD QUALITY CONTROL: Make notification to manufacturer's representative and Construction Manager when sections of Work are complete, to allow review prior to covering the barrier system.

3.14 PROTECTION: Damp substrates must not be inhibited from drying out. Do not expose the backside of the substrate to moisture or rain. Cap and protect exposed back-up walls against wet weather conditions during and after application of membrane. Drying time varies depending on temperature and relative humidity. Protect air barrier Work against wet weather conditions for a minimum of 24 hours.

END OF SECTION 07 25 00

SECTION 07 27 00 – AIR BARRIER REQUIREMENTS AND TESTING

PART 1 - GENERAL

A. CONTRACTOR RESPONSIBILITY: The Contractor is responsible for the construction of an air/vapor barrier system that is contiguous and connected across the six surfaces of the building envelope meeting the performance requirements as outlined in this specification.

1. A third party testing technician (not hired by the air barrier installer, waterproofer, etc.) shall be contracted to perform a building air tightness test and thermography test to demonstrate that the building envelope is properly sealed and insulated. The testing shall be performed in accordance with the procedures outlined in this specification.

B. ENVIRONMENTAL CONSIDERATIONS: This project is designed and constructed with practices and procedures to meet the project's environmental considerations and goals. These considerations and goals are to establish a facility which is environmentally responsible, profitable, and a healthy place to live and work. To guide this process, this project is pursuing LEED Silver level certification per the 2009 Green Building Design and Construction Reference Guide for New Construction. Compliance with all credits and prerequisites shown in the checklist attached to section 01 35 13 is required. All team members will be required to perform some amount of associated documentation. Refer to Sections listed below for environmental considerations and goals, and applicable paragraphs of this specification section. The Contractor shall ensure that the requirements related to these considerations and goals, as defined in the Contract Documents, are implemented to the fullest extent.

C. REFERENCES: The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. ASTM INTERNATIONAL (ASTM)

ASTM C 1060	(90; R 2003) Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
ASTM E 779	(2003) Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
ASTM E 1677	(2005) Standard Specification for an Air Barrier (AB) Material or System for Low-Rise Framed Building Walls
ASTM E 1827	(96; R 2002) Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
ASTM E 2178	(2003) Standard Test Method for Air Permeance of Building Materials
ASTM D 4541	(2002) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

D. SUBMITTALS

1. Building Air Tightness Test Procedures;
   a. The third party testing technician shall submit detailed test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed for the Building Air Tightness Test to the Owner's Building Enclosure Commissioning Agent (BECxA). The Building Air Tightness Test Procedures shall be submitted not later than 60 days after Notice to Proceed.
   b. The third party testing technician shall submit detailed test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed for the Thermography Test.
2. Test Reports;
   a. The inspection and testing agency will submit a certified written report, in duplicate, of each inspection, test, or similar service to the Contractor with duplicate copies to the Commissioning Agent no later than 15 days after each test.
   b. Report Data: Written reports of each inspection, test, or similar service include, but are not limited to, the following
   c. Date of Issue
   d. Project title and number
   e. Name, address, and telephone number of testing agency
   f. Dates and locations of samples and tests or inspections
   g. Names of individuals making the inspection or test
   h. Identification of product and specification section
   i. Complete inspection or test data
   j. Test results and an interpretation of test results

k. Ambient conditions at the time of sample taking and testing
l. Comments or professional opinion on whether inspected orstested work complies with Contract Document requirements
m. Name and signature of inspector
n. Recommendations on retesting

3. Building Air Tightness Test Reports;
   a. The Building Air Tightness Test analysis and report shall be submitted not later than 15 days after the test.
4. Thermography Test Reports;
   a. The Thermography Test analysis and report shall be submitted not later than 15 days after the test.

E. ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS
1. This section includes administrative and procedural requirements for accomplishing an airtight building enclosure that controls infiltration or exfiltration of air.
   a. The airtight components of the building enclosure and the joints, junctures and transitions between materials, products, and assemblies forming the airtightness of the building enclosure are called "the air barrier system".
   b. The Contractor is responsible for the coordination between the trades, the proper scheduling and sequencing of the work, preconstruction meetings, inspections, tests, and related actions including reports by independent inspection and testing agencies.
   c. The Contractor shall ensure that the intent of constructing the building enclosure with a continuous air barrier system to control air leakage into or out of the conditioned space is achieved. The air barrier system shall have the following characteristics:
   d. It must be continuous with all joints sealed.
   e. It must be structurally supported to withstand positive and negative air pressures applied to the building enclosure.
   f. Connection shall be made between:
   g. Foundation and walls
   h. Walls and windows
   i. Walls and doors
   j. Different wall systems
   k. Walls and roof
   l. Walls and roof over unconditioned space
   m. Walls, floors, and roofs across construction, control, and expansion joints.
   n. Walls, floors, and roofs to utility, pipe and duct penetrations.
   o. It is the Contractor's responsibility to ensure that all penetrations through the air/vapor barrier system, and all paths of air infiltration or exfiltration, are sealed airtight.
   p. Inspection and testing services are required to verify compliance with requirements specified or indicated.
   q. The Contractor is required to coordinate between subcontractors required to provide an airtight building enclosure, customized fabrication and installation procedures and the following:
   r. Continuity of the air/vapor barrier materials and products with joints to provide assemblies. Continuity of all the enclosure assemblies with joints and transition materials to provide a whole building air barrier system.
   s. Specific quality control requirements for individual construction activities are specified in the sections of the specifications. Requirements in those sections may also cover production of standard products. It is the Contractor's responsibility to ensure that each subcontractor is adequately and satisfactorily performing the quality assurance documentation, tests, and procedures required by each section.
   t. Specified inspections, tests, and related actions do not limit the Contractor's quality control procedures that facilitate compliance with Contract Document requirements.

F. THIRD PARTY BUILDING AIR TIGHTNESS TEST TECHNICIAN
1. Responsibilities
   a. Describe the test procedures, test apparatus, and analysis method.
   b. Perform the Building Air Tightness Test.
   c. Perform the Thermography Test.
   d. Participate in identifying deficiencies in the building construction utilizing smoke testing.
   e. Submit a report of each air tightness test whether successful or not.
   f. Submit a report of each thermography test identifying problem areas.

G. QUALITY CONTROL
1. On-Site Quality Control: The Installers are required to undertake quality control measures on a daily basis. They shall have completed air barrier training and shall utilize equipment to inspect and test the quality of their work.
2. Documentation and Reporting: Installers shall document the entire installation process on daily job site reports. These reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results. Every job site report is data based and reviewed by the Contractors Quality Assurance Manager.

H. CONTRACTOR RESPONSIBILITIES
1. Coordination of Sub-Contractor(s): The Contractor shall provide coordination between the Sub-Contractors involved in the construction of the air barrier system, coordinate the sequence of construction to ensure

continuity of the air barrier system joints, junctures, and transitions between materials and assemblies of materials and products from substructure to walls to roof. The Contractor shall provide quality assurance procedures, testing and verification as specified herein. The Contractor shall facilitate inspections, tests, and other quality control services specified elsewhere in the Contract Documents and required by the Architect. These coordination efforts are critical to avoid costly removal and replacement of construction materials to accommodate inspections and tests. The cost of all tear out and rework shall be at the Contractors expense.

2. Pre-Construction Conferences: The Contractor shall organize pre-construction conferences between the sub-contractors involved in the construction of the air/vapor/water control systems to discuss where each sub-contractor begins and ends, the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, and transitions between materials, products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.
3. Construction Mock-Up: The Contractor shall build a construction mock-up of every joint, juncture, and transition between materials, products, and assemblies of products specified in the different sections to be installed. Work will not begin until the mock-up is satisfactory to the Architect.
4. Pre-Test Preparation: The General Contractor shall prepare the building and all of its components for proper air barrier testing which include, but is not limited to:
    a. All “intentional” holes in the building enclosure must be sealed or otherwise effectively isolate. This includes air intake or exhaust louvers, make-up air intakes, pressure relief dampers or louvers, dryer and exhaust vent dampers and any other intentional hole that is not included in the air barrier design or construction.
    b. Plumbing traps must be filled with water or capped off.
    c. The HVAC system must be shut down or disabled.
    d. All interior doors that access the building enclosure (roof, walls and fenestrations, floor) will be held open during the test to create a single uniform zone.
    e. Buildings with a dropped ceiling plenum will need to have tiles removed at a rate of one per every 500 sq ft. Additional tiles may be removed at the discretion of the testing agent so a uniform pressure distribution in the plenum space is achieved.
    f. Combustion equipment must be disabled or be in the “pilot” position.
    g. Door closers or other equipment that crosses the door threshold must be removed to allow for a tight seal between the door panels and the door frame.
    h. If the test zone is within a larger building enclosure that is not subject to the testing, the areas outside of the test zone must be at ambient (outdoor) conditions. This can be achieved by open man-doors or overhead coiling doors in the open position.
    i. Power must be supplied with-in 50 feet of all locations of testing equipment and each piece of equipment shall be on different circuits.
    j. Construct temporary walls where needed in order to section the building into smaller test zones.
    k. All door openings utilized for testing equipment shall be no larger than 48” wide by 84” high and no smaller than 32” wide and 77” high. If door openings are not within these size requirements, the contractor shall construct a temporary acceptable air barrier to meet the size requirements.

I. AIR/VAPOR BARRIER SYSTEM PERFORMANCE REQUIREMENTS

1. The air barrier system performance requirements shall comply with this section as follows:
    a. Materials: materials used for the air barrier system in the opaque envelope shall have an air permeance not to exceed 0.004 cfm/sqft under a pressure differential of 0.3-inches water gage (1.57psf) (0.02L/s.m2@75Pa) when tested in accordance with ASTM E 2178.
    b. Assemblies: assemblies of materials and components shall have an air permeance not to exceed 0.03 cfm/sqft under a pressure differential of 0.3-inches water gage (1.57psf)(0.15L/s.m2@75Pa) when tested in accordance with ASTM E 1677.

PART 2 - PRODUCTS

A. AIR/VAPOR BARRIER MEMBRANE SYSTEM

1. Membrane
   Liquid applied, 40 mil thick, 100 percent rubber copolymer membrane.
2. Transition Strip
   Self-adhering SBS smooth surfaced 40 mil modified bitumen membrane with primer as recommended by the manufacturer.
3. Substrate Filler and Mastic
   As recommended by membrane manufacturer.

PART 3 - EXECUTION

A. REPAIR AND PROTECTION

1. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or sample taking and similar services. Upon completion of inspection, testing, or sample taking and similar services, the Contractor shall repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

B. TESTING AND INSPECTION

1. The following qualitative and quantitative tests and inspections shall be conducted by the Contractor during installation of the air/vapor barrier system.

a. Qualitative Testing and Inspection:
   (1) Ensure continuity of the air/vapor barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.
   (2) Ensure structural support of the air/vapor barrier system to withstand design air pressures.
   (3) Ensure masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.
   (4) Ensure site conditions for application temperature, and dryness of substrates are within guidelines.
   (5) Ensure substrate surfaces are properly primed.
   (6) Ensure laps in materials are at least a 2-inch minimum, shingled in the correct direction or mastic applied on exposed edges with no fishmouths.
   (7) Ensure that mastic is applied on cut edges.
   (8) Ensure that a roller has been used to enhance adhesion.
   (9) Measure application thickness of liquid applied materials to manufacturer's specifications for the specific substrate.
   (10) Ensure that the correct materials are installed for compatibility.
   (11) Ensure proper transitions for change in direction and structural support at gaps.
   (12) Ensure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

b. Quantitative Tests:
   (1) Provide written test reports of all tests performed with a copy to the Commissioning Agent and Architect.

C. THIRD PARTY BUILDING AIR TIGHTNESS TEST

1. Test the building for air tightness. This test is intended to demonstrate that the building construction has produced an effective air barrier so that air infiltration and exfiltration are minimized. An adequate air barrier demands close attention to construction and installation of the building envelope components. For example, close attention must be paid to all seals, to caulking around window, door, and louver frames, to sealing of joints between panels, to sealing the wall-to-floor interface and especially to sealing the wall-to-roof interface.
   a. The test shall be performed when the building envelope is enclosed and prior to the installation of the finished ceilings.
   b. The contractor shall notify the Architect and BECxA at least 48 hours prior to the Building Air Tightness Test. A representative of the architect may witness the test and record test readings.
   c. Prior to the test, the third party testing technician shall submit evidence that the test equipment has been calibrated within the past two years.
   d. The measuring instruments used in the tests shall be digital meters, not analog gages. Tests shall be performed when the wind speed is less than 10 mph, and no rain unless biases can be accounted for in the software and test procedures.
   e. The fans used in the testing procedure shall have a minimum of 6,500 CFM capacity at 75 Pa pressure.
   f. The following conditions and Building Air Tightness Test Procedures will be provided by the contractor before the testing:
      (1) All exterior doors and windows shall be closed with the exception of the mechanical room door to the outside which shall be open;
      (2) All interior doorways including stairway doors shall be open with the exception of any mechanical room doors to the inside which shall be closed;
      (3) All HVAC systems shall be de-energized;
      (4) All appliances shall be de-energized;
      (5) All plumbing traps shall be full;
      (6) The contractor shall follow the Recommended Test Envelope Conditions in ASTM E 1827, Table 1, for the Closed Envelope condition.
   g. The third party testing technician shall first test the building by pressurizing the building positively relative to outdoors at multiple pressures up to at least 0.30 in.w.g. (inches water gauge). From the positive pressure test, the building leakage rate shall be measured in accordance with ASTM E 1827 or ASTM E 779.
   h. The third party testing technician shall then perform a negative pressure test at multiple pressures up to at least 0.30 in.w.g. and compare the results to the positive test. Where differences of 10% exist between the tests, the contractor shall investigate the causes and resolve the reasons for the differences. The contractor shall retest the building.
   i. The acceptable leakage in cubic feet per minute maximum at a differential pressure of 0.3 in. w.g. is as follows:

(1) Main building excluding loading docks and maintenance areas: 0.25 cfm per s.f. of Building.

j. Use techniques described in ASTM E 1186 to locate the leak sources, then correct the significant deficiencies in the building construction, then retest. Fog/smoke agents used to identify leaks shall be the non-toxic type. Smoke generators shall have a minimum output capacity of 11,000 cubic feet per minute to reduce testing time.

k. For each test, the third party testing technician shall take a minimum of 5 readings at various pressures and air flows within the range of the calibrated equipment. In the test report, test points shall be shown in graphical form on a log-log scale with pressure in inches water column displayed on the horizontal axis and flow in cfm displayed on the vertical axis.

l. A report shall be submitted for each leak test whether successful or not.

m. If the pressure test fails to meet the established criteria, it is the General Contractor's responsibility to provide permanent sealing measures to reduce or eliminate leak sources. The General Contractor shall be responsible for each retest (perform another pressure test) after sealing has been completed up to a maximum of 3 retests. Repeat this sequence of documenting test results in the test report, performing diagnostic tests, documenting recommendations for additional sealing measures in the test report, sealing leak locations per recommendations, and re-testing as necessary until the building envelope passes the pressure test and is in compliance with the performance requirements, or up to a maximum of 3 retests. If the pressure test fails to meet the established criteria after 3 retests, the General Contractor, Owner, and Commissioning Agent shall meet to determine the best course of action.

D. THERMOGRAPHY TEST

1. The building envelope shall be tested using Infrared Thermography technology. The thermography testing shall be completed in accordance with the requirements of ASTM C 1060. The Commissioning Agent and Building Envelope Commissioning Agent shall be notified two days in advance of the testing. The third party testing technician shall note any areas of compromise in the building envelope, and shall note all actions taken to correct those areas. The thermography shall be used to demonstrate the problem areas have been corrected.

E. TEST REPORTS

1. Submit all Building Air Tightness Test Reports and Thermography Test Reports to the Commissioning Agent and Building Envelope Commissioning Agent to be distributed to the Project Team.

END OF SECTION 07 27

SECTION 07 50 00 – MEMBRANE ROOFING SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide an integrated, membrane roofing system to include roof insulation and a single-ply roofing membrane, where indicated on the Drawings, as specified herein, and as necessary for complete installation. Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist uplift pressures, thermally induced movement, and exposure to weather without failure. The membrane roofing system includes the following:

A. Air-barrier sheet over roofing substrate
B. Double-layered insulation board to achieve the indicated thermal value
C. Tapered insulation to achieve positive slope to roof drains, scuppers or gutters, as applicable
D. Mechanically attached roof deck board
E. Fully-adhered thermoplastic roof membrane,
F. TPO coated sheet metal as part of integral roof gutter system.
G. Installation of roofing system terminations and penetrations in accordance with manufacturer's recommendations
H. Roof protection pads around HVAC equipment, and at roof-mounted piping supports.

1.02 REFERENCED STANDARDS: In addition to compliance with Manufacturer's standards and recommended installation details, comply with the following unless more stringent details are indicated in the Drawings:

A. National Roofing Contractors Association (NRCA) Roofing Manual: Membrane Roof Systems – most recent edition.

1.03 RELATED SECTIONS

A. Section 018113 Certification Requirements.
B. 07 72 00 – Roof Accessories

1.04 PERFORMANCE REQUIREMENTS

A. PROVIDE INSTALLED ROOFING MEMBRANE AND BASE FLASHINGS that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
B. MATERIAL COMPATIBILITY: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

1.05 LEED PERFORMANCE REQUIREMENTS

A. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material must be within 100 miles of project site for credit.
B. Recycled Content: Provide materials with recycled or reused content.
C. Provide documentation for the initial SRI rating value complying with 82 for low-sloped roof.

1.06 FM/GLOBAL LISTING: Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a membrane roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings, and as follows:

A. Fire/Windstorm Classification: Class 1A-90
B. Hail Resistance: SH (Sever Hazard).

1.07 ENERGY PERFORMANCE REQUIREMENTS:

A. SOLAR REFLECTIVITY: Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency. Provide roofing system that is listed on the DOE's Energy Star "Roof Products Qualified Product List" for low-slope roof products. Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.
B. LONG-TERM THERMAL RESISTANCE (LTTR): Comply with ASTM C 1289-11A for "aged" thermal-resistane values of roof insulation, equivalent to a time-weighted thermal design R-value for not less than 15 years.

1.08 INSTALLER QUALIFICATIONS: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.

1.09 EXTERIOR FIRE-TEST CHARACTERISTICS: "Class B" per ASTM E-108 by testing identical products to the approval of AHJ representatives.

1.10 SUBMITTALS

A. SUBMIT PRODUCT DATA for each type of product indicated.
B. SHOP DRAWINGS: For roofing system. Include plans, elevations, sections, details, and attachments to other Work:
   1. Base flashings and membrane terminations.
   2. Tapered insulation, including slopes.
   3. Insulation fastening patterns.
   4. Membrane seaming plan (indicating additional perimeter and corner attachments)
C. INSTALLER CERTIFICATES: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

D. MANUFACTURER CERTIFICATES: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article. Submit evidence of meeting performance requirements.
E. QUALIFICATION DATA: For Installer and manufacturer.
F. MAINTENANCE DATA: For roofing system to include in maintenance manuals.
G. WARRANTIES: Special warranties specified in this Section.
H. INSPECTION REPORT: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.11 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material. Include distance to Project and cost for each regional material.
C. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.
D. Provide manufacturer's documentation / test report for the initial SRI rating value complying with 82 for low-sloped roof

1.12 QUALITY ASSURANCE

A. INSTALLER QUALIFICATIONS: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
B. MANUFACTURER QUALIFICATIONS: A qualified manufacturer that has FMG approval for membrane roofing system identical to that used for this Project.
C. SOURCE LIMITATIONS: Obtain components for membrane roofing system either from or approved by the roofing membrane manufacturer.
D. FIRE-TEST-RESPONSE CHARACTERISTICS: Provide membrane roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to AHJ representatives. Materials must be identified with appropriate markings of applicable testing and inspecting agency.
E. EXTERIOR FIRE-TEST EXPOSURE: Class B; ASTM E 108, for application and roof slopes indicated.
F. SURFACE-BURNING CHARACTERISTICS OF FOAM PLASTIC INSULATION: Provide materials that meet requirements of FM/Global 4450 or UL 1256 (provide written confirmation to AHJ representatives upon request).

1.13 PRE-INSTALLATION CONFERENCE: Conduct at the Project site. Comply with requirements in Division-01. Review methods and procedures related to roofing system including, but not limited to, the following:

A. Meet with Architect, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.
B. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
C. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
D. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
E. Review structural loading limitations of roof deck during and after roofing.
F. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
G. Review governing regulations and requirements for insurance and certificates if applicable.
H. Review temporary protection requirements for roofing system during and after installation.
I. Review roof observation and repair procedures after roofing installation.

1.14 DELIVERY, STORAGE, AND HANDLING

A. DELIVER ROOFING MATERIALS to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
B. STORE LIQUID MATERIALS in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
C. PROTECT ROOF INSULATION MATERIALS from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
D. HANDLE AND STORE ROOFING MATERIALS and place equipment in a manner to avoid permanent deflection of deck.

1.15 WARRANTY

A. SPECIAL ROOF SYSTEM AND FLASHING WARRANTY: Manufacturer's warranty to include labor and material payment without monetary limitation (NDL), in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks. Special warranty includes roofing membrane, base flashings, roofing membrane accessories, roof insulation, fasteners, metal edge and associated sheet metal flashings, and other components of the membrane roofing system, and as follows:

1. Non-prorated, and fully transferable (not limited to original Owner)
2. Warranty limit up to 100 MPH wind speed (calculated at ground level)
3. No Owner’s signature required for execution of warranty, and
4. Dispute settlement to be held in the state where the project is located

B. WARRANTY PERIOD: TWENTY (20) years from date of Substantial Completion.

PART 2 - PRODUCTS:

2.01 FLEECEBACK TPO ROOF MEMBRANE: Uniform, flexible sheet formed from a thermoplastic polyolefin, internally fabric or scrim reinforced, with a bottom surface application of fleece:

A. Manufacturer: Basis of Design: GAF

1. Equivalent products Firestone, John Manville, Carlisle, or Sarnafil are acceptable.
2. Other manufacturers may be approved by Substitution Request.

B. System: FleeceBACK TPO Adhered Roofing System
C. Nominal roof sheet thickness: 60 mils minimum
D. Total roof sheet thickness: 115 mils
E. Roof Membrane surface color:

1. LOW ROOF: White
2. HIGH ROOF: Solar Gray

F. Roof Membrane parapet wall flashing color:

1. LOW ROOF: White
2. HIGH ROOF: Solar Gray

2.02 PROVIDE AUXILIARY MEMBRANE MATERIALS recommended by roofing system manufacturer for intended use and compatible with membrane roofing. Liquid-type auxiliary materials must meet VOC limits of AHJ representatives.

2.03 TYPICAL SHEET FLASHING: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as primary roofing sheet membrane.

2.04 TPO COATED SHEET FLASHING: Manufacturer's standard TPO coated sheet flashing of same material, type, reinforcement, thickness, and color as primary roofing sheet membrane.

2.05 BONDING ADHESIVE: Manufacturer's standard solvent-based bonding adhesive for membrane, and solvent-based bonding adhesive for base flashings.

2.06 METAL TERMINATION BARS: Manufacturer's standard predrilled stainless-steel, aluminum or polymer bars, approximately 1 by 1/8 inch thick; with anchors.

2.07 FASTENERS: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

2.08 MISCELLANEOUS ACCESSORIES: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, and other accessories as recommended by the Manufacturer.

2.09 ROOF INSULATION:

A. PROVIDE PREFORMED ROOF INSULATION BOARDS that comply with primary roofing membrane manufacturer's requirements and referenced standards, selected from manufacturer's standard sizes.
B. REQUIRED MINIMUM INSULATION THICKNESS (roof insulation only – not including roof deck board, air-surfaces or other roofing or deck materials): Except for a 1 inch deep evenly tapered recess within two (2) feet of drains or scuppers, provide the following minimum thickness of insulation throughout the roof system. When the roof structure does not provide the minimum slope, increase the insulation thickness with tapered insulation, preformed saddles, valley crickets, tapered edge strips, and other insulation shapes to provide the required slope:
C. MINIMUM ROOF SLOPE (of field-areas): 1/4 inch per foot per AHJ requirements (with positive slope at valleys)
D. TWO-LAYER POLYISO ROOF INSULATION: Provide minimum of two (2) separate layers (not a composite system) of staggered, rigid, closed cell polyisocyanurate-board insulation meeting ASTM C 1289, Type II, with felt or glass-fiber mat facer on both surfaces, in overall thickness required to meet minimum insulation value indicated above:

1. TYPICAL MINIMUM THICKNESS: R-30 = 5-1/4 inch overall at R-5.7/inch – subject to insulation mfgr's verification

2.10 AIR BARRIER: Provide self adhering rubberized asphalt laminated to woven polypropylene film with release liner from same manufacturer as roofing membrane.

A. Basis of Design: GAF SA Vapor Retarder XL
B. Provide all accessories required by manufacturer for fully warrantied installation including but not limited to:

1. Adhesive(s) / Primers
2. Lap Sealants

C. Performance Requirements

1.

Physical Property	Test Method	Requirement
Thickness	ASTM D1970	40 mils
Tensile Strength	ASTM D412	250 psi
Elongation	ASTM D412	250%
Peel Adhesion	ASTM D90	35 lbs/in
Puncture Resistance	ASTM E154	60 lbs
Permeability	ASTM D1970*	0.015 perms
Air Permeance	ASTM E2178	0.000 L*m2 @ 75 Pa

*D1970 is tested to E96 standards for permeability

2.11 ROOF DECK COVER BOARD: Provide minimum 5/8 inch thick “Dens-Deck StormX” roof board above all insulation boards as a membrane substrate, installed per manufacturer’s recommendations with joints staggered, above the double-layers of insulation, and secure to substrate decking.

A. FM Very Severe Hail (VSH) Classification
B. Type X
C. ANSI/UL 790 and ULC-CAN S114 Classification – Class A (unlimited slope)
D. UL 1256 Classification
E. FM Class 1
F. When used as part of a UL 1256 or FM 4450 classified system, no additional thermal barrier is required per IBC

2.12 AGGREGATE BALLAST: **AT LOW ROOF**

A. Where indicated on drawings, provide smooth, washed, riverbed gravel or other applicable smooth-faced stone materials without broken pieces that will adequately withstand weather exposure without significant deterioration and that will not contribute to membrane degradation.

1. Size Range: 16 mm to 32 mm

2.13 INSULATION ACCESSORIES

A. PROVIDE ACCESSORIES recommended by insulation manufacturer for intended use and compatible with membrane roofing.
B. MECHANICAL FASTENERS: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
C. COLD FLUID-APPLIED ADHESIVE: Manufacturer's standard cold fluid-applied adhesive formulated to adhere roof insulation to substrate.

PART 3 - EXECUTION

3.01 EXAMINATION

A. EXAMINE SUBSTRATES, AREAS, AND CONDITIONS, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
B. VERIFY THAT ROOF OPENINGS AND PENETRATIONS are in place and set and braced and that roof drains are securely clamped in place.
C. VERIFY THAT WOOD BLOCKING, CURBS, AND NAILERS are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
D. VERIFY THAT SURFACE PLANE FLATNESS and fastening of steel roof deck comply with requirements in Division 5 Section "Steel Deck."

3.02 PREPARATION

A. CLEAN SUBSTRATE of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
B. PREVENT MATERIALS FROM ENTERING AND CLOGGING roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
C. COMPLETE TERMINATIONS AND BASE FLASHINGS and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.03 INSULATION INSTALLATION

A. COORDINATE INSTALLING MEMBRANE ROOFING system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
B. COMPLY WITH membrane roofing system manufacturer's written instructions for installing roof insulation.
C. INSTALL MULTIPLE LAYERS OF INSULATION under area of roofing to achieve required thickness, with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
D. TRIM SURFACE OF INSULATION where necessary at roof drains so completed surface is flush and does not restrict flow of water.
E. INSTALL INSULATION WITH LONG JOINTS of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
F. FASTEN INSULATION PER FMG's "Approval Guide" for specified Windstorm Resistance Classification, including additional anchors at perimeters and building corners.

3.04 AIR BARRIER INSTALLATION: Loosely lay in a single layer, with sides and ends lapping a minimum of 6 inches.

3.05 FULLY-ADHERED ROOFING MEMBRANE INSTALLATION

A. LAYOUT MEMBRANE SHEETS with primary seams perpendicular to ribs of metal decking, with side laps and seams shingled with slope of roof deck when possible.
B. INSTALL ROOFING MEMBRANE over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing. Accurately align roofing membranes and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
C. APPLY BONDING-ADHESIVE TO SUBSTRATE and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.

D. SEAMS: Clean entire seam area, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation. Probe all seams after welds have cooled to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane. Verify field strength of seams a minimum of twice daily and repair seam sample areas. Repair tears, voids, and lapped seams in roofing membrane that does not meet requirements.
E. APPLY ADHESIVE AND MECHANICALLY FASTEN roofing membrane securely at terminations, penetrations, and perimeter of roofing, and seal all edges. Space fasteners for “Grade-C” metal deck unless otherwise indicated. Spread sealant or mastic bed over drain-flanges at deck-drains and securely seal membrane in place with clamping ring.

3.06 BASE FLASHING INSTALLATION

A. INSTALL SHEET FLASHINGS AND PREFORMED FLASHING ACCESSORIES and adhere to substrates according to membrane roofing system manufacturer's written instructions.
B. APPLY SOLVENT-BASED BONDING ADHESIVE to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
C. FLASH PENETRATIONS and field-formed inside and outside corners with sheet flashing.
D. CLEAN SEAM AREAS AND OVERLAP and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.
E. TERMINATE AND SEAL TOP OF SHEET FLASHINGS and mechanically anchor to substrate through termination bars.

3.07 INSTALL PROTECTION PADS by cleaning roofing of dirt and debris prior to installation. Apply pads securely to surface of roofing membrane, by heat welding to substrate or adhere with roofing system Manufacturer’s approved compatible adhesive per their written instructions:

A. WALKWAY PADS: Provide at all traffic concentration points and where indicated on the Drawings. Place individual units with 6” minimum space between each pad. Install at the following locations:
    1. Around all sides of HVAC equipment mounted on roof
    2. Around all sides of skylights, roof hatches or access doors.
    3. Provide path from roof hatch / access ladder to all HVAC equipment requiring periodic service.
B. PIPING SUPPORTS: Install below piping support units provided by others for rooftop mounted electrical conduits, gas piping, or for condensate piping, if provided. Coordinate with other trades for locations required.

3.08 FIELD QUALITY CONTROL

A. ROOF SYSTEM TESTING: Engage a qualified testing agency to inspect the substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to the Architect. The testing agency must survey the entire roof area for potential leaks using electric field vector mapping (EFVM).
B. OWNER’S TESTING: Owner reserves the right to engage a separate, qualified independent testing and roof inspecting entity to review test reports and to perform separate, roof tests and inspections.
C. TESTING AGENCY: Owner reserves the right to engage a qualified independent testing and roof inspecting entity to perform roof tests and inspections and to prepare test reports.
D. MANUFACTURER’S FINAL ROOF INSPECTION: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
E. REPAIR OR REMOVE AND REPLACE components of membrane roofing system that do not comply with specified requirements. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
F. PROTECT MEMBRANE ROOFING SYSTEM from damage and wear during remainder of construction period. Repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

3.09 PROTECTING AND CLEANING

A. PROTECT MEMBRANE ROOFING SYSTEM from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
B. CORRECT DEFICIENCIES in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

END OF SECTION 07 50 00

SECTION 07 54 00 – ROOFING INSTALLER'S WARRANTY

ROOFING INSTALLER'S WARRANTY
WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

Owner:	University of Arkansas
Address:	10 McDonnell Way
Building Name/Type:	Track Operations High Performance Center
Address:	10 McDonnell Way
Area of Work:	TPO Roof is _____s.f.
Acceptance Date:	_____.
Warranty Period:	20 years
Expiration Date:	_____.

AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

This Warranty is made subject to the following terms and conditions:
Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by: lightning;peak gust wind speed exceeding 100 MPH; fire; failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;vapor condensation on bottom of roofing; and activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.

During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.

This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

IN WITNESS THEREOF,

this instrument has been duly executed this _____ day of _____, _____.

Authorized Signature: _____.

Name: _____.

Title: _____.

END OF SECTION 07 54 23

SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 PROVIDE SHEET METAL FLASHING and sheet metal trim, where indicated on the Drawings, as specified herein, and as required for the prevention of water penetration into the building.

A. This Section includes requirements for sheet metal work associated with roofing and siding Work of other Sections.

1.02 RELATED SECTIONS include the following:

A. Section 018113 Certification Requirements.
B. Division-06 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
C. Applicable Division-07 Sections for roofing Work
D. Division-07 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
E. Division-07 Section "Joint Sealants" for field-applied sealants to sheet metal flashing and trims.

1.03 PERFORMANCE REQUIREMENTS

A. INSTALL SHEET METAL FLASHING AND TRIM TO WITHSTAND wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
B. FABRICATE AND INSTALL ROOF EDGE FLASHING and copings capable of resisting forces according to recommendations in FMG Loss Prevention Data Sheet 1-49, for the following windstorm classification. Identify materials with nameof fabricator and design approved by FM Approvals.
   1. Windstorm Classification: Class 1-90
C. THERMAL MOVEMENTS: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
   2. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.04 LEED PERFORMANCE REQUIREMENTS

A. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material shall be within 100 miles of project site for credit if possible.
B. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.

1.05 SUBMITTALS

A. SUBMIT PRODUCT DATA including manufacturer's installation instructions and general recommendations for each specified sheet material and fabricated product.
B. SUBMIT SHOP DRAWINGS showing layout, joining, profiles, and anchorages of fabricated work, including major counter-flashings, trim/fascia units, expansion joint systems, etc., with plan & elevation layout at 1/4" scale, details at 3" scale. Show 3-dimensional details in shop drawings where different joint conditions connect so that tradespersons can clearly understand the intent and relationship of different materials and conditions.
C. SAMPLES FOR VERIFICATION: For each type of exposed finish required, prepare Samples of size indicated below:
   1. Sheet Metal Flashing: 12 inches long for each color used.
   2. Metal Roofing: 12 x 12 inch panel of each panel and finish

1.06 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material (this includes components of the mix design). Include distance to Project and cost for each regional material. (if applicable)
C. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.

1.07 QUALITY ASSURANCES:

A. REFERENCED QUALITY STANDARD: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1.08 MOCKUP:

A. PROVIDE MATERIALS for construction of a field mockup of each different color/finish and exposed application of sheet metal Work indicated, showing the full range of exposed color and finish textures to be expected in the completed construction.
B. BEFORE INSTALLING THE WORK OF THIS SECTION, build mockup to verify selections made under sample Submittals and to demonstrate aesthetic effects. Refer to Division-01 Section Quality Requirements for general requirements of Mockup.

1.09 DELIVERY, STORAGE, AND HANDLING

A. DELIVER SHEET METAL FLASHING MATERIALS and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.
B. STACK MATERIALS on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.10 COORDINATE INSTALLATION of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.01 TYPICAL PRE-FINISHED ALUMINUM SHEET: ASTM B 209, Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:

A. Fluoropolymer 2-Coat System: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
B. Color: as selected by the Architect from the manufacturer’s full range

2.02 ZINC SHEET:

A. Color: To match Zinc Wall Panels. Refer to Drawings and Section 07 42 13 Metal Wall Panels.

2.03 UNDERLAYMENT MATERIALS

A. SYNTHETIC UNDERLAYMENT: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F; and complying with physical requirements of ASTM D 226 for Type I and Type II felts. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Atlas Roofing Corporation; Summit.
2. Engineered Coated Products; Nova-Seal II.
3. SDP Advanced Polymer Products Inc; Palisade.

B. SELF-ADHERING, HIGH-TEMPERATURE SHEET: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Carlisle Residential, a division of Carlisle Construction Materials; WIP 300HT.
2. Grace Construction Products, a unit of W. R. Grace & Co.-Conn.; Grace Ice and Water Shield HT
3. Metal-Fab Manufacturing, LLC; MetShield.
4. Owens Corning; WeatherLock Specialty Tile & Metal Underlayment.
5. Polyguard Products, Inc.; Deck Guard HT.
6. SDP Advanced Polymer Products Inc; Palisade SA-HT.
7. SLIP SHEET: Rosin-sized paper, minimum 3 lb/100 sq. ft.

2.04 MISCELLANEOUS MATERIALS

A. PROVIDE MATERIALS AND TYPES OF FASTENERS, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
B. FASTENERS: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads. At exposed fasteners, provide heads matching color of sheet metal by means of plastic caps or factory-applied coating. At flashing and trim, provide blind fasteners of high-strength aluminum or stainless-steel, or self-drilling screws, gasketed, with hex washer head.
C. SEALING TAPE: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
D. ELASTOMERIC SEALANT: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
E. BUTYL SEALANT: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.
F. BITUMINOUS COATING: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
G. REGLETS: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated.

1. Material: Stainless steel, 0.019 inch thick – mill finished
2. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
3. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
4. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
5. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.

6. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
7. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
8. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Cheney Flashing Company.
    b. Fry Reglet Corporation.
    c. National Sheet Metal Systems, Inc.
    d. Sandell Manufacturing.

2.05 GENERAL FABRICATION

A. CUSTOM FABRICATE SHEET METAL flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
B. FABRICATE SHEET METAL flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
C. TYPICAL SEALED JOINTS: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
D. EXPANSION PROVISIONS: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.
E. CONCEAL FASTENERS AND EXPANSION PROVISIONS where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
F. FABRICATE CLEATS AND ATTACHMENT DEVICES from same material as accessory being anchored or from compatible, noncorrosive metal. Fabricate in thickness as recommended by SMACNA's "Architectural Sheet Metal Manual" and FMG Loss Prevention Data Sheet 1-49 for application but not less than thickness of metal being secured.
G. PROTECT MECHANICAL AND PAINTED FINISHES on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.06 FABRICATED ITEMS:

A. THROUGH-WALL SHEET METAL (SM) FLASHINGS: Fabricate in sections not exceeding 12-foot- long (minimum 8-feet long at continuous units) at shelf angles in masonry construction, at head and sill openings in either masonry or frame construction, and at all locations where indicated on the Drawings. Fabricate discontinuous lintel, sill, and similar flashings to extend a minimum of four (4) inches beyond each side of wall openings. Form with 2-inch-high end dams where flashing is discontinuous. Fabricate with drip edge, by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees. Fabricate with preformed corners, end dams, other special shapes, and seaming materials at splices as applicable. Fabricate through-wall flashings from one of the following materials:
    1. Stainless Steel: 0.016 inch thick.
    2. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch thick.
B. WALL-PANEL FLASHINGS: Provide "Z"-shaped units at exterior horizontal panel joints and other wall panel trims where indicated on the Drawings to match color of wall panels to greatest extent feasible:
    1. Metal: 0.032 inch thick minimum “typical prefinished” aluminum
C. SHEET METAL FASCIA: Provide flush faced finish of typical prefinished 0.040 inch thick sheet metal in lengths not to exceed ten (10) feet maximum.
    1. Joints shall be constructed with flush, hemmed edges butted with 3/8 inch wide joint over six (6) inch wide back plate of same material.
        a. Align joints with building column lines and metal panel wall and/or soffit joints.
    2. Install with continuous cleats for concealed anchorages as applicable.
D. BRAKE-METAL WINDOW & DOOR OPENING TRIMS: At window and door openings, provide anodized finished, flush fabricated metal brake-metal formed trims as indicated on the Drawings and as required herein:
    1. Fabricate in one-piece units up to ten (10) feet maximum, with flush sealed, butted joints of 3/8 inch space over 6 inch wide joint plates of equal thickness, when required.
    2. Provide continuous metal cleats of 0.040 inch thick aluminum sheet, attached through WRB typically @ 12 inch centers, and anchor to masonry when necessary at outside edges.
    3. At sills, break-form outside edge to fit over continuous cleat and extend down to cover top edge of masonry or wall panel minimum of one (1) inch high. Fold-up (end dam) both sides to extend up behind wall trim not less than four (4) inches. Anchor and seal sill unit to substrate – lapping wall unit over end dam to drain
    4. Install so that sealant between units will be concealed behind exposed opening trims to the greatest extent feasible.
    5. At head and jamb trims, align outside edge to be flush with exterior wall finish typically.
    6. At head trims, fold-down sides behind jamb trims not less than two (2) inches.

7. Apply jamb trims after installation of head and sill trims, over end dams of sills and turned-down edges of head trims.

E. THROUGH-WALL SHEET METAL (SM) FLASHINGS (typical at openings in masonry or frame construction): Fabricate in sections not exceeding 12-foot- long (minimum 8-feet long at continuous units) at shelf angles in masonry construction, at head and sill openings in either masonry or frame construction, and at all locations where indicated on the Drawings. Fabricate discontinuous lintel, sill, and similar flashings to extend a minimum of four (4) inches beyond each side of wall openings. Form with 2-inch-high end dams where flashing is discontinuous. Fabricate with drip edge, by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees. Fabricate with preformed corners, end dams, other special shapes, and seaming materials at splices as applicable. Fabricate from 0.016 inch thick (25 gage) minimum stainless-steel sheet meeting ASTM A 240 or ASTM A 666, Type 304, dead soft, fully annealed, in 2D (dull, cold-rolled) finish, unless otherwise noted.

F. CAST-IN-PLACE (CIP) SHEET METAL (SM) REGLETS: Fabricate from not less than 0.0187 inch thick (26 gage) stainless-steel sheet meeting ASTM A 240 or ASTM A 666, Type 304, dead soft, fully annealed, in 2D (dull, cold-rolled) finish, unless otherwise noted. Temporarily fill or cover face opening of reglet unit to prevent intrusion of concrete or debris.

G. FABRICATE SCUPPERS of dimensions indicated with a closure flange trim at exterior side extending one (1) beyond face of wall, and with a fully welded (not seamed) wall flange returning on the roof side of the wall four (4) inches minimum, and a base flange on the interior extending 4 inches onto the field of the roof inside the exterior wall. Fabricate scupper from 0.024 inch thick (24 gage) stainless steel or TPO coated sheet metal. Fabricate exterior-side scupper trim-ring of minimum 2-1/2 inch width of pre-finished metal to match building standard material.

H. FABRICATE CONDUCTOR HEADS with flanged back and stiffened top edge of dimensions and in conformance with shape or profile as indicated on the Drawings. Provide angled bottom shape to prevent damage from freezing water typically, complete with outlet tube, exterior flange trim, downspout strainer, and built-in overflows of double the area of the downspout (except at open-topped conductor head not exceeding the primary drainage level). Fabricate conductor heads from 0.032 inch minimum thickness (20 gage) prefinished steel metal, unless otherwise indicated.

I. FABRICATE ROOF-EDGE to comply with requirements of SPRI/FM 4435 ES-1 Wind Design Standard, and provide verification of compliance by wind-testing to that standard with the shop-drawing submittal. Fabricate in eight (8) foot minimum to ten (10) foot maximum length units, with 1/2 inch wide joints between sections. Fabricate joint plates of same thickness as metal roof edge. Provide continuous cleat fastening bottom edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld to be watertight.

1. Fascia Height: Four (4) inch minimum exposed face – or greater if indicated on the Drawings or as otherwise required to comply with referenced wind design standard.
2. Fascia Metal: Typical prefinished sheet metal of 0.024 inch thick (24 gage) galvanized steel sheet in color indicated on the Drawings or as selected by Architect from Manufacturer's full range of available options, including metallic finishes
3. Continuous Cleats: 0.0312 inch thick (20 gage) galvanized steel sheet
4. Fascia Metal: Typical prefinished "Kynar 500" aluminum sheet metal, in minimum 0.040 inch thicknes in color indicated on the Drawings or as selected by Architect from Manufacturer's full range of available options, including metallic finishes.
5. Continuous Cleats: 0.050 aluminum sheet metal
6. Joint Style: Butt, with 6-inch- wide cover plates

J. PRE-ENGINEERED ROOF-EDGE FASCIA: Provide a two-piece, pre-engineered roof-edge and fascia system meeting SPRI/FM 4435 ES-1 Wind Design Standard, consisting of a snap-on pre-finished sheet metal fascia cover in section lengths not exceeding 10 feet, and a continuous metal anchor bar with integral drip edge cleat to engage fascia cover. Provide matching mitered and welded/sealed corner units as applicable:

1. Fascia Height: Four (4) inch minimum exposed face – or greater if indicated on the Drawings or as otherwise required to comply with referenced wind design standard.
2. Fascia Metal: Typical prefinished aluminum, 24 gage sheet in color indicated on the Drawings or as selected by Architect from Manufacturer's full range of available options, including metallic finishes
3. Continuous Cleats: 0.0312 inch thick (20 gage) galvanized steel sheet or as otherwise required by system design
4. Fascia Metal: Typical prefinished "Kynar 500" aluminum sheet metal, in minimum 0.040 inch thickness in color indicated on the Drawings or as selected by Architect from Manufacturer's full range of available options, including metallic finishes.
5. Continuous Cleats: 0.050 aluminum sheet metal or as otherwise required by system design
6. Fascia Joint Style: Butt type with six (6) inch wide concealed splice plates
7. APPROVED SYSTEMS / MANUFACTURERS:
    a. "TerminEdge" by A. W. P. Hickman Company (Ph: 800-892-9173 - website: www.wph.com)
    b. "Anchor-Tite Coping" by Metal-Era, Inc., (Ph: 262-549-6900 - website: www.metalera.com)

K. MANUFACTURED COPINGS: Provide pre-engineered coping system meeting SPRI/FM 4435 ES-1 Wind Design Standard, consisting of a continuous metal anchor system with an integrated drip edge cleat on both sides of the parapet wall to engage the coping, in section lengths not exceeding 10 feet. Provide matching mitered and welded corner units, and as follows:

1. Fascia Height: Four (4) inch minimum exposed faces – or greater if indicated on the Drawings or as otherwise required to comply with referenced wind design standard.
2. Fascia Joints: butt type with concealed splice plates.

3. Fascia Metal: Typical prefinished “Kynar 500” sheet metal, in minimum 0.050 sheet aluminum thickness, in color indicated on the Drawings or as selected by Architect from Manufacturer’s full range of available options, including metallic finishes.
4. APPROVED SYSTEMS / MANUFACTURERS:
   a. “PermaSnap 2” by A. W. P. Hickman Company (P: 800-892-9173 - web: www.wph.com)
   b. “Perma-Tite Gold Coping” by Metal-Era, Inc., (P: 262-549-6900 - web: www.metalera.com)
   c. Other manufacturers pre-approved by Architect

L. BASE FLASHINGS, COUNTER-FLASHINGS, & FLASHING RECEIVERS: Fabricate from pre-finished aluminum: 0.040 inch thick.
M. FABRICATE GUTTER UNITS from pre-finished .032 aluminum, to cross-section indicated on the Drawings, complete with end pieces, outlet tubes, and other accessories as required.
1. Stiffen outer edges with hemmed return.
2. Fabricate in minimum 96-inch- long sections, but no more than 50 feet long.
3. Fabricate with all internal joints at ‘facets’ welded.
4. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
5. Provide all gutters with screen of 1/4" aluminum hardware cloth in aluminum frame.

N. DOWNSPOUTS: Internal drains. RE: Plumbing.
O. ROOF DRAIN LEADER / DOWNSPOUT NOZZLE: Round fabricated stainless steel frame with fabricated secured perforated stainless steel hinged strainer to discharge roof drain leader, with extending not less than 2 inches beyond wall surface, in nominal unit size to match pipe leader.
1. Basis-of-Design: # Z199 Downspout Cove by Zurn., https://www.zurn.com/products/building-drainage/roof-drains/downspouts/z199-dc , or equal

2.07 MISCELLANEOUS SHEET METAL FABRICATIONS:

A. ROOF FLASHING TRANSITIONS: At roof and roof-to-wall transitions, roof-to-roof-edge flashings and fascia-cap transitions, shop-fabricate interior and exterior corners from 0.034 inch thick (20 gage) minimum galvanized steel sheet
B. AT ROOF BASE FLASHINGS, shop fabricate interior and exterior corners from 0.028 inch thick (22 gage) minimum galvanized steel sheet
C. AT COUNTERFLASHINGS, shop fabricate interior and exterior corners from 0.022 inch thick (24 gage) minimum galvanized steel sheet
D. FLASHING RECEIVERS: shop fabricate from 0.022 inch thick (24 gage) minimum galvanized steel sheet
E. ROOF-PENETRATION FLASHING: Fabricate from 0.019 inch thick (26 gage) stainless steel sheet minimum
F. METAL SPLASH PANS: Fabricate from 0.019 inch thick (26 gage) stainless steel sheet minimum
G. EQUIPMENT SUPPORT FLASHING: Fabricate from 0.028 inch thick (22 gage) minimum galvanized steel sheet
H. OVERHEAD-PIPING SAFETY PANS: Fabricate from 0.040 inch thick (18 gage) minimum galvanized steel sheet

PART 3 - EXECUTION

3.01 ANCHOR SHEET METAL FLASHING AND TRIM and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system. Torch cutting of sheet metal flashing and trim is not permitted.

3.02 METAL PROTECTION: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals. Coat side of sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.

3.03 UNDERLAYMENT: Install all sheet metal flashing over a course of underlayment, and cover with a slip sheet. Install underlayment wrinkle free in accordance with its manufacturer’s instructions, typically using adhesive to minimize mechanical fasteners under the sheet metal flashing and trim. Prime substrate when recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment material. Apply underlayment in a shingle fashion to shed water, with end laps not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Cover underlayment within fourteen (14) days. Apply slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trims.

3.04 INSTALL EXPOSED SHEET METAL FLASHING AND TRIM without excessive oil canning, buckling, and tool marks. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of sealant. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

3.05 INSTALL CONTINUOUS CLEATS anchored at 12” inch centers minimum at face.

3.06 EXPANSION PROVISIONS: Provide for thermal expansion of exposed flashing and trim, by spacing joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.

3.07 FASTENERS: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws. With aluminum sheet metal, use aluminum or stainless-steel fasteners.

3.08 SEAL JOINTS WITH ELASTOMERIC SEALANT as required for watertight construction. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant.

When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants." Rivet or weld joints in uncoated aluminum where necessary for strength.

3.09 ROOF FLASHING INSTALLATION

A. INSTALL SHEET METAL ROOF FLASHING AND TRIM to produce a complete roof drainage system, and to comply with SMACNA's "Architectural Sheet Metal Manual" as applicable. Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight. Coordinate installation of roof perimeter flashing with installation of roof drainage system items.

B. metal ROOF EDGE FLashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated. When face of roof edge exceeds 4 inches in height, interlock exterior bottom edge of with a continuous cleats anchored to substrate at 6-inch centers. Anchor interior leg of coping with screw fasteners and washers at 3-inch OC in staggered rows (6 inch OC each row) or as otherwise required by Manufacturer's tested unit.

C. COPINGS: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 16-inch centers. Anchor interior leg of coping with screw fasteners and washers at 24-inch centers.

D. ROOF-PENETRATION FLASHING: Seal units with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

E. PIPE OR POST COUNTERFLASHING: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

F. COUNTERFLASHING: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant.

3.10 HANGING GUTTERS: Join sections with riveted and soldered joints or with lapped joints sealed with elastomeric sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets straps spaced not more than 36 inches apart. Provide end closures and seal watertight with sealant. Slope to downspouts. Fasten gutter spacers to front and back of gutter. Loosely lock straps to front gutter bead and anchor to roof deck. Anchor and loosely lock back edge of gutter to continuous cleat, eave or apron flashing. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart. Anchor gutter with spikes and ferrules spaced not more than 24 inches apart. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion joint caps.

A. Install continuous gutter screens on gutters with noncorrosive fasteners, removable for cleaning gutters.

3.11 INSTALL PARAPET SCUPPERS by continuously supporint unit, set to correct elevation for rainwater flow, and seal flanges to interior wall face, over tapered edge strips, and under roofing membrane. Anchor scupper closure trim flange to exterior wall and seal with elastomeric sealant to scupper. Loosely lock front edge of scupper with conductor head.

3.12 INSTALLATION OF DOWNSPOUTS: Telescope upper sections into lower section 1-1/2" minimum, rivet and seal. Elbow downspouts away from building at building offsets and toward building immediately below gutter connection. Attach to wall strap anchors at downspout top, bottom, horizontal joints and at 10 feet maximum centers. Secure straps to wall at masonry where downspouts are open ended, and extend 3" minimum into storm drain boot or underground drainage system, when indicated.

3.13 INSTALL SPLASH PANS where downspouts discharge on low-slope roofs, even if not so indicated in the Drawings. Set in elastomeric sealant compatible with the roofing substrate.

3.14 WALL FLASHING INSTALLATION

A. INSTALL SHEET METAL WALL FLASHING to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. WINDOW AND STOREFRONT OPENINGS: Install sill flashings with end-dams in framed wall systems. Install through-wall flashings to extend 4 inches beyond wall openings in masonry construction.

C. INSTALL EXPANSION JOINT COVERS at locations and of configuration indicated. Lap joints a minimum of four (4) inches in direction of water flow.

3.15 OVERHEAD-PIPING SAFETY PANS: Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.

3.16 INSTALLATION TOLERANCES: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.17 CLEANING AND PROTECTION

A. CLEAN EXPOSED METAL SURFACES of substances that interfere with uniform oxidation and weathering.

B. REMOVE TEMPORARY PROTECTIVE COVERINGS and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

C. REPLACE SHEET METAL FLASHING AND TRIM that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 62 00

SECTION 07 72 00 – ROOF ACCESSORIES

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide roof specialties and accessories as shown on the drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents.

1.02 SUBMIT PRODUCT DATA including manufacturer's technical product data, rough-in diagrams, details, installation instructions and general product recommendations.

1.03 SUBMIT SHOP DRAWINGS indicating plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and fieldassembled work.

1.04 QUALITY STANDARDS: Comply with SMACNA "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap- flashing to coordinate with type of roofing indicated. Comply with "NRCA Roofing and Waterproofing Manual" details for installation of units. Provide manufacturers' standard units, modified as necessary to comply with requirements. Shop fabricate each unit to greatest extent possible.

PART 2 - PRODUCTS

2.01 ROOF CURBS: Provide internally reinforced roof-curb units with integral spring-type vibration isolators and capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, integral metal cant and integrally formed deck-mounting flange at perimeter bottom. Coordinate curb dimensions with roughing-in information or Shop Drawings of equipment to be supported. Coordinate loading requirements with applicable subcontractor / supplier of equipment to be supported.

A. MINIMUM HEIGHT: sixteen (16) inches unless otherwise indicated
B. MATERIAL: Zinc-coated (galvanized) steel sheet, 0.079 inch thick (14 gage) minimum, in mill phosphatized finish.
C. INSULATION: Factory insulated with 1-1/2-inch thick cellulosic or glass-fiber board insulation, with factory-installed treated wood nailer at top of curb, continuous around unit perimeter.
D. BASE FLANGE: Three (3) inch minimum of same material as curb unit, with roof slope accommodated by sloping the deck-mounting flange. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
E. LINER: Same material as curb, of manufacturer's standard thickness and finish.
F. TOP SURFACE: Level around perimeter
G. AVAILABLE MANUFACTURERS: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

(1) AES Industries, Inc.
(2) Curbs Plus, Inc.
(3) Custom Solution Roof and Metal Products.
(4) Greenheck Fan Corporation.
(5) LM Curbs.
(6) Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
(7) Roof Products, Inc.
(8) Thybar Corporation.
(9) Vent Products Co., Inc.

2.02 EQUIPMENT SUPPORTS: Provide internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, integral metal cant, and integrally formed deckmounting flange at perimeter bottom. Coordinate curb dimensions with roughing-in information or Shop Drawings of equipment to be supported. Coordinate loading requirements with applicable subcontractor / supplier of equipment to be supported.

A. MINIMUM HEIGHT: sixteen (16) inches unless otherwise indicated
B. MATERIAL: Zinc-coated (galvanized) steel sheet, 0.079 inch thick (14 gage) minimum, in mill phosphatized finish.
C. INSULATION: Factory insulated with 1-1/2-inch thick cellulosic or glass-fiber board insulation, with factory-installed 3-1/2 inch wide continuous treated wood nailer at top of equipment support.
D. BASE FLANGE: Three (3) inch minimum of same material as curb unit, with roof slope accommodated by sloping the deck-mounting flange. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
E. AVAILABLE MANUFACTURERS: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

(1) AES Industries, Inc.
(2) Curbs Plus, Inc.
(3) Custom Solution Roof and Metal Products.
(4) Greenheck Fan Corporation.
(5) LM Curbs.
(6) Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
(7) Pate Company (The).
(8) Roof Products, Inc.
(9) Thybar Corporation.
(10) Vent Products Co., Inc.

2.03 ROOF HATCHES: Provide metal roof-hatch units with lids and insulated double-walled curbs, with welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter

gasketing, and integrally formed deck-mounting flange at perimeter bottom. Reinforce frame at corners for mounting safety railing.

A. FOR SHIP'S LADDER - UNIT SIZE & TYPE: Double-leaf lid, in 30 by 96 inch nominal size, unless otherwise indicated
B. FOR LADDER – UNIT SIZE & TYPE: Single-leaf lid, in 30 by 36 inch nominal, unless otherwise indicated
C. MINIMUM HEIGHT: fourteen (14) inches unless otherwise indicated
D. MATERIAL: Zinc-coated (galvanized) steel sheet, 0.079 inch thick (14 gage) minimum, in mill phosphatized finish.
E. LOADS: Minimum 40-lbf/sq. ft external live load and 20-lbf/sq. ft. internal uplift load.
F. HATCH LID MATERIAL: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
G. LID HARDWARE: Galvanized or Stainless-steel spring latch with turn handles inside and outside, butt- or pintle-type hinge system, and padlock hasps inside and outside. Provide two-point latch on lids larger than 84 inches.
H. INSULATION: Factory insulated with 1-1/2-inch thick cellulosic or glass-fiber board insulation, with factory-installed treated wood nailer at top of curb, continuous around unit perimeter.
I. BASE FLANGE: Three (3) inch minimum of same material as curb unit, with roof slope accommodated by sloping the deck-mounting flange. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
J. LINER: Same material as curb, of manufacturer's standard thickness and finish.
K. TOP SURFACE: Level around perimeter
L. AVAILABLE MANUFACTURERS: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

(1) ThermalMAX #BRHTA, by Babcock-Davis

2.04 ROOF-HATCH SAFETY RAILING SYSTEM: Provide integrated system at roof hatch opening sides adjacent to roof edge, including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to the roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction, and as follows:

A. HEIGHT: 42 inches minimum above finished roof deck.
B. POSTS AND RAILS: Galvanized-steel pipe, 1-1/4 inches in diameter or galvanized-steel tube, 1-5/8 inches in diameter.
C. MAXIMUM OPENING SIZE: System constructed to prevent passage of a sphere 21 inchesin diameter.
D. POST AND RAIL TOPS AND ENDS: Weather resistant, closed or plugged with prefabricated end fittings. Provide weep holes or another means to drain entrapped water in hollow sections of handrail or railing members. Fabricate joints exposed to weather to be watertight.
E. FASTENERS: Manufacturer's standard, finished to match railing system.
F. FINISH: Manufacturer's standard two-coat polymer, in color as selected by Architect from full range of available options

2.05 LADDER SAFETY-ASSIST POST (at vertical ladder only – not for ships-ladder): Safety railing system Manufacturer's standard ladder safety post that will lock in place on full extension, with release mechanism to return post to closed position: Height: 42 inches minimum above finished roof deck.

A. Material and Finish: 1-5/8" minimum diameter galvanized steel tube or mill finished aluminum.

2.06 PIPE SUPPORTS: Provide adjustable-height, extruded-aluminum tube type units in Manufacturer's standard finish, filled with urethane insulation; 2 inches in diameter; with aluminum baseplate, EPDM base seal, manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, and extruded-aluminum carrier assemblies; suitable for quantity of pipe runs and sizes.

A. PIPE SUPPORT HEIGHT: As indicated on the Drawings.
B. ROLLER ASSEMBLY: With stainless-steel roller, sized for supported pipes.
C. PIPE SUPPORT FLASHING: Manufacturer's standard insulated sleeve flashing with integral base flange; of 0.062 inch thick mill finished aluminum sheet
D. MANUFACTURERS: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

(1) Thaler Metal USA Inc.

2.07 PREFORMED EXHAUST VENT FLASHING SLEEVES: Provide double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and slotted metal collar.

A. METAL: 0.063 inch thick aluminum sheet, in mill finish
B. SIZE / diameter: As required for vent size indicated on the Drawings.
C. MANUFACTURERS: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

(1) Custom Solution Roof and Metal Products.
(2) Thaler Metal USA Inc.

2.08 ROOF VENTS

A. Provide vents as shown on the drawings and required by code.

2.09 CONDENSER PADS

A. Unless otherwise indicated or specified in the Drawings, provide the following condenser pads:

(1) Thermoplastic

(2) 2-inch thick, unless 3-inch thick is required by local code.
(3) Size to fit condenser.
(4) Acceptable manufacturers:
  (a) Diversitech
  (b) Bramec
  (c) OR equal.

2.10 FASTENERS: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened. Where removal of exterior exposed fasteners affords access to building, provide nonremovable fastener heads.

PART 3 - EXECUTION

3.01 EXAMINE SUBSTRATES, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored. Verify dimensions of roof openings for roof accessories. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION: Comply with manufacturer's instructions and recommendations. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks. Coordinate with installation of roof deck and other substrates to receive accessory units, and vapor barriers, roof insulation, roofing and flashing; as required to ensure that each element of the work performs properly, and that combined elements are waterproof and weathertight.

A. Install roof curbs and hatches so that top surface is level
B. Install equipment supports so that top surfaces are level with each other.
C. Install pipe supports so top surfaces are in contact with and provide equally distributed support along length of supported items.
D. Attach safety railing system to roof-hatch curb and attach ladder-assist post according to manufacturer’s instructions.

3.03 ANCHOR UNITS SECURELY to supporting structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

3.04 INSTALL ROOF ACCESSORY ITEMS in accordance with construction details of "NRCA Roofing and Waterproofing Manual", and in accordance with requirements of the manufacturer of the prime roofing materials.

3.05 ISOLATION: Where metal surfaces of units are to be installed in contact with noncompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation.

3.06 OPERATIONAL UNITS: Test operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

3.07 CLEAN exposed metal surfaces in accordance with manufacturer's instructions. Touch up damaged metal coatings. Clean exposed surfaces according to manufacturer's written instructions. Clean off excess sealants.

3.08 REMOVE AND REPLACE ROOF ACCESSORIES that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 72 00

SECTION 07 81 00 - APPLIED FIREPROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes sprayed fire-resistive materials.
B. Related Requirements:
   (1) Section 078123 "Intumescent Fireproofing" for mastic and intumescent fire-resistive coatings.
   (2) Section 099646 "Intumescent Painting" for intumescent paints that are fire retarding but not fire resistive.

1.03 DEFINITIONS

A. SFRM: Sprayed fire-resistive materials.

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.
B. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Sustainable Design Submittals:
   (1)
C. Shop Drawings: Framing plans or schedules, or both, indicating the following:
   (1) Extent of fireproofing for each construction and fire-resistance rating.
   (2) Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
   (3) Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
   (4) Treatment of fireproofing after application.
D. Samples: For each exposed product and for each color and texture specified, [**in manufacturer's standard dimensions**] [**4 inches (102 mm) square**] <**Insert dimensions**> in size.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**] [**and**] [**testing agency**].
B. Product Certificates: For each type of fireproofing.
C. Evaluation Reports: For fireproofing, from ICC-ES.
D. Preconstruction Test Reports: For fireproofing.
E. Field quality-control reports.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.
B. Mockups:
   (1) Build mockups [to verify selections made under Sample submittals and to demonstrate aesthetic effects] [to set quality standards for materials and execution] [and] [for preconstruction testing].
   (2) Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
C. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: **Owner will engage** a qualified testing agency to perform preconstruction testing on **field mockups of** fireproofing.
B. Field Mockup: Size and location to be determined in field during construction.
   (1) Provide test specimens and assemblies representative of proposed materials and construction.
   (2) Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.
   (3) Bond Strength: Test for cohesive and adhesive strength according to ASTM E736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   (4) Density: Test for density according to ASTM E605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
C. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.

D. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
E. For materials failing tests, obtain applied-fireproofing manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.09 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 44 deg F (7 deg C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.
B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.
C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings from an applicable testing agency.
D. Steel members are to be considered unrestrained unless specifically noted otherwise.
E. Asbestos: Provide products containing no detectable asbestos.

2.02 SPRAYED FIRE-RESISTIVE MATERIALS

A. Materials and finishes vary with manufacturer and product and are based on approved fire-resistance designs that comply with the fire-resistance ratings of building elements as required by code. Coordinate the approved fire-resistance design with the material composition and other salient characteristics retained.
B. Sprayed Fire-Resistive Material: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application or conveyed in a dry state and mixed with atomized water at place of application.
C. Application: Designated for both interior and exterior use by a qualified testing agency acceptable to authorities having jurisdiction.
D. Bond Strength: Minimum **430-lbf/sq. ft. (20.59-kPa)** cohesive and adhesive strength based on field testing according to ASTM E736.
E. Density: Not less than density specified in the approved fire-resistance design, according to ASTM E605.
F. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E605, whichever is thicker, but not less than 0.375 inch (9 mm).
G. Combustion Characteristics: ASTM E136.
H. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
I. Flame-Spread Index: **10** or less.
J. Smoke-Developed Index: **10** or less.
K. Compressive Strength: Minimum **100 lbf/sq. in. (689 kPa)** according to ASTM E761.
L. Corrosion Resistance: No evidence of corrosion according to ASTM E937.
M. Deflection: No cracking, spalling, or delamination according to ASTM E759.
N. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E760.
O. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours according to ASTM E859.
P. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in **no growth on specimens per ASTM G21**.
Q. Sound Absorption: **NRC** of**0.65 to 0.75** according to ASTM C423 for Type A mounting according to ASTM E795.
R. Finish: As selected by Architect from manufacturer's standard finishes; Apply separate, colored topcoat after finishing.
S. Color: As selected by Architect from manufacturer's full range

2.03 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:
C. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
D. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E736.
E. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.
F. Metal Lath (as required by UL assembly specified): Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and fireproofing manufacturer's

written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive fireproofing.

G. Reinforcing Fabric (as required by UL assembly specified):: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by fireproofing manufacturer.

H. Reinforcing Mesh (as required by UL assembly specified):: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fireproofing manufacturer. Include pins and attachment.

I. Sealer: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by fireproofing manufacturer for each fire-resistance design.

J. Topcoat: Suitable for application over applied fireproofing; of type recommended in writing by fireproofing manufacturer for each fire-resistance design.

(1) Cement-Based Topcoat: Factory-mixed, cementitious hard-coat formulation for trowel or spray application over SFRM.

(2) Water-Based Permeable Topcoat: Factory-mixed formulation for brush, roller, or spray application over applied SFRM. Provide application at a rate of **60 sq. ft./gal.** **(1.5 sq. m/L)**

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.

B. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.

C. Verify that objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.

D. Verify that substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.

E. Verify that concrete work on steel deck is complete before beginning fireproofing work.

F. Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning fireproofing work.

G. Conduct tests according to fireproofing manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

H. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.02 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.

B. Clean substrates of substances that could impair bond of fireproofing.

C. Prime substrates where included in fire-resistance design and where recommended in writing by fireproofing manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fireproofing.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.03 APPLICATION

A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.

B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.

D. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.

E. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.

F. Metal Decks:

(1) Do not apply fireproofing to underside of metal deck substrates until concrete topping, if any, is completed.

(2) Do not apply fireproofing to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fireproofing.

G. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.

H. Spray apply fireproofing to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.

I. Extend fireproofing in full thickness over entire area of each substrate to be protected.

J. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.

K. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fireproofing that differs in color from that of encapsulant over which it is applied.

L. Where sealers are used, apply products that are tinted to differentiate them from fireproofing over which they are applied.
M. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.
N. Cure fireproofing according to fireproofing manufacturer's written instructions.
O. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.
P. Finishes: Where indicated, apply fireproofing to produce the following finishes:
   (1) Spray-Textured Finish: Finish left as spray applied with no further treatment.
   (2) Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.

3.04 FIELD QUALITY CONTROL

A. Special Inspections: **Owner will engage** a qualified special inspector to perform the following special inspections:
B. Test and inspect as required by the IBC, Subsection 1705, "Sprayed Fire-Resistant Materials."
C. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
D. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
E. Fireproofing will be considered defective if it does not pass tests and inspections.
F. Remove and replace fireproofing that does not pass tests and inspections, and retest.
G. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.
H. Prepare test and inspection reports.

3.05 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.
B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing is without damage or deterioration at time of Substantial Completion.
C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.
D. Repair fireproofing damaged by other work before concealing it with other construction.
E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 07 81 00

SECTION 07 84 00 – FIRESTOPPING

PART 1 - GENERAL

1.01 THIS SECTION INCLUDES firestop systems for system terminations and penetrations through the fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items.

1.02 PERFORMANCE REQUIREMENTS

A. PROVIDE 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 assembly penetrated.
B. F-RATED SYSTEMS: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
C. FOR PIPING PENETRATIONS for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

1.03 SUBMITTALS

A. PRODUCT DATA: For each type of through-penetration firestop system product indicated.
B. SHOP DRAWINGS: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to AHJ representatives that evidences compliance with requirements for each condition indicated.

1.04 QUALITY ASSURANCE

A. INSTALLER QUALIFICATIONS: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
B. SOURCE LIMITATIONS: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.
C. FIRE-TEST-RESPONSE CHARACTERISTICS: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" paragraph above:
    (1) Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for firestop systems acceptable to AHJ representatives.
    (2) Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements.
    (3) Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
    (4) Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
    (5) Underwriters Laboratory (UL)’s "Fire Resistance Directory."

1.05 DELIVERY, STORAGE, AND HANDLING

A. DELIVER PRODUCTS to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.
B. STORE AND HANDLE MATERIALS for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.06 PROJECT CONDITIONS

A. ENVIRONMENTAL LIMITATIONS: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
B. VENTILATE through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.07 COORDINATION

A. COORDINATE CONSTRUCTION of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
B. COORDINATE SIZING of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

1.08 PRODUCTS

A. MANUFACTURERS: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    (1) A/D Fire Protection Systems Inc.
    (2) Grace Construction Products.
    (3) Hilti, Inc.
    (4) Johns Manville.

(5) Nelson Firestop Products.
(6) NUCO Inc.
(7) Passive Fire Protection Partners.
(8) RectorSeal Corporation.
(9) Specified Technologies Inc.
(10) 3M Fire Protection Products.
(11) Tremco, Inc.; Tremco Fire Protection Systems Group.
(12) USG Corporation.DAP Inc.

1.09 COMPATIBILITY: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

1.10 ACCESSORIES: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1.11 Permanent forming/damming/backing materials, including the following:

A. Slag-/rock-wool-fiber insulation.
B. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
C. Fire-rated form board.
D. Fillers for sealants.
E. Temporary forming materials.
F. Substrate primers.
G. Collars.
H. Steel sleeves.

1.12 FIRESTOPPING MATERIALS

A. GENERAL: Provide through-penetration firestop systems containing the types of fill materials indicated by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
B. LATEX SEALANTS: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
C. FIRESTOP DEVICES: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
D. INTUMESCENT PUTTIES: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
E. INTUMESCENT WRAP STRIPS: Single-component intumescent elastomeric sheets with aluminum foil on one side.
F. MORTARS: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
G. SILICONE FOAMS: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
H. SILICONE SEALANTS: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
   (1) Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.
I. CAST-IN-PLACE FIRESTOP DEVICES: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
J. PILLOWS/BAGS: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

1.13 MIXING: For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 2 - EXECUTION

2.01 EXAMINATION: Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

2.02 PREPARATION

A. SURFACE CLEANING: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
   (1) Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.

(2) Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.

B. PRIMING: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. USE MASKING TAPE to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

2.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. INSTALL FIRESTOP SYSTEMS to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. INSTALL FORMING/DAMMING/BACKING MATERIALS and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. INSTALL FILL MATERIALS for firestop systems by proven techniques to produce the following results:

D. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

(1) Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
(2) For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

E. IDENTIFY THROUGH-PENETRATION FIRESTOP SYSTEMS with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

(1) The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
(2) Contractor's name, address, and phone number.
(3) Through-penetration firestop system designation of applicable testing and inspecting agency.
(4) Date of installation.
(5) Through-penetration firestop system manufacturer's name.
(6) Installer's name.

2.04 CLEANING AND PROTECTION

A. CLEAN OFF 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 damage materials in which openings occur.

B. PROVIDE FINAL PROTECTION AND MAINTAIN CONDITIONS during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

2.05 FIRESTOPPING SCHEDULE

Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
For all systems below, the type of fill material must be as required to achieve the rating required, per manufacturer’s testing and recommendations.

A. FIRESTOPPING WITH NO PENETRATING ITEMS: UL-Classified Systems C-AJ-.Submit number of systems compatible with fire rating of system being penetrated.

B. FIRESTOPPING FOR METALLIC PIPES, CONDUIT, OR TUBING: UL-Classified Systems: C-AJ-.Submit number of systems compatible with fire rating of system being penetrated.

C. FIRESTOPPING FOR NONMETALLIC PIPE, CONDUIT, OR TUBING: UL-Classified Systems: C-AJ-.Submit number of systems compatible with fire rating of system being penetrated

D. FIRESTOPPING FOR ELECTRICAL CABLES: UL-Classified Systems: C-AJ-.Submit number of systems compatible with fire rating of system being penetrated.

E. FIRESTOPPING FOR CABLE TRAYS WITH ELECTRIC CABLES: UL-Classified Systems: C-AJ-.Submit number of systems compatible with fire rating of system being penetrated.

F. FIRESTOPPING FOR INSULATED PIPES: UL-Classified Systems: C-AJ-.Submit number of systems compatible with fire rating of system being penetrated.

G. FIRESTOPPING FOR MISCELLANEOUS ELECTRICAL PENETRANTS UL-Classified Systems: C-AJ-.Submit number of systems compatible with fire rating of system being penetrated

H. FIRESTOPPING FOR MISCELLANEOUS MECHANICAL PENETRANTS: UL-Classified Systems: C-AJ-.Submit number of systems compatible with fire rating of system being penetrated.

I. FIRESTOPPING FOR GROUPINGS OF PENETRANTS: UL-Classified Systems: C-AJ-.Submit number of systems compatible with fire rating of system being penetrated

J. TOP OF WALL SEAL AT SHAFTWALL: UL # HW-D-0119 using sealant or approved equivalent.

END OF SECTION 07 84 00

SECTION 07 92 00 – JOINT SEALANTS

PART 1 - GENERAL

1.01 PROVIDE sealants complying with requirements included herein, in order to establish and maintain airtight, vermin proof, and waterproof continuous seals on a permanent basis. Failures of installed sealants to comply with this requirement will recognized as failures of materials and workmanship. Types of applications include but are not limited to the following:

1.02 EXTERIOR JOINTS in the following vertical or horizontal surfaces:

A. Pavement joints
B. Construction joints in cast-in-place concrete.
C. Control and expansion joints in unit masonry.
D. Joints in stone cladding and cast stone.
E. Joints in exterior insulation and finish systems.
F. Perimeter joints between exterior cladding materials and frames of doors, windows, and louvers.
G. Control and expansion joints in soffits and other overhead surfaces.

1.03 INTERIOR JOINTS in the following vertical surfaces and horizontal nontraffic surfaces:

A. Control and expansion joints on exposed interior surfaces of exterior walls.
B. Perimeter joints of exterior openings where indicated.
C. Vertical joints on exposed surfaces of interior unit masonry concrete walls and partitions.
D. Perimeter joints between interior wall surfaces and frames of interior doors windows.
E. Joints at Tile Work
F. Joints between plumbing fixtures and adjoining walls, floors, and counters.

1.04 SUBMITTALS

A. PRODUCT DATA: For each joint-sealant product indicated.
B. SAMPLES: For each kind and color of joint sealant required, provide samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to the joint sealants.
C. LIST OF MOCKUP MATERIALS: List manufacturer’s product/color names, finishes, and other information as required to identify materials used. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents, unless such deviations are specifically brought to the attention of the Architect and approved in writing.

1.05 QUALITY ASSURANCE

A. INSTALLER QUALIFICATIONS: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
B. SOURCE LIMITATIONS: Obtain each type of joint sealant through one source from a single manufacturer.
C. MOCKUP: Provide materials for construction of a field mockup of each different color and finish of sealant Work indicated, showing the full range of exposed color and finish textures to be expected in the completed construction. Before installing the work of this section, build mockup to verify selections made under sample Submittals and to demonstrate aesthetic effects. Refer to Division-1 Section Quality Requirements for general requirements of Mockup.

1.06 PROJECT CONDITIONS

A. DO NOT PROCEED WITH INSTALLATION of joint sealants under the following conditions:
   (1) When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   (2) When joint substrates are wet.
   (3) Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   (4) Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.07 WARRANTY

A. SPECIAL INSTALLER'S WARRANTY: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   (1) Warranty Period: Two years from date of Substantial Completion.
B. SPECIAL MANUFACTURER'S WARRANTY: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
   (1) Warranty Period: Two years from date of Substantial Completion.
C. SPECIAL WARRANTIES specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
   (1) Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
   (2) Disintegration of joint substrates from natural causes exceeding design specifications.
   (3) Mechanical damage caused by individuals, tools, or other outside agents.
   (4) Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.01 AVAILABLE MANUFACTURERS / PRODUCTS: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.02 COMPATIBILITY: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

2.03 SEALANT COLORS: Match adjacent material color typically, as approved by the Architect.

A. The quantity of sealant colors is limited only by the number and color of adjacent materials indicated in the Drawings
B. Provide custom colors to match adjacent materials at no additional cost if manufacturer's "standard" colors do not match adjacent materials, in the professional opinion of the Architect
C. Provide multiple-colors of sealant as required by field-conditions when adjacent materials and their colors change throughout the height or width of a sealant joint

2.04 VOC CONTENT OF INTERIOR SEALANTS: Sealants and sealant primers used inside the weatherproofing system must comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

A. Architectural Sealants: 250 g/L.
B. Sealant Primers for Nonporous Substrates: 250 g/L.
C. Sealant Primers for Porous Substrates: 775 g/L.

2.05 LOW-EMITTING INTERIOR SEALANTS: Sealants and sealant primers used inside the weatherproofing system must comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.06 ELASTOMERIC JOINT SEALANTS

A. ELASTOMERIC SEALANTS: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
B. STAIN-TEST-RESPONSE CHARACTERISTICS: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

2.07 URETHANE TRAFFIC-JOINT SEALANT: Comply with ASTM C 920 Type S (single component), grade P (pourable), class 25, use T (traffic). Available Products include but are not limited to the following:

A. BASF Building Systems; Sonolastic NP1.
B. May National Associates, Inc.; Bondaflex PUR 40 FC.
C. Pacific Polymers International, Inc.; Elasto-Thane 230 Type II.
D. Sika Corporation, Construction Products Division; Sikaflex - 1a.
E. Tremco Incorporated; Vulkem 116.

2.08 EXTERIOR SILICONE SEALANT: Comply with ASTM C 920 Type S (single component), grade NS (nonsag), class 100/50, Use NT (nontraffic) and use related to joint substrates of M, G, A, and, as applicable to joint substrates indicated, O. Available Products:

A. Dow Corning Corporation; 790.
B. GE Silicones; SilPruf LM SCS2700.
C. Pecora Corporation; 890FTS.
D. Sika Corporation, Construction Products Division; SikaSil-C990.
E. Tremco Incorporated; Spectrem 1.

2.09 BUTYL-RUBBER SEALANT: Comply with ASTM C 1085. Available Products:

A. Bostik Findley; Bostik 300.
B. Fuller, H. B. Company; SC-0296.
C. Fuller, H. B. Company; SC-0288.
D. Pecora Corporation; BC-158.
E. Polymeric Systems Inc.; PSI-301
F. Sonneborn, Division of ChemRex Inc.; Sonneborn Multi-Purpose Sealant.
G. Tremco; Tremco Butyl Sealant.

2.10 LATEX INTERIOR JOINT SEALANTS: Comply with ASTM C 834, Type P, Grade NF. Available Products:

A. BASF Building Systems; Sonolac.
B. Bostik, Inc.; Chem-Calk 600.
C. Pecora Corporation; AC-20+.
D. Schnee-Morehead, Inc.; SM 8200.
E. Tremco Incorporated; Tremflex 834.

2.11 SANITARY SILICONE SEALANT: Comply with ASTM C 920 Type S (single-component) and Grade NS (nonsag), Class 25, white colored (unless otherwise indicated) mildew-resistant, acid-curing silicone sealant. Available Products include:

A. Dow Corning Corporation; 786 Mildew Resistant
B. GE Silicones; Sanitary SCS1700
C. Pecora Corporation; 898 Sanitary Silicone.
D. Tremco; Tremsil 200

2.12 FSE SANITARY SILICONE SEALANT: (Food-Service-Equipment / food preparation type sealant without mold-mildew resistance): Comply with ASTM C 920 Type S (single-component) and Grade NS (nonsag) Class 25, white colored (unless otherwise indicated) acid-curing. Products include:

A. Dow Corning Corporation; 999-A.
B. GE Silicones; Sanitary SCS1700.
C. Pecora Corporation; 860 Silicone
D. Tremco; Tremsil 200.

2.13 PREFORMED FOAM JOINT SEALANT: Preformed, pre-compressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. and impregnated with a nondrying, water-repellent agent, factory produced in pre-compressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.

A. ACCEPTABLE PRODUCTS: Subject to compliance with above requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

(1) Dayton Superior Specialty Chemicals; Polytite Standard.
(2) EMSEAL Joint Systems, Ltd.; Emseal 25V.
(3) Sandell Manufacturing Co., Inc.; Polyseal.
(4) Schul International, Inc.; Sealtite or Sealtite 50N, as appropriate.
(5) Willseal USA, LLC; Willseal 150 or Willseal 250, as appropriate.

2.14 ACOUSTICAL JOINT SEALANT: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

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

(1) Pecora Corporation; AC-20 FTR OR AIS-919.
(2) USG Corporation; SHEETROCK Acoustical Sealant.

2.15 JOINT-SEALANT BACKING

A. PROVIDE SEALANT BACKINGS of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
B. CYLINDRICAL SEALANT BACKINGS: ASTM C 1330, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
C. ELASTOMERIC TUBING SEALANT BACKINGS: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.
D. BOND-BREAKER TAPE: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.16 MISCELLANEOUS MATERIALS

A. PRIMER: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
B. CLEANERS FOR NONPOROUS SURFACES: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
C. MASKING TAPE: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.
D. WEEPS: Absorbent, UV-resistant synthetic fiber rope, 3/8 inch minimum diameter, in length required to produce an initial 2-inch exposure on the exterior face extending through sealant backing into the internal drainage plane.

PART 3 - EXECUTION

3.01 EXAMINE JOINTS indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SURFACE CLEANING OF JOINTS: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

A. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
B. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include concrete and masonry.
C. Remove laitance and form-release agents from concrete.
D. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include metal and glass.

3.03 JOINT PRIMING: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.04 MASKING TAPE: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.05 INSTALLATION OF JOINT SEALANTS

A. COMPLY WITH JOINT-SEALANT MANUFACTURER'S WRITTEN INSTALLATION INSTRUCTIONS for products and applications indicated, unless more stringent requirements apply.
B. SEALANT INSTALLATION STANDARD: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
C. INSTALL SEALANT BACKINGS of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

(1) Do not leave gaps between ends of sealant backings.
(2) Do not stretch, twist, puncture, or tear sealant backings.
(3) Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

3.06 INSTALL WEEPS IN SEALANT JOINTS above head and sill flashings, at spacing not to exceed twenty-four (24) inch centers. Install with weeps two (2) inches outside of sealant joint face, and extend through the sealant backing into the internal drainage plane. After sealant is cured, cut off weeps flush with face of sealant joint.

3.07 INSTALL BOND-BREAKER TAPE behind sealants where sealant backings are not used between sealants and backs of joints.

3.08 INSTALL SEALANTS using proven techniques that comply with the following and at the same time backings are installed:

A. Place sealants so they directly contact and fully wet joint substrates.
B. Completely fill recesses in each joint configuration.
C. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

3.09 INSTALLATION OF PREFORMED FOAM SEALANTS: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.

3.10 ACOUSTICAL SEALANT INSTALLATION: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.11 TOOLING OF NONSAG SEALANTS: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

A. Remove excess sealant from surfaces adjacent to joints.
B. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
C. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
D. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
E. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.12 FIELD QUALITY CONTROL

A. FIELD-ADHESION TESTING: Field test joint-sealant adhesion to joint substrates as follows:

(1) Extent of Testing: Test completed and cured sealant joints as follows:
(2) Perform 10 tests for the first 1000 feet Insert dimension of joint length for each kind of sealant and joint substrate.
(3) Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
(4) Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
(5) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
(6) Inspect tested joints and report on the following:
(7) Whether sealants filled joint cavities and are free of voids.
(8) Whether sealant dimensions and configurations comply with specified requirements.
(9) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

(10) Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

(11) Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. EVALUATION OF FIELD-ADHESION TEST RESULTS: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.13 CLEAN OFF EXCESS SEALANT OR SEALANT SMEARS adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.14 PROTECT JOINT SEALANTS during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.15 JOINT / SEALANTS SCHEDULE:

EXTERIOR PAVEMENT JOINTS: at perimeter of building at pavement (including sidewalks and curbs), and at pavement expansion Joints:..... **Urethane**

TYPICAL EXTERIOR VERTICAL BUILDING JOINTS, at perimeters of doors, windows, storefront frames (both sides) exterior wall penetrations, exterior building joints including metal siding, metal wall panels, wood siding, masonry or stone as applicable, and at material control joints in masonry and EIFS system: ..... **Exterior Silicone**

EXTERIOR DOOR THRESHOLDS:..... **Butyl Rubber**

ACOUSTICALLY (SOUND) RATED DRYWALL PARTITIONS, ON BOTH SIDES OF STUDS BETWEEN GYPSUM BOARD AND ADJACENT MATERIALS AT BOTH BASE AND TOP OF PARTITION, AND WHERE INDICATED ON THE DRAWINGS: ..... **Acoustic Sealant**

TYPICAL INTERIOR JOINTS including but not limited to drywall joints: ..... **Latex**

TILE JOINTS and joints between countertops and walls: ..... **Sanitary Silicone**

PLUMBING FIXTURES to walls:..... **Sanitary Silicone**

TYPICAL INTERIOR JOINTS IN KITCHEN / FOOD SERVICE AREAS:..... **FSE Sanitary-Silicone**

END OF SECTION 07 92 00

END OF DIVISION 07

DIVISION 08 – OPENINGS

SECTION 08 11 00 – METAL DOORS AND FRAMES

SECTION 08 11 73 – ACCORDION FIRE & SMOKE DOORS WITH EGRESS

SECTION 08 14 00 – FLUSH WOOD DOORS

SECTION 08 17 13 – INTEGRATED METAL DOOR OPENING ASSEMBLIES

SECTION 08 31 00 – ACCESS DOORS

SECTION 08 33 23 – OVERHEAD COILING DOORS

SECTION 08 41 13 – ALUMINUM ENTRANCE, CURTAIN WALLS AND STOREFRONT

SECTION 08 71 00 – DOOR HARDWARE

SECTION 08 80 00 – GLASS, GLAZING AND MIRRORS

SECTION 08 87 00 – GLAZING SURFACE FILMS

SECTION 08 90 00 – LOUVERS AND VENTS

SECTION 08 11 00 – METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 PROVIDE metal door frames and hollow metal doors, where noted on the Drawings and as specified herein. The Work of this Section includes:

A. Steel Doors & Frames - exterior locations: insulated and galvanized, including transom panels, when indicated
B. Steel Doors & Frames - interior locations: nonrated, honeycomb core units typically except as otherwise indicated.
C. Fire rated, mineral core door units, when indicated in the Door Schedule.
D. Acoustically rated doors and frames, where indicated.
E. Glass and glazing associated with metal doors and frames.
F. Door louvers, when indicated, and
G. Shop priming and field finishing.

1.02 RELATED SECTIONS

A. Section 018113 Certification Requirements.

1.03 COMPLY WITH applicable requirements of the Steel Door Institute's ANSI/SDI 100 "Recommended Specifications for Standard Steel Doors and Frames" and as indicated herein.

1.04 SUBMITTALS

A. SUBMIT PRODUCT DATA for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, sound ratings, profiles, and finishes.
B. SUBMIT DOOR SCHEDULE indicating doors and frames with the same reference numbers for details and openings as those on Contract Drawings. Indicate coordination of glazing frames and stops with glass and glazing requirements.

1.05 LEED PERFORMANCE REQUIREMENTS

A. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material shall be within 100 miles of project site for credit if possible.
B. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.
C. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.
D. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification. ..

1.06 LEED DOCUMENTATION REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material (this includes components of the mix design). Include distance to Project and cost for each regional material. (if applicable)
C. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.
D. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.
E. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable

1.07 DELIVER DOORS AND FRAMES cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

1.08 INSPECT DOORS AND FRAMES on delivery for damage. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect; otherwise, remove and replace damaged items as directed.

1.09 STORE DOORS AND FRAMES at building site under cover. Place units on minimum 4-inch- (100-mm-) high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If cardboard wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch (6-mm) spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

A. Amweld International, LLC.
B. Ceco Door Products; an Assa Abloy Group company.
C. Commercial Door & Hardware Inc.
D. Curries Company; an Assa Abloy Group company.
E. Custom Metal Products.
F. Deansteel.
G. Door Components, Inc.
H. Hollow Metal Inc.

I. Hollow Metal Xpress.
J. Karpen Steel Custom Doors & Frames.
K. MPI Group, LLC (The).
L. National Custom Hollow Metal.
M. North American Door Corp.
N. Republic Doors and Frames.
O. Steelcraft; an Ingersoll-Rand company.
P. Steward Steel; Door Division.

2.02 FIRE-RATED ASSEMBLIES: Comply with NFPA 80 and provide units listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C. Provide smoke- and draft-control assemblies with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.03 MATERIALS

A. Hot-Rolled Steel Sheets and Strip: Commercial-quality carbon steel, pickled and oiled, complying with ASTM A 569.
B. Cold-Rolled Steel Sheets: Carbon steel complying with ASTM A 366, commercial quality, or ASTM A 620, drawing quality, special killed.
C. Galvanized Steel Sheets: Zinc-coated carbon steel complying with ASTM A 526, commercial quality, or ASTM A 642, drawing quality, hot-dip galvanized according to ASTM A 525, with A 60 or G 60 coating designation, mill phosphatized.
D. Supports and Anchors: Fabricated from not less than 0.0478-inch- thick steel sheet; 0.0516-inch- thick galvanized steel where used with galvanized steel frames.
E. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built into exterior walls, hot-dip galvanize complying with ASTM A 153, Class C or D as applicable.

2.04 DOORS

A. STANDARD STEEL DOORS: Provide 1-3/4-inch- thick doors of materials and ANSI/SDI 100 grades and models specified below, or as indicated on Drawings or schedules:
B. INTERIOR DOORS: Provide doors complying with requirements indicated below by referencing ANSI 250.8 for level and model and ANSI A250.4 for physical-endurance level:
    1. Level 2 and Physical Performance Level B (Heavy Duty) with 0.042-inch (18 GA) steel faces both sides, Model 2 (seamless seams).
C. EXTERIOR DOORS: Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
    1. Level 3 and Physical Performance Level A (Extra Heavy Duty) with 0.053-inch (16 GA) steel faces both sides, Model 2 (seamless seams), galvanized.

2.05 HARDWARE REINFORCEMENT: Fabricate reinforcement plates from same material as door face sheets to comply with the following minimum sizes:

A. Hinges: Minimum 0.123 inch thick (10 gage) by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
B. Pivots: Minimum 0.167 inch thick (7 gage) by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
C. Lock Face, flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick (14 gage).
D. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick (14 gage).

2.06 FRAMES

A. PROVIDE STEEL FRAMES for doors, transoms, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated.
B. FABRICATE frames with mitered corners and continuously welded construction, and as follows:
    1. Interior frames for Level 2 interior doors: 0.042-inch (18 gage) thick steel sheet
    2. Exterior frames for Level 3 Exterior Doors: 0.053-inch (16 gage) thick galvanized steel sheet.
C. HARDWARE REINFORCEMENT: Fabricate reinforcement plates from same material as frames to comply with the following minimum sizes:
    1. Hinges: Minimum 0.123 inch (10 gage) thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
    2. Pivots: Minimum 0.167 inch (7 gage) thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
    3. Lock Face, flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch (14 gage) thick.
    4. All Other Surface-Mounted Hardware: Minimum 0.067 inch (14 gage) thick.
    5. Supports and Anchors: Fabricated from electrolytic zinc-coated or metallic-coated steel sheet.
D. JAMB ANCHORS:
    1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (18 gage) thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
    2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (18 gage) thick.

3. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
4. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (18 gage) thick, and as follows:
5. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
6. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.07 DOOR SILENCERS: Except on weatherstripped frames, drill stops to receive 3 silencers on strike jambs of single-door frames and 2 silencers on heads of double-door frames.

2.08 MORTAR GUARD ENCLOSURES: When electrified hinges, strikes or power transfers are indicated to be provided in the Division-08 Hardware Section, provide frames fabricated with minimum 0.016-inch- (24 gage) thick steel enclosures on the back side of the hardware preparation(s) so that mortar or other materials will not obstruct hardware operation and to close off interior of the openings.

2.09 FIXED FRAME MOLDINGS: Formed integral with standard steel frames, minimum 5/8 inch high, unless otherwise indicated.

2.10 GENERAL FABRICATION: Fabricate steel door and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Where possible, fit and assemble units in manufacturer's plant. Shop prime all hollow metal doors and frames.

2.11 INTERNAL CONSTRUCTION: One of the following manufacturer's standard core materials according to SDI standards:

A. Rigid polystyrene conforming to ASTM C 578.
B. Rigid mineral fiber with internal sound deadener on inside of face sheets.

2.12 CLEARANCES: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch (6.4 mm) between non-fire-rated pairs of doors. Not more than 3/4 inch at bottom.

2.13 FABRICATE EXPOSED FACES of doors and panels, including stiles and rails of nonflush units, from only cold-rolled steel sheet.

2.14 TOLERANCES: Comply with SDI 117 "Manufacturing Tolerances Standard Steel Doors and Frames."

2.15 FABRICATE CONCEALED STIFFENERS, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.

2.16 EXPOSED FASTENERS: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

2.17 THERMAL-RATED (INSULATING) ASSEMBLIES: At exterior locations and elsewhere as shown or scheduled, provide doors fabricated as thermal-insulating door and frame assemblies and tested according to ASTM C 236 or ASTM C 976 on fully operable door assemblies. Unless otherwise indicated, provide thermal-rated assemblies with U-value rating as follows:

A. 0.41 Btu/sq. ft. x h x deg F or better.

2.18 HARDWARE PREPARATION: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of SDI 107 and ANSI A115 Series specifications for door and frame preparation for hardware. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

2.19 LOCATE HARDWARE as indicated on Drawings or, if not indicated, according to the Door and Hardware Institute's (DHI) "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2.20 PREFIT DOORS at factory with clearance of 1/8" at vertical edges and at top, 1/8" in 2" bevel at lock edge, bottom clearance : 3/8" without threshold, 3/4" with threshold.

2.21 SHOP FINISHING:

A. SURFACE PREPARATION: Solvent-clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel to comply with SSPC-SP 5 (White Metal Blast Cleaning) or SSPC-SP 8 (Pickling).
B. PRETREATMENT: Immediately after surface preparation, apply a conversion coating of type suited to organic coating applied over it.
C. AT GALVANIZED STEEL SHEET FINISHES, apply zinc-dust, zinc-oxide primer paint complying with performance requirements of FS TT-P-641, Type II for field painting.
D. FACTORY PRIMING FOR FIELD-PAINTED FINISH: Apply shop primer that complies with ANSI A224.1 acceptance criteria, is compatible with finish paint systems indicated, and has capability to provide a sound foundation for field-applied topcoats. Apply primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.01 INSTALL STEEL DOORS, FRAMES, AND ACCESSORIES according to Shop Drawings, manufacturer's data, and as specified.

3.02 PLACING FRAMES: Comply with provisions of SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

A. Except for frames located in existing concrete, masonry, or gypsum board assembly construction, place frames before constructing enclosing walls and ceilings.

B. In masonry construction, install at least 3 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
C. At concrete or masonry construction, install at least 3 completed opening anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices.
D. In framed metal or wood partitions, install at least 3 wall anchors per jamb at hinge and strike levels. In steel-stud partitions, attach wall anchors to studs with screws.
E. In in-place gypsum board partitions, install knock-down, slip-on, drywall frames.

3.03 DOOR INSTALLATION: Fit hollow-metal doors accurately in frames, within clearances specified in ANSI/SDI 100.

3.04 ADJUSTING AND CLEANING

A. PRIME COAT TOUCHUP: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.
B. PROTECTION REMOVAL: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION 08 11 00

SECTION 08 11 73 – ACCORDION FIRE & SMOKE RATED DOORS WITH EGRESS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

(1) Accordion-type, fire- and smoke-rated horizontal sliding door with egress, complete with electric operator and automatic closing system.

B. Related Sections:

(1) Section 05 50 00 – Metal Fabrications.
(2) Section 06 10 00 – Rough Carpentry.
(3) Section 08 31 00 – Access Doors and Panels.
(4) Section 09 91 00 – Painting.
(5) Division 26 – Electrical.

1.02 SUBMITTALS

A. Procedures: Furnish submittals in accordance with the General Requirements specified.
B. Shop Drawings: Furnish shop drawings for architect's approval. Include elevations, sections, and details indicating dimensions, materials, finishes, and conditions for anchorage and support of each door.
C. Certifications:

(1) Submit manufacturer's Underwriters Laboratories, Intertek, or Factory Mutual laboratory testing listing report verifying product compliance with the required fire and smoke ratings.
(2) Submit manufacturer's Code Compliance Research Report, published by an independent third-party testing agency certified by the International Accreditation Service, confirming compliance of the fire door assembly with the International Building Code.
(3) Provide assemblies tested, certified, and labeled for a minimum 3-hour fire rating.

D. Product Data: Submit manufacturer's technical literature describing the product to be used under this section.
E. Maintenance and Operating Manuals: Furnish complete manuals describing the materials, devices, and procedures to be followed in operating and maintaining all doors under this section, including manufacturer's brochures and parts lists describing the actual materials used in the product.

1.03 QUALITY ASSURANCE

A. Fire and Smoke Rated Assemblies: Provide doors with fire and smoke resistance ratings required to comply with governing regulations, inspected, tested, listed, and labeled by Underwriters Laboratories, Intertek, or Factory Mutual, and complying with NFPA 80 for the class of opening. Provide units tested in accordance with UL 10B, UL 1784, NFPA 252, and ASTM E152. Provide testing laboratory label permanently fastened to each fire and smoke door assembly.
B. Regulatory Requirements:

(1) Comply with applicable requirements of the laws, codes, ordinances, and regulations of federal, state, and municipal authorities having jurisdiction.
(2) Listed under a certified Code Compliance Research Report in accordance with the applicable sections of the International Building Code.

C. Manufacturer Qualifications: Door manufacturer shall have a minimum of five (5) years' experience manufacturing the type of product covered under this section, with a credible service record. Provide a list of at least ten (10) completed projects that include the products covered under this section.

1.04 DELIVERY, STORAGE, AND HANDLING

A. General: Deliver and store materials in manufacturer's original packaging, labeled to show name, brand, and type. Store materials in a protected, dry location off the ground in accordance with manufacturer's instructions.

1.05 WARRANTY

A. Door Warranty: Provide a two (2) year warranty, effective as of the date of shipment, signed by the manufacturer and installer, agreeing to repair or replace work that has failed as a result of defects in materials or workmanship. Upon notification within the warranty period, such defects shall be repaired at no cost to the owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Accordion fire- and smoke-rated door with egress shall be the Safescape Compact Pocket, Model AC8814-G, as manufactured by McKeon Door Company.

(1) Approved Manufacturer Substitutions:

(a) Won-Door FireGuard with Egress, by Won-Door Coorporation

2.02 MATERIALS

A. General: Each unit shall consist of an interlocking single folding panel curtain system suspended from a steel head track assembly, designed to be stored in a reduced-size compact pocket. Curtain shall travel in a horizontal plane, smoothly and without binding, and shall be driven to the open and close position by a positive-action sprocket and integral endless drive chain system.

B. Curtain Panels: Fabricated of 18 gauge, G90 galvanized steel interlocking panels with an approximate cross section not greater than 14 inches wide.
C. Leading Edge: Curtain shall be furnished with a structural steel member of tubular design to provide stiffness, limit deflection, and provide a tight-fitting closure.
D. Receiving Edge: Fabricated of a steel member with sufficient depth, designed to accept the leading edge and form a tight-fitting closure when the door is in the fully closed position.
E. Head Track: Not less than 1/8 inch thick formed steel shape with removable pans that conceal and protect the integral positive-action endless drive chain system. Overall track width shall not be greater than 15-1/2 inches.
F. Perimeter Smoke Seals: Provide perimeter smoke seals and sweeps as required to maintain smoke and draft rating in accordance with UL 1784. Sweeps shall be located at both the top and bottom ends of each curtain panel.
G. Electric Motor Operator: Fire door shall be provided with a compact AC-powered unit mounted above the head track assembly for ease of accessibility and service. Operator shall be equipped with an adjustable, remotely programmable limit switch to break the circuit at termination of travel. Operator shall be housed in a NEMA Type 1 enclosure.
    (1) Motor: Intermediate duty, thermally protected, ball bearing type with Class A or better insulation. Motor horsepower shall be 1/3 hp minimum.
    (2) Starter: Size "0" magnetic reversing starter, across-the-line type, with mechanical and electrical interlocks, 10 amp continuous rating, and 24 volt control circuit.
    (3) Reducer: Planetary gear type, 80% efficiency minimum.
    (4) Brake: Magnetically activated, integral within the operator housing.
    (5) Remote Control Station: Provide flush-mount key switch control station marked open, close, and stop, field wired to the operator's control panel and mounted at a location indicated on the contract drawings.
H. Primary and Secondary Power Supplies: The fire door assembly shall be powered by the building's AC power source and shall not be dependent on a battery source as the primary means of operation during normal or fire emergency conditions. Only if the fire door loses primary AC power shall the internal secondary battery back-up power support source operate the fire door.
I. Automatic Closing System: Listed in accordance with UL 864 and designed to interface with the fire alarm control panel and/or other fire alarm initiating devices. When activated by smoke detection or fire alarm, the door shall be power-driven to the fully closed position, with the ability to open for egress by any building occupant, pause, and re-close until the fire alarm system has been deactivated. The automatic closing system shall consist of the following:
    (1) Microprocessor-based electronic control center capable of the following:
        (a) Monitor dual power sources, including battery low or failure, charging circuit failure, fuse failures, input power, and AC failure.
        (b) Monitor inputs, including brake, clutch, overload, close limit contact, motor running, MCU failure, alarm power output, sensing device, key switch (optional), and 3-button control station (optional).
        (c) Function and timer display, egress touch pad(s), and sound warning alarms.
J. Egress Exit Device: Egress paddle devices shall be located on both sides of the fire door assembly. Activation of either egress paddle device shall cause the fire door to power open to a pre-determined programmable distance, momentarily stop, and then automatically return to the fully closed position.
K. Master Control Station: Provide a single master control station capable of simultaneously activating all fire-rated doors in the facility, or in a designated zone, to the open or close position. The master control station shall remain operable as long as there is no main power failure to the fire doors' motor operators.
L. Selectable Security Access Control Mode: The operating system shall allow the fire door to also function as a security door. When switched to security access control mode, the fire door's fire exit devices shall become inactive and the door shall be operable for authorized use only via the local key switch control station or the remote master control station. In the event of a fire emergency while the door is set in security access control mode, a notification or signal from the facility's fire alarm or smoke detection system shall automatically override the security access control mode and all fire exit devices shall immediately become active.
M. Obstruction Sensing Device: The obstruction-sensing safety edge shall be programmable to either stop or reverse when coming in contact with an obstruction during the fire door's closing cycle. During normal operation, the obstruction-sensing safety edge shall remain active and operable as long as there is power supply to the motor operator. During an alarm condition, the obstruction-sensing safety edge shall stop or reverse a maximum of three times. If programmed to reverse, on the fourth attempt to close, if an obstruction still remains in the fire door's path, the fire door shall come to rest on the obstruction until it has been removed, then continue to the fully closed position.
N. Finish: After completion of fabrication, clean all metal surfaces to remove dirt and chemically treat to provide for paint adhesion. Panels shall receive a prime coat of 0.2 mils epoxy primer and 0.8 mils polyester paint in McKeon Sterling Gray finish. [Confirm finish selection with Architect.]

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces and field conditions to which this work is to be applied. Notify Architect if conditions exist that are detrimental to proper installation and timely completion of work.
B. Verify all dimensions taken at the job site affecting the work. Notify the Architect of any instance where dimensions vary.
C. Coordinate and schedule work under this section with work of other sections so as not to delay job progress.

3.02 INSTALLATION

A. Perform installation using only factory-approved and certified representatives of the door manufacturer.
B. Install door assemblies at locations shown, in perfect alignment and elevation, plumb, level, straight, and true.

C. Adjust door installation to provide uniform clearances and smooth, non-binding operation.
D. Install wiring in accordance with applicable local codes and the National Electrical Code. Materials shall be UL listed.
E. Test door closing sequence when activated by the building's fire alarm system. Reset door after successful test.

3.03 PROTECTION AND CLEANING

A. Protect installed work using adequate and suitable means during and after installation until accepted by Owner.
B. Remove, repair, or replace materials that have been damaged in any way.
C. Clean surfaces of grime and dirt using acceptable and recommended means and methods.

END OF SECTION 08 34 29

Draft section adapted from McKeon Safescape Compact Pocket (Model AC8814-G) manufacturer literature for coordination/pricing. Confirm basis-of-design vs. substitution language, finish selection, fire-rating and code requirements for the specific project jurisdiction, and related-section cross-references before issuing for construction.

SECTION 08 14 00 – FLUSH WOOD DOORS

PART 1 - GENERAL

1.01 PROVIDE wood doors, where noted on the Drawings, as specified herein and in compliance with applicable requirements of AWI "Architectural Woodwork Quality Standards".

1.02 The Work of this Section includes:

A. Flush Wood Doors
B. Acoustic Wood Doors

1.03 RELATED SECTIONS:

A. Section 018113 Certification Requirements.
B. DIVISION-06 Section: “Rough Carpentry” for wood blocking at door frames in metal framed partitions
C. DIVISION-06 Section "Architectural Woodwork” for quality and fabrication requirements of wood frames
D. DIVISION-08 Section “Glazing” for glazing in wood doors

1.04 SUBMITTALS:

A. SUBMIT PRODUCT DATA including manufacturer's technical data for each type of door, including details of core and edge construction, trim for openings and louvers, indicating compliance with these specifications.
B. SUBMIT SHOP DRAWINGS indicating location and size of each door, elevation of each kind of door, details of construction, location and extent of hardware blocking, fire ratings, requirements for factory finishing and other pertinent data.
C. SUBMIT FACTORY FINISH SAMPLES applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished Work.

1.05 LEED PERFORMANCE REQUIREMENTS

A. Provide products that meets meet one of the following requirements: EPA TSCA Title VI for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins, California Air Resources Board (CARB) ATCM for formaldehyde requirements for ultra-low emitting formaldehyde (ULEF) resins, EPA TSCA Title VI formaldehyde requirements for no added formaldehyde resins (NAF), or CARB ATCM formaldehyde requirements for no added formaldehyde resin (NAF).
B. Provide products that are SFI, FSC, ATES, CSA, or PEFC Certified.
C. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan. .

1.06 LEED DOCUMENTATION REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Provide third-party certificate confirming products meet one of the following requirements: EPA TSCA Title VI for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins, California Air Resources Board (CARB) ATCM for formaldehyde requirements for ultra-low emitting formaldehyde (ULEF) resins, EPA TSCA Title VI formaldehyde requirements for no added formaldehyde resins (NAF), or CARB ATCM formaldehyde requirements for no added formaldehyde resin (NAF). Note manufacturer’s claims for meeting above-mentioned requirements do not meet LEED standards.
C. Provide documentation for all wood showing that it is SFI, FSC, ATES, CSA, or PERC Certified. For FSC Certified wood: Lumber and plywood shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001 , "FSC Principles and Criteria for Forest Stewardsheip," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification
D. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan. s.

1.07 QUALITY STANDARDS:

A. NWWDA QUALITY STANDARD: I.S.1 "Industry Standard for Wood Flush Doors", of National Wood Window and Door Association (NWWDA).
B. AWI QUALITY STANDARD: "Architectural Woodwork Quality Standards"; including Section 1300 "Architectural Flush Doors", of Architectural Woodwork Institute (AWI) for grade of door, core construction, finish and other requirements exceeding those of NWWDA quality standard.
C. FIRE-RATED WOOD DOORS: Provide wood doors which are identical in materials and construction to units tested in door and frame assemblies per ASTM E 152 and which are labeled and listed for ratings indicated by UL, Warnock Hersey or other testing and inspection agency acceptable to AHJ representatives.
D. MANUFACTURER: Obtain doors from a single manufacturer. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers.
E. STORAGE AND PROTECTION:
    1. PROTECT DOORS & FRAMES DURING TRANSIT, storage and handling to prevent damage, soiling and deterioration. Comply with requirements of referenced standards and recommendations of NWWDA pamphlet "How to Store, Handle, Finish, Install, and Maintain Wood Doors", as well as with manufacturer's instructions.
    2. IDENTIFY EACH DOOR with individual opening numbers which correlate with designation system used on shop drawings for door, frames, and hardware, using temporary, removable or concealed markings.

3. CONDITIONING: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during remainder of construction period to comply with AWI quality standard including Section 100-S-3 "Moisture Content".

F. WARRANTY:

1. GENERAL WARRANTY: Door manufacturer's warranty specified in this Article must not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
2. DOOR MANUFACTURER'S WARRANTY: Submit written agreement on door manufacturer's standard form signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section or that show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span, or do not conform to tolerance limitations of referenced quality standards. Warranty must be in effect during the following period of time after date of Substantial Completion:
3. Solid Core Interior Doors: Life of installation.
4. Hollow Core Interior Doors: Two (2) years

PART 2 - PRODUCTS

2.01 MANUFACTURERS: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

A. Algoma Hardwoods, Inc.
B. Ambico
C. Ampco.
D. Chappell Door Co.
E. Eggers Industries.
F. General Veneer Manufacturing Co.
G. Graham Wood Doors; an Assa Abloy Group company.
H. Haley Brothers, Inc.
I. Lambton Doors.
J. Marshfield Door Systems, Inc.
K. Mohawk Doors; a Masonite Co.
L. Vancouver Door Company.
M. VT Industries, Inc.

2.02 FLUSH WOOD DOORS

A. QUALITY STANDARD: In addition to requirements specified, comply with WDMA‘s "Architectural Wood Flush Doors.":
B. WDMA I.S.1-A Performance Grade: Heavy Duty.

2.03 FIRE-RATED WOOD DOORS: Comply with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

A. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
B. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
C. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
D. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
E. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

2.04 ACOUSTIC WOOD DOORS:

A. Refer to Section 08 34 76 Sound Retardant Swinging Doors

2.05 SMOKE- AND DRAFT-CONTROL ASSEMBLIES: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

2.06 PARTICLEBOARD-CORE DOORS (typical core if not fire-rated):

A. Particleboard: ANSI A208.1, Grade LD-2, made with binder containing no urea-formaldehyde.
B. Particleboard: Straw-based particleboard complying with ANSI A208.1, Grade LD-2 or M-2, except for density.
C. Provide doors with glued-wood-stave or structural-composite-lumber cores instead of particleboard cores for doors indicated to receive exit devices.

2.07 MINERAL-CORE DOORS:

A. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
B. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding
C. capability and split resistance. Comply with specified requirements for exposed edges.
D. Screw-Holding Capability: 475 lbf per WDMA T.M.-10.

2.08 SOLID-CORE FLUSH WOOD DOORS (for natural wood finish): 1-3/4-inch-thick WDMA Premium grade, extra heavy duty per WDMA/AWS, hardwood face veneer, solid core units, and as follows:

A. Wood Species of Face Veneers: As indicated on the Drawings, or if not indicated, as selected by Architect from Manufacturer's full range of available wood species / cut and finish options
B. Veneer leaf application: Book matched
C. Provide 45 minute, or 90-minute fire-rated assemblies where indicated
D. Basis of Design Product / Manufacturer: "GPD-PC-5 ply by Graham or equal
E. Acceptable Manufacturers: Subject to compliance with requirements indicated, other manufacturers include:
    1. Algoma Hardwoods, Inc.
    2. Eggers Industries, Architectural Door Division.
    3. V-T Industries Inc.
    4. Marshfield Door Systems, Inc. (Formerly Weyerhauser)
        a. Wood beads for light openings: Provide same species as door faces.

2.09 STILE & RAIL WOOD DOORS (for natural – transparent wood finish): 1-3/4-inch-thick units meeting NWWDA Grade "Select" for transparent finish, fabricated from hardwood-veneered, structural composite lumber, or hardwood veneered, edge-glued, finger-jointed clear lumber, with hardwood veneers selected for similarity of grain and color, and arranged for optimum match between adjacent pieces.

A. Panel Design and stile/rail layout: as indicated on the Drawings – or if not indicated, provide units with intermediate lock-height rail and with two (2) glazed panels typically – with side, intermediate and top rails of 5-1/2" nominal width minimum.
    1. Bottom Rail Height: 10" minimum per ADA/ANSI Standards``
    2. Wood Species / cut: White Oak – rift sawn
    3. Factory Finish: Sealer coat only on all sides – for field finishing
    4. Acceptable Manufacturers: Subject to compliance with requirements indicated, other manufacturers include:
        a. Eggers Industries, Architectural Door Division
        b. Marshfield Door Systems, Inc. (formerly Weyerhauser)
        c. Simpson Door Company
        d. TruStile Doors

2.10 SOLID-CORE PREFINISHED FLUSH WOOD DOORS: WDMA Premium grade, extra heavy duty per WDMA/AWS, hardwood face veneer solid core units:

A. Wood Species of Face Veneers: FSC certified rift-cut white oak
B. Veneer leaf application: Book matched
C. Provide 45 minute, or 90 minute fire-rated assemblies where indicated
D. Basis of Design Product / Manufacturer: "GPD-PC-5 ply by Graham or equal

2.11 WOOD BEADS FOR LIGHT OPENINGS: Provide same species as door faces. Square profile.

2.12 WOOD DOOR FRAMES: Except as otherwise indicated, provide wood door frames fabricated of hardwood per AWI "Custom" Quality Standard, to match species of door panels, surfaced 4 sides (S4S) typically with exposed edges eased. Assemble frames and casings in shop to the greatest extent feasible except where shipping limitations require field assembly.

A. Construction: 1-1/2 inch wide solid hardwood "T" stop typical, double rabbeted in jamb
B. Provide fire-rated labeled frames where indicated on the Drawings
C. Provide three (3) or (4) each butt hinges as required for door height / weight for each door/frame unit, matching similar butt-hinge hardware as specified in other Division-08 Sections

2.13 FABRICATION:

A. FACTORY FIT DOORS to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements of NFPA 80 for fire-resistance-rated doors.
B. FACTORY MACHINE DOORS & FRAMES FOR HARDWARE that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Pre-drill pilot holes for all hardware. Comply with final hardware schedules, door frame shop drawings, DHI A115-W series standards, and hardware templates. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before proceeding with factory machining.
C. OPENINGS: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of doors required. Trim openings with moldings of material and profile to match color and finish of door finish.
D. FACTORY FINISHING – GENERAL: Finish doors at factory. Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing. Finish faces, all four edges, edges of cutouts, and mortises. Use only paints and coatings that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
E. NATURAL / TRANSPARENT FINISH: AWI System TR-2 Catalyzed Polyurethane:
    1. Grade: AWI "Custom" grade.
    2. Finish: Manufacturer's standard finish with performance comparable to AWI System TR-6
    3. Staining: As selected by Architect from manufacturer's full range.
    4. Effect: Open-grain finish.
    5. Sheen: Satin.

F. NATURAL / TRANSPARENT STAINED FINISH:
   1. Grade: Custom.
   2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 10, UV curable, water based.
   3. Staining: As selected by Architect from manufacturer's full range.
   4. Sheen: Semigloss.

G. OPAQUE FINISH:
   1. Grade: Custom.
   2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 10, UV curable, water based.
   3. Color: As selected by Architect from manufacturer's full range.
   4. Sheen: Semigloss.

PART 3 - EXECUTION

3.01 EXAMINATION: Examine installed door frames prior to hanging door. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads. Reject doors with defects. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. HARDWARE: For installation, see Section 087100 "Door Hardware".
B. INSTALLATION INSTRUCTIONS: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated. Install fire-rated doors according to NFPA 80. Install smoke- and draft-control doors according to NFPA 105.
C. JOB-FITTED DOORS: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
D. CLEARANCES: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated. Comply with NFPA 80 for fire-rated doors.
   1. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
   2. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.
E. FACTORY-FITTED DOORS: Align in frames for uniform clearance at each edge.
F. FACTORY-FINISHED DOORS: Restore finish before installation if fitting or machining is required at Project site.
G. ADJUSTING AND PROTECTION: Rehang or replace doors which do not swing or operate freely. Refinish or replace doors damaged during installation. Protect doors as recommended by door manufacturer to ensure that wood doors will be without damage or deterioration at time of Substantial Completion.

END OF SECTION 08 14 00

SECTION 08 17 13 – INTEGRATED METAL DOOR OPENING ASSEMBLIES

PART 1 - GENERAL

1.01 GENERAL NOTE

A. The General Conditions, Supplementary General Conditions, and Division 1 - General Requirements are hereby made a part of this Section as fully as if repeated herein

1.02 SUMMARY

A. Section Includes
B. Integrated metal door opening assemblies with doors, operating hardware, accessories, and installation for a complete assembly.

1.03 RELATED SECTIONS

A. Section 01 33 00, Submittal Procedures.
B. Section 01 25 13, Product Substitution Procedures.

1.04 LEED REQUIREMENTS

A. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material shall be within 100 miles of project site for credit if possible.
B. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.
C. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.
D. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.05 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material (this includes components of the mix design). Include distance to Project and cost for each regional material. (if applicable)
C. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.
D. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.
E. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable

1.06 REFERENCES

A. ANSI/BHMA A156.32 – Integrated Door Opening Assemblies, 2015.
B. ANSI/UL 10C -- Positive Pressure Fire Tests of Door Assemblies, American National Standards Institute/Underwriters Laboratories, 2001.
C. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, American Society of Testing and Materials; 2004a.
D. AWI AWQS - Architectural Woodwork Quality Standards **P-208;** The Architectural Woodwork Institute; 8th Edition.
E. NFPA 101 – Life Safety Code, National Fire Protection Association, 2003.
F. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies, National Fire Protection Association, 2003.
G. SDI 111 A - Recommended Steel Door Frame Details, Steel Door Institute; 2002.
H. SDI 112 - Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames, Steel Door Institute, 1997.
I. UL 1784 – Air Leakage Tests for Door Assemblies without an artificial bottom seal, Underwriters Laboratories Inc., 2001 (For Smoke Containment, Enclosed Elevator Lobbies, Fire Service Access Elevator Lobby Doors, Hoistway Opening Protection).

1.07 SYSTEM DESCRIPTION

A. Performance Requirements
    1. Certified to BHMA – A156.32, Integrated Door Opening Assemblies, 2015.

1.08 SUBMITTALS

A. Shop Drawings
    1. In accordance with Section 01 33 00.
    2. Indicate each door and frame condition; frame type, profile and installation detail; items of finish hardware, finishes and electrical rough-in requirements.
B. Samples
    1. In accordance with Section 01 33 00.
C. Environmental
    1. Submit UL certification for Environmental Product Declaration (EPD).

D. Performance
   1. Submit certification for ANSI/BHMA 156.32

1.09 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturer: Firm with not less than 5 years successful experience in fabrication of integrated metal door opening assemblies with full-height latch/lock and full-height hinge.
   2. Supplier: Authorized distributor of manufacturer.
   3. Installer: Manufacturer certified.

B. Regulatory Requirements
   1. Rated door assemblies shall have been tested to meet conditions of NFPA 252 as required by NFPA 101 section 6-2.3.3.

1.10 DELIVERY, STORAGE AND HANDLING

A. Packaging: Polyvinyl wrapped, palette by floor, and clearly marked for each opening.
B. Delivery: Deliver to site in original unopened containers and pallets bearing system manufacturers name, and brand.
C. Store: Horizontally on level surface, not less than 2 inches off floor in a clean, dry well-ventilated area protected from sunlight, extreme heat, dryness and moisture.
D. Receiving, off-loading, and site distribution should be handled by an authorized Total Door Distributor unless otherwise stipulated by contract. If the G.C. or other entity handles all or any portion of the receiving, off-loading, and site distribution, they are held responsible for any and all damages that may result from potential miss handling of the product.

1.11 PROJECT CONDITIONS

A. Do not bring door systems to site until building temperature and humidity ranges are compatible with recommended values for preservation of wood moisture content as listed by AWI AWQS. Building shall be stabilized at 30 to 60 percent humidity.

1.12 WARRANTY

A. Integrated metal door opening assembly: Manufacturer's standard 5 year warranty against defects in material and workmanship. Refer to Manufacturer's published warranty.
B. Store doors in a clear, dry ventilated space having controlled temperature and a relative humidity range between 30 and 60 percent. Stack doors flat and off the floor to prevent warpage.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Integrated metal door systems
   1. Total Door: www.totaldoor.com.
   2. Substitutions: Refer to Section 01 25 00

B. Hardware
   1. Total Door: www.totaldoor.com and as called for in Section 08 71 00 Door Hardware
   2. Substitutions: Refer to Section 01 25 00

2.02 MATERIALS

A. Frames
   1. To be supplied by others.
   2. In accordance with ANSI/SDI A250.8, SDI 111A, and SDI 112.
   3. Construction: KD or All-welded units.
   4. Material: Steel, cold rolled, ASTM A1008, 16 gauge.
   5. Fire Resistance Rating: Where indicated in Contract Documents for doors.
   6. Spreader Bar: Removable, at sill (For all welded type).

B. Frame Anchorage Devices
   1. To securely fasten to wall construction without distortion or stress.
   2. In accordance with fire resistance rating indicated in Contract Documents.

C. Integrated Door Assembly
   1. Integrated Door Assembly
   2. Stiles: Steel, galvannealed, 16-gauge, spot welded.
   3. Top and Bottom Rails: 5-1/2 inch 18-gauge steel rails.
   4. Cores:
      a. Solid polystyrene continuously bonded to faces.
      b. Temperature Rise.
   5. Thickness: 1-3/4 inches.
   6. Faces: Steel, stretcher leveled, without seams or spot welds, galvannealed 20 gauge.
   7. Weld pattern: In accordance with manufactures standard details.
   8. Gasketing
      a. Door System: Factory applied to locking channel
      b. Frame: Factory supplied, field apply to head of frame.

c. Floor: Factory supplied Surface Smoke Seal to be field applied. (must be ordered with elevator shaft & lobby applications)

2.03 FINISHES

A. Hinge and Locking Channel
   1. Finish: Factory Pre-Finished.
      a. Color to be selected by Architect.

B. Door Faces, Interior
   1. Finish: To be selected by Architect, refer to door schedule.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Field Conditions
   1. Prior to commencing installation, examine parts of building structure, which are to receive door systems and component parts.
   2. Report, in writing, conditions which would prevent proper execution or endanger permanency of the work to the Architect.

B. Field Dimensions
   1. Where possible, verify frame tolerances before fabrication of door systems.
   2. Notify Architect of variances with reviewed shop drawings.

C. Corrective measures, when necessary, shall be determined and approved prior to commencing fabrication.

D. Coordinate door opening assembly details with adjacent work to assure proper attachments, clean junctions, etc.

3.02 INSTALLATION

A. Install work in accordance with Contract Documents and reviewed shop drawings.
   1. Install door systems and hardware in accordance with manufacturer's recommendations.
   2. Installer: Manufacturer certified.

B. Frames: Installed by others
   1. Set plumb and square in accordance with DHI standards.
      a. Out-of-square at frame head: Not to exceed 1/16 inch.
      b. Out-of-plumb for each frame jamb: Not to exceed 1/16 inch.
      c. Out-of-alignment for each side in plan: Not to exceed 1/16 inch.
      d. Twist dimension: Not to exceed 1/16 inch.
   2. Brace until adjacent wall is constructed.
   3. Securely anchor to adjacent wall.
   4. Furnish and install clips, fastenings, and anchorages and conceal unless otherwise noted.

C. Integrated Door Assembly
   1. Hang to maintain manufacturer's installation tolerances.
   2. Adjust to freely swing without binding, sticking, or sagging, and to eliminate excessive clearances.

D. Hardware: When installation is otherwise complete, confirm proper operation and function.

PART 4 - Integrated Door Assembly Schedule

4.01 Door manufacturer to provide the following Door Hardware:

A. TBD.

END OF SECTION 08 17 13

SECTION 08 31 00 – ACCESS DOORS

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide access doors as specified herein, and as necessary for complete installation. Provide units for both wall access, and for ceiling access at the following locations, and at locations indicated on the Drawings:

A. Access to concealed spaces
B. Access to valves, controls, panels and other concealed items requiring maintenance.
C. Provide fire-rated units when located within fire-rated partitions

1.02 RELATED SECTIONS

A. Section 018113 Certification Requirements.

1.03 LEED PERFORMANCE REQUIREMENTS

A. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material shall be within 100 miles of project site for credit if possible.
B. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.

1.04 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material (this includes components of the mix design). Include distance to Project and cost for each regional material. (if applicable)
C. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.

1.05 SUBMIT PRODUCT DATA for each type of door and frame indicated. Include construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required) for access doors and frames.

1.06 QUALITY ASSURANCE – FIRE RATED UNITS: Provide door and frame assemblies complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

A. NFPA 252 or UL 10B for vertical access doors and frames.

PART 2 - PRODUCTS

2.01 BASIS OF DESIGN PRODUCT / MANUFACTURER:

A. WILLIAMS BROTHER COPRORATION OF AMERICA:
   1. Non-Rated Walls: WB-DWAL 412 Series drywall finish, frameless, mud-in, touch latch access panel with detachable door.
   2. Non-Rated Ceilings: WB GY 3000 Series Glass-Fiber-Reinforced Gypsum (GFRG) Ceiling Access Panel
   3. Rated Walls: WB FR-RDW 860 Series Recessed Drywall Fire Rated Access Door for Walls
   4. Rated Ceilings: WB FR-RDW 870 Series Recessed Drywall Fire Rated Access Door for Ceilings
B. Substitutions must be approved by Architect through submittal process.

2.02 AVAILABLE MANUFACTURERS: Subject to compliance with requirements and aestetics, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

A. Acudor Products, Inc.
B. Babcock-Davis; A Cierra Products Co.
C. Bar-Co, Inc. Div.; Alfab, Inc.
D. Cendrex, Inc.
E. Cesco Products.
F. Elmdor/Stoneman; Div. of Acorn Engineering
G. Jensen Industries.
H. J. L. Industries, Inc.
I. Karp Associates, Inc.
J. Larsen's Manufacturing Company.
K. MIFAB Manufacturing, Inc.
L. Milcor Limited Partnership.
M. Nystrom Building Products Co.
N. Precision Plumbing Products, Inc.
O. Williams Bros. Corporation of America (The).

2.03 MATERIALS

A. Non-Rated Wall Access Panels:
   1. Door: Fully detachable, corrosion resistant, welded aluminum frame with or without inlayed 1/2" or 5/8" drywall
   2. Frame & Trim: 1 5/8" wide with outer and inner frame assembly consisting of high grade aluminum bonded with a special welding process
   3. Reveal: Reveal of 1/16” of an inch is visible between the outer frame and door hatch
   4. Finish: Mill finish

5. Latches: Concealed snap locks (two per door) open the access panel when pressure is applied to the spring loaded latch side
6. Hinge: Open pin hinge top and bottom, 12” x 12” and up access panels are equipped with a safety-system to prevent accidental opening - must be reattached after each opening
7. Application: Walls

B. Non-Rated Ceiling Access Panels

1. Door: Fully detachable, corrosion resistant, welded aluminum frame with or without inlayed 1/2" or 5/8" drywall
2. Frame & Trim: 1 5/8" wide with outer and inner frame assembly consisting of high grade aluminum bonded with a special welding process
3. Reveal: Reveal of 1/16” of an inch is visible between the outer frame and door hatch
4. Finish: Mill finish
5. Latches: Concealed snap locks (two per door) open the access panel when pressure is applied to the spring loaded latch side
6. Hinge: Open pin hinge top and bottom, 12” x 12” and up access panels are equipped with a safety-system to prevent accidental opening - must be reattached after each opening
7. Application: Ceilings

C. Rated Wall Access Panels:

1. Recess: Door is fitted with 5/8" fire rated drywall pre-installed
2. Hinge: Concealed Hinge
3. Door 22 Gauge Steel
4. Fire Rating: Meets 1-1/2 hour (90 minute) fire rating UL 10 (b)
5. Latch: Self-latching bolt, operated by flush key
6. Finish: Satin coat steel
7. Frame: Preforated to accept finish once installed for concealed flanges

D. Rated Ceiling Access Panels

1. Recess: Door is fitted with 5/8" fire rated drywall pre-installed
2. Hinge: Concealed Hinge
3. Door 22 GaugeSteel
4. Fire Rating: Meets 1-1/2 hour (90 minute) fire rating in accordance to CAN ULC S101-14, ASTM E119-16 and NFPA 251
5. Latch: Self-latching bolt, operated by flush key
6. Finish: Satin coat steel
7. Frame: Preforated to accept finish once installed for concealed flanges

2.04 FABRICATION:

A. PROVIDE ACCESS DOOR ASSEMBLIES manufactured as integral units ready for installation. For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness. Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels.

2.05 TYPICAL SIZE

A. FOR WALL ACCESS: 36 x 36 inch minimum, unless otherwise indicated.
B. FOR SOFFIT / CEILING ACCESS: 24 x 24 inch minimum, unless otherwise indicated.
C. Smaller sizes may be used for limited access to valves, junctions, etc. that are within arms reach of access door.

2.06 FINISHES

A. APPLY SHOP PRIMER to uncoated surfaces of metal fabrications. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.
B. Sheetrock panel finished flush and painted to match adjacent surface.
C. GFRG panel finished flush and painted to match adjacent surface.

PART 3 - EXECUTION

3.01 PREPARATION: Advise installers of other work about specific requirements relating to access door and floor door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

3.02 INSTALLATION: Comply with manufacturer's written instructions for installing access doors and frames. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces. Install access doors with trimless frames flush with adjacent finish surfaces or recessed to receive finish material.

3.03 ADJUSTING AND CLEANING: Adjust doors and hardware after installation for proper operation. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 00

SECTION 08 33 23 – OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Upward coiling service doors.

1.02 RELATED REQUIREMENTS

A. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.
B. Section 087100 - Door Hardware: Cylinder cores and keys.
C. Section 260583 - Wiring Connections: Power to disconnect.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
C. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
D. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).
E. FBC TAS 201 - Impact Test Procedures; Testing Application Standard; 1994.
F. FBC TAS 202 - Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components Using Uniform Static Air Pressure; Testing Application Standard; 1994.
G. ICC (IECC)-2018 - International Energy Conservation Code; 2018.
H. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's standard literature showing materials and details of construction and finish. Include data on electrical operation
B. Shop Drawings: Indicate rough and actual opening dimensions, anchorage methods, hardware locations, and installation details.
C. Manufacturer's Instructions: Indicate installation sequence and installation, adjustment, and alignment procedures.
D. Installer's qualification statement.
E. Operation and Maintenance Data: Indicate modes of operation, lubrication requirements and frequency, and periodic adjustments required.
F. Specimen warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in performing work of this section with minimum of 5 years
B. Installer Qualifications: Company specializing in performing work of this section with minimum of 3 years
C. Products Requiring Electrical Connection: Listed and classified by UL (DIR); TUV

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.
B. Protect materials from exposure to moisture.
C. Store materials in dry, warm, ventilated, weathertight location.

1.07 WARRANTY

A. Manufacturer Door and Operator Warranty: Provide manufacturer's limited warranty for door and operator system free from material and workmanship defects for duration and cycles indicated under individual doors; counterbalance spring and finish not covered by warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Overhead Door Corporation; www.overheaddoor.com; 1 (800) 929-3667.
B. Substitutions: Not permitted.

2.02 UPWARD COILING SERVICE DOORS

A. Overhead DoorTM Brand; Model 610S EverServe.
    (1) Slats: Interlocking, roll-formed, metal slats.
    (2) Width: Refer to Door Schedule
    (3) Height: Refer to Door Schedule
    (4) Mounting: Surface mounted on side indicated on drawings.
    (5) Opening Speed: Door to operate at variable speed of 8 to 12 inches (203 to 305 mm) per second.
    (6) Closing Speed: Door to operate at variable speed of 8 to 12 inches (203 to 305 mm) per second.
    (7) Operation Cycles: Capable of operating for minimum 500,000 cycles. One operation cycle is complete when door is opened from closed position to fully open position and returned to closed position.
    (8) Available Warranty:
        (a) Limited Warranty: For 3 years or 500,000 cycles, whichever comes first.
    (9) Wind Load: Design door assembly to withstand ultimate static pressure load of

(a) Wind Load: Not Required.

(10) Impact Rating: Available with certification for large missile impact resistance

(a) None - N/A

(11) Curtain Material:

(a) Galvanized Steel: 18 gauge, 0.0516 inch (1.31 mm)
(b) Slat Profile: F-265.

Fenestrated Slats: Perforated holes with minimum opening size of 2.14sqft.

(c) Galvanized Steel Finish:

(i) PowderGuard Premium powder coat

1. Color: Dark Bronze

(12) Bottom Bar: Galvanized steel

(a) Profile: Double angle.
(b) Finish: PowderGuard Premium powder coat.
(c) Color: Match curtain.

(13) Weatherstripping and Seals:

(a) Bottom Seal Astragal: Included.
(b) Interior Guide Seal: Not required.
(c) Exterior Guide Seal: Not required.
(d) Lintel Brush Seal: Not required.

(14) Side Guides, Channels: Constructed of steel with members fully bolted together.

(a) Finish: PowderGuard Premium powder coat

(i) Color: Match curtain.

(15) Brackets: Steel to support counterbalance and curtain.

(a) Finish: PowderGuard Premium powder coat

(i) Color: Match curtain.

(16) Door Roll: Directly driven, springless roll constructed of steel tube with integral shafts, keyed on drive end and supported by self-aligning, greasable, sealed bearings. Counterbalance device not required.

(17) Hood: 24 gauge, 0.0278 inch (0.63 mm) galvanized steel;

(a) Finish: Match curtain;

(18) Motor Operation: Direct drive, integrated gear motor and brake assembly; size as recommended by manufacturer to move door in either direction at minimum 8 inches (203 mm), maximum 1 foot (305 mm) per second. Operator and drive assembly is factory preassembled and provided with wiring harnesses needed direct from factory.

(a) Manual Override: Hoist.
(b) Timer to Close: Time-delay self-close timer and non-resettable cycle counter.
(c) Operation Supply Voltage: 208V 3-phase 60Hz;
(d) Signaling Device: Horn and strobe combination;.
(e) Actuation Device: Provide push button; key switch; treadle switch; and radio control.
(f) Motor Mounting: Shaft mount.
(g) Obstruction Safety Detection:

(i) Primary, Monitored:

1. Photo Eyes: Thru-beam photo-eyes; .
2. Safety Edge: 2-wire reversing safety edge.

(ii) Secondary, Non-Monitored:

1. Photo Eyes: Reflective photo-eyes; .
2. Safety Edge: 2-wire reversing safety edge

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions; and meet manufacturer's requirements before starting work.
B. Verify opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Install in accordance with manufacturer's written instructions.
B. Use anchorage devices to securely fasten assembly to wall construction and building structure without distortion or stress.
C. Secure guides to structural members only
D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
E. Coordinate installation of electrical service; see Section 260583.
F. Install enclosure and perimeter trim.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation from Plumb: 1/16 inch (1.6 mm)
C. Maximum Variation from Level: 1/16 inch (1.6 mm)
D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 feet (3.2 mm per 3 m)

3.04 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
B. Clean installed components.
C. Remove labels and visible markings.

3.06 PROTECTION

A. Protect finishes until completion of project.
B. Touch up damaged finishes after Substantial Completion.

END OF SECTION 08 33 23

SECTION 08 41 13 – ALUMINUM ENTRANCE CURTAIN WALLS AND STOREFRONT

PART 1 - GENERAL

1.01 PROVIDE ALUMINUM-FRAMED entrance doors, curtain walls and storefront framing as shown on Drawings, as required herein, and as needed to meet the requirements of the construction shown in the Contract Documents.

1.02 RELATED SECTIONS

A. Section 018113 Certification Requirements.

1.03 ACCESSIBLE ENTRANCES: Provide entrances in compliance with both the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG).", and ICC/ANSI A117.1.

1.04 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, hardware, finishes, and installation instructions for each type of aluminum-framed storefront system indicated.
   1. Recycled Content:
      a. Provide documentation that aluminum has a minimum of 50% mixed pre- and post-consumer recycled content with a sample document illustrating project specific information that will be provided after product shipment.
      b. Once product has shipped, provide project specific recycled content information, including:
         (1) Indicate recycled content; indicate percentage of pre- and post-consumer recycled content per unit of product.
         (2) Indicate relative dollar value of recycled content product to total dollar value of product included in project.
         (3) Indicate location recovery of recycled content.
         (4) Indicate location of manufacturing facility.
   2. Environmental Product Declaration (EPD).
      a. Include a Type III Product-Specific EPD created from a Product Category Rule.

B. Shop Drawings: Include plans, elevations, sections, details, hardware, and attachments to other work, operational clearances and installation details.

C. Samples for Initial Selection: For units with factory-applied color finishes including samples of hardware and accessories involving color selection.

D. Samples for Verification: For aluminum-framed storefront system and components required.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for each type, of aluminum-framed storefront.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of aluminum-framed systems, made from 12" (304.8 mm) lengths of full-size components and showing details of the following:
   1. Joinery, including concealed welds.
   2. Anchorage.
   3. Expansion provisions.
   4. Glazing.
   5. Flashing and drainage.

G. Other Action Submittals:
   1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

1.05 LEED PERFORMANCE REQUIREMENTS

A. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material shall be within 100 miles of project site for credit if possible.

B. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.

C. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.

D. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.06 LEED DOCUMENTATION REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

B. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material. Include distance to Project and cost for each regional material.

C. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.

D. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.

E. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable.

1.07 QUALITY ASSURANCE:

A. Installer Qualifications: An installer which has had successful experience with installation of the same or similar units required for the project and other projects of similar size and scope.
B. Manufacturer Qualifications: A manufacturer capable of providing aluminum-framed storefront system that meet or exceed performance requirements indicated and of documenting this performance by inclusion of test reports, and calculations.
C. Source Limitations: Obtain aluminum-framed storefront system through one source from a single manufacturer.
D. Product Options: Drawings indicate size, profiles, and dimensional requirements of aluminum-framed storefront system and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements”. Do not modify size and dimensional requirements.
    1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
    1. Build mockup for type(s) of storefront elevation(s) indicated, in location(s) shown on Drawings.
F. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section “Project Management and Coordination”.

1.08 Project Conditions

A. Field Measurements: Verify actual dimensions of aluminum-framed storefront openings by field measurements before fabrication and indicate field measurements on Shop Drawings.

1.09 Warranty

A. Manufacturer’s Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty.
    1. Warranty Period: Two (2) years from Date of Substantial Completion of the project.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.
B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
    1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
    2. Failure also includes the following:
        a. Thermal stresses transferring to building structure.
        b. Glass breakage.
        c. Noise or vibration created by wind and thermal and structural movements.
        d. Loosening or weakening of fasteners, attachments, and other components.
        e. Failure of operating units.
C. Structural Loads:
    1. Wind Loads: As indicated on Drawings.
    2. Other Design Loads: As indicated on Drawings
D. Deflection of Framing Members: At design wind pressure, as follows:
    1. Deflection Normal to Wall Plane: Limited to [edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite] [1/175 of clear span for spans of up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m)] <Insert deflection limit> or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
    2. Deflection Parallel to Glazing Plane: Limited to [1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller] [amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).
        a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
    3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
        a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 11 feet 8-1/4 inches (3.6 m) or 1/175 times span, for spans of less than 11 feet 8-1/4 inches (3.6 m).
E. Structural: Test according to ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
2. When tested at [150] <Insert number> percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding [0.2] <Insert number> percent of span.
3. Test Durations: As required by design wind velocity, but not less than [10] <Insert number> seconds.

F. Air Infiltration: Test according to ASTM E283 for infiltration as follows:
1. Fixed Framing and Glass Area:
a. Maximum air leakage of [0.06 cfm/sq. ft. (0.30 L/s per sq. m)] <Insert value> at a static-air-pressure differential of [1.57 lbf/sq. ft. (75 Pa)] [6.24 lbf/sq. ft. (300 Pa)] <Insert value>.
2. Entrance Doors:
a. Single Doors: Maximum air leakage of [0.5 cfm/sq. ft. (2.54 L/s per sq. m)] <Insert value> at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).

G. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than [6.24 lbf/sq. ft. (300 Pa)] [10 lbf/sq. ft. (480 Pa)] [15 lbf/sq. ft. (720 Pa)] <Insert value>.

H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than [6.24 lbf/sq. ft. (300 Pa)] [10 lbf/sq. ft. (480 Pa)] [15 lbf/sq. ft. (720 Pa)] <Insert value>.
2. Maximum Water Leakage: [According to AAMA 501.1] [No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation]. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

I. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement[and 1.5 times the design displacement].

J. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas as a system shall have U-factor of not more than [0.41 Btu/sq. ft. x h x deg F (2.33 W/sq. m x K)] [0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K)] [0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K)] [0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K)] <Insert value> as determined according to NFRC 100.
2. Solar Heat Gain Coefficient (SHGC): Fixed glazing and framing areas as a system shall have SHGC of no greater than [0.26] [0.35] [0.40] [0.45] <Insert value> as determined according to NFRC 200.
3. Condensation Resistance: Fixed glazing and framing areas as a system shall have an NFRC-certified condensation resistance rating of no less than [15] [25] [35] [45] [55] [65] [75] <Insert value> as determined according to NFRC 500.

K. Noise Reduction: Test according to ASTM E90, with ratings determined by ASTM E1332, as follows.
1. Outdoor-Indoor Transmission Class: Minimum [26] [30] [34] <Insert number>.

L. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of [180 deg F (82 deg C)] <Insert temperature>.
b. Low Exterior Ambient-Air Temperature: [0 deg F (minus 18 deg C)] <Insert temperature>.
c. Interior Ambient-Air Temperature: [75 deg F (24 deg C)] <Insert temperature>.

M. Structural-Sealant Joints:
1. Designed to carry gravity loads of glazing.
2. Structural Sealant: ASTM C1184 and ASTM C1401 (SSG). Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed, aluminum-framed entrances and storefronts without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.02 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by aluminum storefront manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070" (1.8 mm) wall thickness at any location for the main frame and complying with ASTM B 221: 6063-T6 alloy and temper.

1. Recycled Content: Shall have a minimum of 50% mixed pre- and post-consumer recycled content.

a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.
c. Indicate location recovery of recycled content.
d. Indicate location of manufacturing facility.

B. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum framing members, trim hardware, anchors, and other components.

C. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.

D. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.

E. Sealant: For sealants required within fabricated storefront system, provide permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement and that comply with structural sealant glazing (SSG) ASTM C1401 standards.

F. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliance with AA Aluminum Standards and Data.

2.03 ACCEPTABLE MANUFACTURERS: Subject to compliance with unit size of products indicated and other requirements specified herein, products of one of the following alternative manufacturers are also acceptable:

A. Arch Amarlite – Arch Aluminum and Glass Inc. (www.archamarlite.com)
B. EFCO Corporation (www.efcocorp.com)
C. BASIS OF DESIGN: Kawneer Company, Inc. (**www.kawneer.com**)
D. Tubelite Architectural Systems (www.tubeliteinc.com)
E. Vistawall Architectural Products (www.vistawall.com)
F. YKK AP America Inc. (www.ykkap.com)
G. Manko (www.mankowindows.com)

2.04 EXTERIOR INSULATED CURTAIN WALL, DOOR & WINDOW AND SHADOW BOX FRAMING: Fabricated system from minimum 1/8 inch thickness ASTM B 221 aluminum extrusions and ASTM B 209 sheet, with steel reinforcement as required to comply with wind-load and deflection limits indicated above:

A. Typical member size: 2” wide/high x (both) 6” and 7 ½” inch deep (refer to Drawings)
B. Finish: Dark Bronze
C. Glazing: Solarban 60 with a ½” spacing Argon cavity
D. BASIS OF DESIGN: Kawneer 1620UT SSG Curtain Wall System
E. System will have SSG horizontals and a custom mullion cap profile for the outer caps.
F. Shadow Box Design: Refer to details in Drawings and note the following:

1. The shadow box within the curtain wall frame must be full sealed to prevent condensation within the shadow box. The curtain wall design must ensure that all finishes, sealants, and other materials in or adjacent to the shadow box cavity are stable at high temperature. The curtain wall designer must determine the highest anticipated temperature inside the cavity and verity the ability of the glass and back pan to withstand the resultant high temperature.

2.05 EXTERIOR STOREFRONT, DOOR & WINDOW FRAMING: Fabricated system from minimum 1/8 inch thickness ASTM B 221 aluminum extrusions and ASTM B 209 sheet, with steel reinforcement as required to comply with wind-load and deflection limits indicated above:

A. Typical member size:

1. Kawneer 451T: 2” wide/high x (both) 4 ½” inch deep
2. Kawneer 601T 2” wide/high x (both) 6” inch deep

B. Finish: Dark Bronze
C. Glazing: Solarban 60 with a ½” spacing Argon cavity; Front Plane Glass
D. BASIS OF DESIGN: Kawneer 451T Framing System

2.06 EXTERIOR INSULATED ALUMINUM ENTRANCE DOORS: Thermally broken and insulated stile and rail type door, two (2) inch thick, with ten (10) inch high minimum bottom rail for accessibility compliance, of minimum 1/8” thick tubular aluminum frame members mechanically fastened and with reinforced joints, for insulated glazing:

A. BASIS OF DESIGN: Kawneer # 350T Insulpour Thermal Entrance Door (2-1/4-inch thick)
B. Glazing: Solarban 60 with a ½” spacing Argon cavity
C. Finish: Dark Bronze

2.07 INTERIOR STOREFRONT, DOOR & WINDOW FRAMING: Fabricated system of ASTM B 221 - 6063 T5 alloy extruded aluminum, in rectangular profile to accept 6 mm (1/4 inch) glass panels, with 1-3/4-inch-wide snap-on outside trims to cover and engage drywall partitions – with an overall “face” profile width of 1-3/4 inch. Provide “throat opening” to match drywall partition thickness. Pre-machine jambs and prepare for door hardware, with concealed reinforcement plates,

drilled and tapped as required, and fastened to the frames. Provide corner reinforcements to allow secure installation without exposed fasteners. Pre-cut in factory, and ship to project site knocked-down for field assembly.

A. Typical member size: 1-3/4" wide/high x 4-1/2-inch deep
B. Glazing location: "centered"
C. Finish: Dark Bronze
D. BASIS-OF-DESIGN: Kawneer- Trifab 450 Framing system

2.08 INTERIOR (NON-THERMAL) ALUMINUM ENTRANCE DOORS: Stile and rail type door, 1-3/4 inch thick, with "wide" profile vertical and top stiles and six (6) inch high minimum bottom rail, of minimum 1/8" thick tubular aluminum frame members mechanically fastened and with reinforced joints, for single-pane glazing:

A. Finish: Dark Bronze
B. BASIS OF DESIGN: Kawneer 350 Medium Stile Standard Entrance

2.09 ALUMINUM ENTRANCE DOOR HARDWARE:

A. Refer to other Division-08 "Door Hardware" Section for other hardware required for storefront doors

2.10 BRAKE-METAL ALUMINUM TRIM: Fabricate flat aluminum sheet in profiles indicated on Drawings or as required to provide closure at adjacent construction elements.

2.11 STEEL REINFORCEMENT complete with manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment, select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard:

A. Structural Shapes, Plates, and Bars: ASTM A 36
B. Cold-Rolled Sheet and Strip: ASTM A 1008
C. Hot-Rolled Sheet and Strip: ASTM A 1011

2.12 FASTENERS: Aluminum, non-magnetic stainless steel, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum components. Exposed fasteners must match finish of members and hardware being fastened.

2.13 CONCEALED FLASHING: Dead-soft stainless steel, 26 gage minimum, or extruded aluminum, 0.062" minimum, as selected by manufacturer for compatibility with other components.

2.14 CONCRETE/MASONRY INSERTS: Cast-iron, malleable iron, or hot-dipped galvanized steel complying with ASTM A-386.

2.15 BITUMINOUS COATINGS: Cold-applied asphalt mastic complying with SSPC-PS 12, compounded for 30-mil thickness per coat.

2.16 COMPRESSION WEATHERSTRIPPING: Manufacturer's standard replaceable stripping of either molded neoprene gaskets complying with ASTM D 2000 or molded PVC gaskets complying with ASTM D 2287.

2.17 GLAZING SYSTEM: Provide manufacturer's standard compression type molded or extruded glazing gaskets that maintain uniform pressure and watertight seal, inside-outside matched, with provisions for glass replacement. Provide elastomeric type spacers and setting blocks.

2.18 MAINTENANCE TOOLS AND INSTRUCTIONS: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

2.19 PREFABRICATION: Complete fabrication, assembly, finishing, hardware application, and other work before shipment to project site. Disassemble components only as necessary for shipment and installation. Comply with AWS recommendations to avoid discoloration; grind exposed welds smooth and restore mechanical finish. Install reinforcing if required for performance requirements; separate dissimilar metals with bituminous paint or other separator which will prevent corrosion. Maintain accurate relation of planes and angles, with hairline fit of contacting members. Conceal fasteners wherever possible.

2.20 DOOR FABRICATION: Provide tubular frame members, fabricated with mechanical joints using heavy inserted reinforcing plates and concealed tie-rods or j-bolts, or fabricate with structurally welded joints, at manufacturer's option.

2.21 ALUMINUM TRIM: Fabricate flat aluminum sheet in profiles indicated on Drawings or as required to provide closure at adjacent construction elements.

2.22 ANODIZED ALUMINUM FINISH: Provide Class 1 "colored" anodized finish per AA-M12C22A42/A44.

A. COLOR: Dark Bronze, or as otherwise indicated in the Drawings

2.23 TAKE FIELD MEASUREMENTS prior to fabrication, to ensure proper fitting of Work.

PART 3 - EXECUTION

3.01 EXAMINE AREAS with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. COMPLY with manufacturer's instructions and recommendations for installation of aluminum entrances and storefronts.
B. SET UNITS PLUMB, level, and true to line, without warp or rack of framing members, doors, or panels. Anchor securely in place, separating aluminum and other corrodible metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials.
C. DRILL AND TAP frames and doors and apply surface-mounted hardware items, complying with hardware manufacturer's instructions and template requirements. Use concealed fasteners wherever possible.

D. SET SILL MEMBERS in bed of sealant as indicated, or with joint fillers or gaskets as indicated to provide weathertight construction. Comply with requirements of Division 7 for sealants, fillers, and gaskets. Install glazing as required by Division-08 “Glazing” Section.
E. ADJUST OPERATING HARDWARE to function properly, without binding, and to prevent tight fit at contact points and weather-stripping.
F. ERECTION TOLERANCES: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
    1. PLUMB: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
    2. LEVEL: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
    3. ALIGNMENT: Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    4. LOCATION: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.03 FIELD QUALITY CONTROL – WATER-SPRAY TESTING: Before installation of interior finishes has begun, test representative areas as designated by the Architect according to AAMA 501.2, in the presence of the Architect and the Owner’s representative. Tested areas must not show any evidence of water penetration. Perform a minimum of two tests in areas as directed by Architect.

3.04 CLEAN COMPLETED SYSTEM, inside and out, promptly after erection and installation of glass and sealants. Remove excess glazing and joint sealants, dirt, and other substances from aluminum surfaces.

3.05 INSTITUTE PROTECTIVE MEASURES and precautions required to assure that aluminum entrances and storefronts will be without damage or deterioration, other than normal weathering, at time of acceptance.

3.06 MAINTENANCE SERVICE FOR ENTRANCE DOOR HARDWARE: Beginning at Substantial Completion, provide maintenance service by skilled employees of the entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

3.07 INITIAL MAINTENANCE SERVICE PERIOD: twelve months after Substantial Completion

END OF SECTION 08 41 13

SECTION 08 71 00 – DOOR HARDWARE AND SCHEDULE

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide door hardware where indicated on the Drawings, as specified herein, and as necessary for complete installation. This Section includes items known commercially as finish or door hardware that are required for swing and sliding doors, and other doors to the extent indicated. Hardware for special types of unique hardware is specified in the same Sections as the doors and door frames on which they are installed. The Work of this Section includes:

A. Mechanical door hardware for swinging and sliding doors
B. Electromechanical door hardware
C. Cylinders specified for doors that are specified in other Sections.

1.02 RELATED SECTIONS

A. Section 018113 Certification Requirements.
B. ACCESS CONTROL SYSTEM are specified in a Division-28 Section of the Specifications

1.03 CODES & REFERENCE STANDARDS: In addition to compliance with the applicable building code, comply with the following referenced standards:

A. ANSI/BHMA Certified Product Standards: A156 Series
B. Underwriters Laboratory: L10C – Positive Pressure Fire Tests of Door Assemblies
C. National Fire Protection Association (NFPA)
    1. NFPA 70 - National Electrical Code.
    2. NFPA 80 - Fire Doors and Windows.
    3. NFPA 101 - Life Safety Code.
    4. NFPA 105 - Installation of Smoke Door Assemblies.

1.04 ACCESSIBILITY STANDARDS: COMPLY WITH ICC/ANSI A117.1 “Accessible and Usable Buildings and Facilities” (most recent edition) and with requirements of the federally required Americans with Disabilities Act (ADA) – 2010 Edition, including but not limited to the following:

A. Provide an accessible clear-floor space at all accessible, operational door hardware
B. Accessible hardware to be operable with one (1) hand in a single motion,
C. Accessible hardware to be operable without tight grasping, pinching, or twisting of the wrist.
D. Maximum operational force for accessible hardware: five (5.0) pounds (except at exterior doors)
E. Allowable height limits for accessible, operational door hardware:
    1. lowest height above grade or floor: 1’-3” (15”)
    2. highest height above grade or floor: 4’-0” (48”)

1.05 FIRE-RATED DOOR ASSEMBLIES: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to AHJ representatives, for fire ratings indicated, based on testing according to NFPA 252 (neutral pressure at 40" above sill) or UL-10C, for positive pressure labeling.

1.06 LEED PERFORMANCE REQUIREMENTS

A. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.
B. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.
C. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.07 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.
C. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.
D. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable

1.08 SUBMITTALS

A. PRODUCT DATA including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
B. DOOR HARDWARE SCHEDULE: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
    1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:
4. Type, style, function, size, label, hand, and finish of each door hardware item.
5. Manufacturer of each item.
6. Fastenings and other pertinent information.
7. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
8. Explanation of abbreviations, symbols, and codes contained in schedule.
9. Mounting locations for door hardware.
10. Door and frame sizes and materials.
11. Warranty information for each product.

C. SUBMITTAL SEQUENCE: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

D. SHOP DRAWINGS: Details of electrified access control hardware indicating the following:

E. WIRING DIAGRAMS: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

1. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
2. Complete (risers, point-to-point) access control system block wiring diagrams.
3. Wiring instructions for each electronic component scheduled herein.
4. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

F. KEYING SCHEDULE: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

G. OPERATING AND MAINTENANCE MANUALS: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

1.09 QUALITY ASSURANCE

A. PROVIDE CONSULTING SERVICES of a experienced Architectural Hardware Consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the Project, for consultation (in addition to the meetings at site as indicated below).

B. SINGLE SOURCE RESPONSIBILITY: Obtain each type of hardware (latch and lock sets, hinges, closers, etc.) from a single manufacturer. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted. Provide integrated access control door hardware from the same manufacturer as standard mechanical door hardware, unless otherwise indicated.

C. SUPPLIER QUALIFICATIONS: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.

1.10 HARDWARE & KEYING COORDINATION MEETING: Coordinate and manage a meeting between the Owner’s representative and the hardware supplier’s AHC certified consultant to confirm requirements of specified hardware items indicated herein before ordering, and to determine or confirm the final keying requirements. Confirm decisions made in writing, and submit to Architect for record within three (3) days of meeting.

A. Allow for a minimum of two (2) meetings, each to take not less than FOUR (4) hours each
B. Conduct meetings at the project site or offices of the Owner (unless otherwise agreed to by Owner’s representative).
C. Include the Owner’s separate Security Contractor in the coordination meetings, if applicable

1.11 INSTALLER QUALIFICATIONS: Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

1.12 PRE-SUBMITTAL CONFERENCE: Conduct coordination conference in compliance with requirements of Division-01 with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

A. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.

B. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades, and the following:
C. Review sequence of operation narratives for each unique access controlled opening.
D. Review and finalize construction schedule and verify availability of materials.
E. Review the required inspecting, testing, commissioning, and demonstration procedures

1.13 INSTALLATION COMPLIANCE VERIFICATION: At completion of installation, provide written documentation to the Owner that door hardware components were installed in accordance with their manufacturer's instructions and recommendations and according to the approved Hardware Schedule.

1.14 PRODUCT HANDLING

A. TAG EACH ITEM OR PACKAGE SEPARATELY with identification related to final hardware schedule, and include basic installation instructions with each item or package. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.
B. INVENTORY DOOR HARDWARE jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.
C. DELIVER INDIVIDUALLY PACKAGED DOOR HARDWARE ITEMS promptly to place of installation (shop or Project site).
D. PROVIDE SECURE LOCK-UP for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.15 SPECIAL PRODUCT WARRANTY

A. PROVIDE WRITTEN WARRANTY, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fail in materials or workmanship within the indicated warranty period after Substantial Completion of the Work. Failures include, but are not limited to, the following:
   1. Structural failures including excessive deflection, cracking, or breakage.
   2. Faulty operation of the hardware.
   3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   4. Electrical component defects and failures within the systems operation.
B. SPECIAL WARRANTY PERIODS (in addition to other contractual and/or implied warranties):
   1. Ten (10) years for mortise locks and latches.
   2. Seven (7) years for heavy duty cylindrical (bored) locks and latches.
   3. Five (5) years for exit hardware.
   4. Twenty five (25) years for manual surface door closer bodies.
   5. Ten (10) years for heavy duty floor closers.
   6. Two (2) years for shallow depth floor closers.
   7. Two (2) years for electromechanical door hardware.

1.16 MAINTENANCE SERVICE

A. MAINTENANCE TOOLS AND INSTRUCTIONS: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
B. KEY CONTROL SYSTEM: Utilize Owner’s existing system
C. CONTINUING SERVICE: Beginning at Substantial Completion, provide continuous (6) months full maintenance including repair and replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S NAME PLATE: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect. Manufacturer's identification will be permitted on rim of lock cylinders only.

2.02 BASE METALS: Produce hardware units of basic metal and forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.

2.03 FASTENERS: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

2.04 FURNISH SCREWS FOR INSTALLATION with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.

2.05 PROVIDE CONCEALED FASTENERS for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work

adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.06 DOOR HANGING DEVICES: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

2.07 HINGES: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware, and as follows:

A. For metal doors and frames install machine screws into drilled and tapped holes.
B. Finish screw heads to match surface of hinges or pivots.
C. Hinge Size: Provide size scheduled or as follows, whichever is stronger per applicable door size:
    1. Width up to 3'-0": 4-1/2 inch, 3'-1' to 4'-0": 5 inch wide units minimum
D. Hinge Weight:
    1. Exterior Doors: Heavy weight, non-ferrous, ball bearing hinges unless Set indicates standard weight.
    2. Interior Doors: Standard weight, steel, ball bearing hinges unless Sets indicate heavy weight.
E. Hinge Pins: Non-removable (NRP) on out-swinging exterior doors, with flat button tips and matching plug, finished to match leaves.
F. Number of Butt Hinges: Provide number of hinges indicated (not less than 3) per door leaf and as follows:
    1. For 91 to 120 inch height: four (4) hinges
    2. Over 121 inches high: Provide four (4) hinges and ADD one (1) hinge per each 30 inches added height
G. Acceptable Manufacturers for Butt Hinges:
    1. Bommer Industries (BO)
    2. Hager (HA)
    3. McKinney (MK)
    4. PBB
    5. Stanley (ST)

2.08 CONTINUOUS GEARED HINGES: ANSI/BHMA A156.26 certified continuous geared hinge with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Units are non-handed, reversible and fabricated to template screw locations. Provide concealed flush mount (with or without inset), in heavy duty models, as specified in the Hardware Sets. Concealed continuous hinges to be U.L. listed for use on up to and including 90 minute rated door installations. Factory cut hinges for door size and provide with removable service power transfer panel where indicated at electrified openings.

A. Acceptable Manufacturers: Bommer Industries (BO), McKinney (MK) Pemko (PE), Select, or Stanley (ST)

2.09 FLOOR CLOSERS: ANSI/BHMA A156.4 certified floor closers. Provide independent and adjustable valves for closing speed, latch speed, and backcheck with built-in dead stop and hold open features as specified. Provide finished cover plates or thresholds as indicated in door Hardware Sets.

A. Acceptable Manufacturers: Rixson Door Controls (RF).

2.10 PIVOTS: ANSI/BHMA A156.4, Grade 1, certified. Space intermediate pivots equally not less than 25 inches on center apart or not more than 35 inches on center for doors over 121 inches high. Pivot hinges to have oil impregnated bronze bearing in the top pivot and a radial roller and thrust bearing in the bottom pivot with the bottom pivot designed to carry the full weight of the door.

A. Acceptable Manufacturers: ABH Manufacturing (AB), Rixson Door Controls (RF).

2.11 POWER TRANSFER DEVICES

A. CONCEALED QUICK CONNECT ELECTRIC POWER TRANSFERS: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
    1. Acceptable Manufacturers: Architectural Builders Hardware (AH) PT1000-EZ Series, Securitron (SU) - EL-CEPT Series.
B. ELECTRIC DOOR WIRE HARNESSES: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
    1. Acceptable Product/Manufacturer: McKinney Products (MK) – QC-C Series.
    2. Provide one (1) each of the following tools as part of the Work of this Section:
    3. McKinney Products (MK) - Electrical Connecting Kit: QC-R001.
    4. McKinney Products (MK) - Connector Hand Tool: QC-R003.

2.12 DOOR OPERATING TRIM

2.13 FLUSH BOLTS AND SURFACE BOLTS: ANSI/BHMA A156.3 and A156.16, Grade 1, certified automatic, self-latching, and manual flush bolts and surface bolts. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt

location approximately six feet from the floor. Furnish dust proof strikes for bottom bolts. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

A. Acceptable Manufacturers: Burns Manufacturing (BU), Door Controls International (DC), Rockwood (RO), Trimco (TC)

2.14 DOOR PUSH PLATES AND PULLS:

A. ANS/BHMA A156.6 certified door pushes and pulls of type and design specified below or in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates, and as follows. Provide manufacturer's designated fastener type as indicated in Hardware Sets.
B. PUSH/PULL PLATES: Minimum .050 inch thick, 4-inches wide by 16-inches high, with square corners and beveled edges, secured with exposed screws unless otherwise indicated.
C. STRAIGHT PULL DESIGN: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection from face of door unless otherwise indicated.
D. OFFSET PULL DESIGN: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection and offset of 90 degrees unless otherwise indicated.
E. PUSH BARS: Minimum 1-inch round diameter horizontal push bars with minimum clearance of 2 1/2-inch projection from face of door unless otherwise indicated.
    1. Acceptable Manufacturers:
        a. Burns Manufacturing (BU)
        b. Rockwood Manufacturing (RO)
        c. Trimco (TC),

2.15 LOCKING LADDER PULL SYSTEM: Post-mount style door pulls with integrated deadbolt locking system in type and design as specified in the Hardware Sets. Pulls available in multiple head, floor, or combination locking options, with outside keyed rim cylinder operation and inside turn piece activation. Mounting applications for aluminum, glass, steel and wood doors, with customized sizing and configuration options. Pull finishes include brass, bronze, and stainless steel.

A. Acceptable Manufacturers: Blumcraft (BL) – Locking Ladder Series, or Rockwood Manufacturing (RO) – LP Series.

2.16 CYLINDERS AND KEYING: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated. Provide original manufacturer cylinders complying with the following:

A. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
B. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
C. Bored-Lock Type: Cylinders with tailpieces to suit locks.
D. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
E. Keyway: Match existing facility standard
F. Security Cylinders: ANSI/BHMA A156.5, Grade 1, patented security cylinders and keys able to be used together under the same facility master or grandmaster key system. Cylinders are to be factory keyed.
G. Acceptable Manufacturers:
    1. Corbin Russwin (RU) - Pyramid PS Series.
    2. Sargent Manufacturing (SA) - Signature Series.
    3. Schlage Lock (SC) - Primus Series.

2.17 EXISTING FACILITY KEYING SYSTEM: Each type of lock and cylinders to be factory keyed. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.

A. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
B. Existing System: Key locks to Owner's existing system.

2.18 KEYING SYSTEM: Each type of lock and cylinders to be factory keyed. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner. Incorporate decisions made in keying conference, and as follows:

A. Master Key System: Cylinders are operated by a change key and a master key.
B. Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.
C. Key Quantity: Provide the following minimum number of keys:
D. Top Master Key: One (1)
E. Change Keys per Cylinder: Two (2)
F. Master Keys (per Master Key Group): Five (5) Two (2)
G. Grand Master Keys (per Grand Master Key Group): Two (2)
H. Construction Control Keys (where required): Ten (10 Two (2)
I. Permanent Control Keys (where required): Two (2)

2.19 CONSTRUCTION KEYING: Provide construction master keyed cylinders or temporary keyed construction cores where specified. Provide construction master keys in quantity as required by project Contractor. Replace construction cores with permanent cores. Furnish permanent cores for installation as directed under specified "Keying Conference".

2.20 KEY REGISTRATION LIST (Bitting List): Provide keying transcript list to Owner's representative in the proper format for importing into key control software. Provide transcript listing in writing or electronic file as directed by the Owner.

2.21 KEY CONTROL SOFTWARE: Provide one network version of "Key Wizard" branded key management software package that includes one year of technical support and upgrades to software at no charge. Provide factory key system formatted for importing into “Key Wizard” software.

2.22 MECHANICAL LOCKS AND LATCHING DEVICES

A. MORTISE LOCKSETS, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified mortise locksets furnished in the functions as specified in the Hardware Sets. Locksets to be manufactured with a corrosion resistant, stamped 12 gauge minimum formed steel case and be field-reversible for handing without disassembly of the lock body. Lockset trim (including knobs, levers, escutcheons, roses) to be the product of a single manufacturer. Furnish with standard 2 3/4" backset, 3/4" throw anti-friction stainless steel latchbolt, and a full 1" throw stainless steel bolt for deadbolt functions. Provide mortise lock bodies functionally compatible with a roseless lever trim option. Acceptable Manufacturers:

1. Corbin Russwin Hardware (RU) – ML2000 Series.
2. Sargent Manufacturing (SA) – 8200 Series.
3. Schlage Lock (SC) – L9000 Series
4. Yale Locks and Hardware (YA) – 8800FL Series.

B. CYLINDRICAL LOCKSETS, Grade 1 (Heavy Duty): ANSI/BHMA A156.2, Series 4000, Grade 1 certified cylindrical (bored) locksets furnished in the functions as specified in the Hardware Sets. Lock chassis fabricated of heavy gauge steel, zinc dichromate plated, with through-bolted application. Furnish with solid cast levers, standard 2 3/4” backset, and 1/2" (3/4" at rated paired openings) throw brass or stainless steel latchbolt. Locks are to be non-handed and fully field reversible. Provide lock trim design as indicated in the Hardware Sets. Acceptable Manufacturers:

1. Corbin Russwin Hardware (RU) – CL3300 Series.
2. Sargent Manufacturing (SA) – 10 Line.
3. Yale Locks and Hardware (YA) 5400LN Series.

C. TUBULAR LOCKSETS: Standard tubular locksets designed to fit ANSI standard 161 door prep without additional through-bolt preps. Locksets to be non-handed with bi-directional lever operation and be available with 2 3/4" standard and 2 3/8" optional backsets. Lever designs must be available to match other locksets and exit devices. Roseless tubular is available for lockset functions only and requires special custom door preparation. Acceptable Manufacturers:

1. Corbin Russwin Hardware (RU) - TL3700 Series.
2. Sargent Manufacturing (SA) – DL Series.
3. Lock Trim Design: As specified in Hardware Sets.

D. AUXILIARY LOCKS - CYLINDRICAL DEADLOCKS: ANSI/BHMA A156.5, Grade 1, cylindrical type deadlocks to fit standard ANSI 161 preparation and 1 3/8" to 1 3/4" thickness doors. Provide tapered collars to resist vandalism and 1" throw solid steel bolt with hardened steel roller pins. Deadlocks to be products of the same source manufacturer and keyway as other locksets. Acceptable Manufacturers:

1. Corbin Russwin Hardware (RU) - DL3000 Series.
2. Sargent Manufacturing (SA) - 480 Series.

E. LOCK AND LATCH STRIKES: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Standards: Comply with the following:
5. Strikes for Mortise Locks and Latches: BHMA A156.13.
6. Strikes for Bored Locks and Latches: BHMA A156.2.
7. Strikes for Auxiliary Deadlocks: BHMA A156.5.
8. Dustproof Strikes: BHMA A156.16.

2.23 ELECTROMECHANICAL LOCKING DEVICES

A. ELECTROMECHANICAL MORTISE LOCKSETS, Grade 1 (Heavy Duty): Subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below. Typically provide electrified lock options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, and request-to-exit signaling. Unless otherwise indicated, provide electrified locksets standard as fail secure. Acceptable Manufacturers:

1. Corbin Russwin Hardware (RU) - ML20900 Series.
2. Sargent Manufacturing (SA) - 8200 Series.
3. Yale Locks and Hardware (YA) - 8890 Series.

B. ELECTROMAGNETIC LOCKING DEVICES: Surface Electromagnetic Locks (Heavy Duty): Electromagnetic locks to be surface mounted type conforming to ANSI A156.23, Grade 1 with minimum holding force strength of 1,200 pounds. Locks to be capable of either 12 or 24 voltage and be UL listed for use on fire rated door assemblies. Electronics are to be fully sealed against tampering and allow exterior weatherproof applications. As indicated in Hardware Sets, provide specified mounting brackets and housings. Power supply to be by the same manufacturer as the lock with combined products having a lifetime replacement warranty. Acceptable Manufacturers:

1. Securitron (SU) – M62 Series.

2. Securitron (SU) – M68 Series.

2.24 EXIT DEVICES:

A. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
B. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
C. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
D. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is not acceptable except in any case where the door light extends behind the device as in a full glass configuration.
E. Flush End Caps: Provide heavy weight impact resistant flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.
F. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with four threaded studs for thru-bolts.
G. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets. Provided free-wheeling type trim where indicated.
H. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
I. Vertical Rod Exit Devices: Provide and install interior surface and concealed vertical rod exit devices as Less Bottom Rod (LBR) unless otherwise indicated.
J. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
K. Rail Sizing: Provide exit device rails factory sized for proper door width application.
L. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

2.25 CONVENTIONAL PUSH RAIL EXIT DEVICES (HEAVY DUTY): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature. Acceptable Manufacturers:

A. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
B. Sargent Manufacturing (SA) - 80 Series.
C. Yale Locks and Hardware (YA) - 7000 Series.

2.26 ELECTROMECHANICAL CONVENTIONAL EXIT DEVICES - Electrified Conventional Push Rail Devices (Heavy Duty): Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified below. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current. As indicated in hardware sets, provide electrified exit device options including: electric latch retraction , electric dogging, outside door trim control, exit alarm, latchbolt monitoring, lock/unlock status monitoring, touchbar monitoring and request-to-exit signaling. Unless otherwise indicated, provide electrified exit devices standard as fail secure. Acceptable Manufacturers:

A. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
B. Sargent Manufacturing (SA) - 80 Series.
C. Yale Locks and Hardware (YA) - 7000 Series.

2.27 DOOR CLOSERS

A. General: Door closers must be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
B. Standards: Closers to comply with UL-10C and UBC 7-2 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
C. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
D. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
E. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
F. Where closers are indicated to have mechanical dead-stop, provide heavy duty arms and brackets with an integral positive stop.
G. Where closers are indicated to have mechanical hold open, provide heavy duty units with an additional built-in mechanical holder assembly designed to hold open against normal wind and traffic conditions. Holder to be manually selectable to on-off position.
H. Where closers are indicated to have a cushion-type stop, provide heavy duty arms and brackets with spring stop mechanism to cushion door when opened to maximum degree.
I. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics. Provide drop plates or other accessories as required for proper mounting.
J. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and through-bolt or security type fasteners as specified in the door Hardware Sets.

2.28 DOOR CLOSERS, SURFACE MOUNTED (HEAVY DUTY): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units and high impact, non-corrosive plastic covers standard. Acceptable Manufacturers:

A. Corbin Russwin Hardware (RU) - DC8000 Series.
B. Sargent Manufacturing (SA) - 351 Series.
C. Norton Door Controls (NO) - 7500 Series.
D. Yale Locks and Hardware (YA) - 4400 Series.

2.29 DOOR CLOSERS, SURFACE MOUNTED (UNITROL): ANSI/BHMA 156.4, Grade 1 certified surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Unitrol arms to have door stop mechanism to absorb dead stop shock on arm and top hinge. Hold-open arms to have a spring loaded mechanism in addition to shock absorber assembly. Arms to be provided with rigid steel main arm and secondary arm lengths proportional to the door width. Provide high impact, non-corrosive plastic covers standard. Acceptable Manufacturers:

A. Corbin Russwin Hardware (RU) - Unitrol DC8000 Series.
B. Norton Door Controls (NO) - Unitrol 7500 Series.
C. Yale Locks and Hardware (YA) - Unitrol 4400 Series.

2.30 DOOR CLOSERS, SURFACE MOUNTED (COMMERCIAL DUTY): ANSI/BHMA 156.4, Grade 1 certified surface mounted, institutional grade door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck, closing sweep, and latch speed control valves. Provide non-handed units with high impact, non-corrosive plastic covers standard. Acceptable Manufacturers:

A. Corbin Russwin Hardware (RU) - DC6000 Series.
B. Norton Door Controls (NO) - 8500 Series.
C. Sargent Manufacturing (SA) - 1431 Series.
D. Yale Locks and Hardware (YA) - 3500 Series.

2.31 MAGNETIC DOOR HOLDER - surface mounted, electromagnetic door holders: Certified ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to accommodate.12VDC, 24VAC, 24VDC and 120VAC. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button. Acceptable Manufacturers:

A. Rixson (RF) - 980/990 Series, Sargent Manufacturing (SA) - 1560 Series.

2.32 ARCHITECTURAL TRIM

A. DOOR PROTECTIVE TRIM: Units to be of type and design as specified below or in the Hardware Sets. Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets. Provide manufacturer's designated fastener type as specified in the Hardware Sets.
B. METAL PROTECTION PLATES: ANSI/BHMA A156.6 certified metal protection plates (kick, armor, or mop), beveled on four edges (B4E), fabricated from Stainless Steel - 050-inch thick, with countersunk screw holes (CSK).
C. METAL DOOR EDGING: Door protection edging fabricated from a minimum .050-inch thick metal sheet, formed into an angle or "U" cap shapes, surface or mortised mounted onto edge of door. Provide appropriate leg overlap to account for protection plates as required. Height to be as specified in the Hardware Sets.
    1. Acceptable Manufacturers: Burns Manufacturing (BU) Rockwood (RO), Trimco (TC)
D. DOOR STOPS AND BUMPERS: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
    1. Acceptable Manufacturers: Rockwood (RO), Trimco (TC), Hiawatha (HI).
E. OVERHEAD DOOR STOPS AND HOLDERS: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
    1. Acceptable Manufacturers: Rixson Door Controls (RF), Sargent Manufacturing (SA)
F. ARCHITECTURAL SEALS: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated. Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
G. SMOKE LABELED GASKETING: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to AHJ representatives, for smoke control ratings indicated, based on testing according to UL 1784. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
H. FIRE LABELED GASKETING: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to AHJ representatives, for fire ratings indicated, based on testing according to UL-10C. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and UBC 7-2, Fire Tests of Door Assemblies.

1. Acceptable Manufacturers: National Guard Products (NG), Pemko (PE), Reese (RS), Zero (ZE).

2.33 ELECTRONIC ACCESSORIES

A. KEY SWITCHES: Key switches furnished standard with stainless steel single gang face plate with a 12/24VDC bi-color LED indicator. Integral backing bracket permits integration with any 1 1/4" or 1 1/2" mortise type cylinder. Key switches available as momentary or maintained action and in narrow face plate options.

1. Acceptable Manufacturers: Securitron (SU) - MK Series.

B. PUSH-BUTTON SWITCHES: Industrial grade momentary or alternate contact, back-lighted push buttons with stainless-steel switch enclosures. 12/24 VDC bi-color illumination suitable for either flush or surface mounting.

1. Acceptable Manufacturers: Securitron (SU) - PB Series.

C. REQUEST-TO-EXIT MOTION SENSOR: Request-to-Exit Sensors motion detectors specifically designed for detecting exiting through a door from the secure area to a non-secure area. Include built-in timers (up to 60 second adjustable timing), door monitor with sounder alert, internal vertical pointability coverage, 12VDC or 24VDC power and selectable relay trigger with fail safe/fail secure modes.

1. Acceptable Manufacturers: Securitron (SU) - XMS Series.

D. DOOR POSITION SWITCHES: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Acceptable Manufacturers: Securitron (SU) - DPS Series.

E. POWER SUPPLIES: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Acceptable Manufacturers:
   a. Corbin Russwin Hardware (RU) – 782,
   b. Securitron (SU) - BPS Series.
   c. Yale Locks and Hardware (YA) 782.

2.34 FASTENERS: Provide door hardware fasteners manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.35 FINISHES:

A. DESIGNATIONS USED in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
B. PROVIDE QUALITY OF FINISH, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
C. PROTECT MECHANICAL FINISHES on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
D. TYPICAL EXPOSED SURFACE FINISHES (Unless Noted Otherwise)

1. 626 Satin Chrome / brass (painted plastic on closers)
2. 630 Satin Stainless Steel (push/pulls & plates)

PART 3 - EXECUTION

3.01 EXAMINE scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance. Notify Architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved.

3.02 PREPARE doors and frames as follows for installation of hardware items:

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.03 INSTALL EACH ITEM of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

3.04 MOUNT HARDWARE UNITS at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations including the ADA and the Building Code, or as otherwise directed by Architect.

A. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by DHI.
B. DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood flush Doors."
C. Comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."

3.05 WOOD BLOCKING IN DRYWALL PARTITIONS: Arrange with the Work of Division-06 Sections to provide solid wood blocking within drywall partitions where wall stops or other wall mounted hardware will be located, for secure mounting.

3.06 INSTALL EACH HARDWARE ITEM in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another

way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division-09 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

3.07 DRILL AND COUNTERSINK UNITS that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

3.08 RETROFITTING: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division-09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

3.09 SET THRESHOLDS FOR EXTERIOR DOORS in full bed of butyl-rubber mastic sealant complying with requirements specified in Division-07 Section "Joint Sealers."

3.10 WEATHERSTRIPPING AND SEALS: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.11 ADJUSTING, CLEANING, AND DEMONSTRATING

A. ADJUST AND CHECK each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
B. CLEAN ADJACENT SURFACES soiled by hardware installation.
C. HARDWARE SUPPLIER'S SITE-OBSERVATION & REPORT: Supplier will perform a final observation of installed door hardware and prepare a written report stating whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.
D. INSTRUCT OWNER'S PERSONNEL in the proper adjustment and maintenance of door hardware and hardware finishes.

3.12 PROVIDE HARDWARE FOR EACH DOOR in the Project, to comply with requirements below.

3.13 DOOR STOPS: If a wall stop is indicated but is not possible or feasible to install, provide an “Ives” # 438 floor stop or equal.

3.14 FRAME SILENCERS: Provide frame-mounted resilient bumpers at all door frames where weatherstripping or other door seals is not provided: 3 ea at single doors, 2 ea door pairs

3.15 PROVIDE ALL ACCESSORY COMPONENTS AND RELATED ITEMS required for operation even if not specifically required in the following schedule. Notify the Architect if discrepancies, conflicting hardware or missing items are discovered. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

3.16 THE FOLLOWING HARDWARE SETS represent the design intent of the Architect and the directions of the Owner, to the best of the Architect’s knowledge, ability and belief. However, these Hardware Sets” sets are a guideline only, and are not to be considered as a final, detailed hardware schedule for this Project, which will be prepared as a part of the Work of this Section.

3.17 TYPICAL EXPOSED SURFACE FINISHES (Unless Noted Otherwise)

A. 626 Satin Chrome / brass (painted plastic on closers)
B. 630 Satin Stainless Steel (push/pulls & plates)

PART 4 - HARDWARE SCHEDULE

TBD

END OF SECTION 08 71 00

SECTION 08 80 00 – GLASS, GLAZING AND MIRRORS

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide glass and glazing at windows, doors, sidelights, interior borrowed lites, storefronts and curtainwalls as indicated on the Drawings, as specified herein, and as needed to meet the requirements of the construction. This Section includes glazing sealants and accessories and applies to both field-applied glazing as well as factory-glazed units, as applicable.

A. Interior glass
B. Exterior glass
C. Mirrors
D. Decorative Glass: Back Painted

1.02 RELATED SECTIONS

A. Section 05500 Metal Fabrications
B. Section 018113 Certification Requirements.
C. Section 084213 Aluminum Entrance Curtain Wall and Storefront
D. Section 084226 All-Glass Entrances

1.03 DEFINITIONS

A. GLASS MANUFACTURER: Firm that produces primary glass, fabricated glass, or both, as defined in referenced glazing publications.
B. GLASS THICKNESS: Indicated by thickness designations in millimeters per ASTM C 1036
C. INTERSPACE: Space between lites of an insulating glass unit.

1.04 COORINATION: Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.05 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and sealants used to install, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.06 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. VOC Emissions Evaluation: For adhesives and sealants used to install, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant

1.07 SUBMITTALS:

A. SUBMIT PRODUCT DATA for each type of product.
B. SUBMIT SAMPLES for each type of glass product other than clear monolithic vision glass, including tinted, coated, or insulating glass units.
C. SUBMIT GLAZING SCHEDULE listing glass types and thicknesses for each size opening and location. Use same designations as indicated in the Drawings.
D. SUBMIT PRODUCT TEST REPORTS for tinted, coated, or insulating glass units for tests performed by a qualified testing agency.

1.08 QUALITY ASSURANCE

A. MANUFACTURER QUALIFICATIONS FOR INSULATING GLASS WITH LOW-E SPUTTER-COATING: Utilize a qualified insulating-glass manufacturer who is approved by the coated-glass manufacturer.
B. INSTALLER QUALIFICATIONS: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for the Project and whose work has resulted in construction with a record of successful in-service performance over a three (3) year period.
C. DELIVERY, STORAGE, AND HANDLING: Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.
D. FIELD CONDITIONS
    1. ENVIRONMENTAL LIMITATIONS: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
    2. DO NOT INSTALL LIQUID GLAZING SEALANTS when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C).
E. WARRANTIES:
    1. SPECIAL WARRANTY FOR COATED-GLASS: Manufacturer agrees to replace coated-glass units that deteriorate within the specified Warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indicates of deterioration in coating.
        a. WARRANTY PERIOD: Ten (10) years from date of Substantial Completion
    2. SPECIAL WARRANTY FOR LAMINATED GLASS: Manufacturer agrees to replace laminated-glass units that deteriorate within the specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standards.
        a. WARRANTY PERIOD: Ten (10) years from date of Substantial Completion
    3. SPECIAL WARRANTY FOR INSULATED GLASS: Manufacturer agrees to replace insulated glass units that deteriorate within the specified Warranty period. Deterioration is defined as failure of hermetic seal under normal use not attributed to glass breakage or to maintaining and cleaning insulated glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture or film on interior-surfaces of glass.
        a. WARRANTY PERIOD: Ten (10) years from date of Substantial Completion
    4. WARRANTY FOR DECORATIVE GLASS
        a. WARRANTY PERIOD: Ten (10) years from date of Substantial Completion

PART 2 - PRODUCTS

2.01 MANUFACTURERS / SOURCE LIMITATIONS: For each glass type and glazing accessory, obtain from a single manufacturer. Approved manufacturers of glass include the following:

A. AGC
B. Cardinal
C. Guardian (Basis of Design)
D. Vitro (formerly PPG)
E. Viracon

2.02 PERFORMANCE REQUIREMENTS

A. PROVIDE GLASS LITES for various size openings in thickness and strengths (heat treated or tempered) required to meet or exceed the following performance criteria. Glass thickness indicated either on the Drawings or within this Specification are minimum requirements and must be verified by analyzing Project loads and in-service conditions.
    1. Minimum nominal glass lite thickness: 1/4 inch (6 mm)

2.03 GENERAL PERFORMANCE REQUIREMENTS: Installed glazing must withstand normal thermal movement, wind and impact loads (for operating sash and doors) without failure, including:

A. loss or glass breakage attributable to defective manufacturer, fabrication, or installation,
B. failure of sealants or gaskets to remain watertight and airtight,
C. deterioration of glazing materials, and
D. other defects in construction.

2.04 STRUCTURAL PERFORMANCE: Glazing must witstand the following design loads within limits and under conditions indicated per the IBC and per ASTM E 1300. Determine wind pressure per ASCE/SEI 7, based on heights above grade as indicated on the Drawings, and as follows:

A. Basic Wind Speed: 90 mph
B. Importance Factor: 1.0
C. Exposure Category: "C" unless higher category is indicated on the Structural Drawings
D. Minimum uniform wind pressure loading: 25 PSF inward and 25 psf outward.
E. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for units set vertically or not more than 15 degrees off vertical and under wind action, with 60 second load duration.

F. Snow loading (for sloped glazing): 30 PSF minimum or greater if indicated on the Structural Drawings, with a probability of breakage for glass surfaces sloped more than 15 degrees from vertical of not greater than 0.001.
G. Maximum Lateral Deflection: For glass supported on all four (4) edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or one (1) inch, whichever is less.

2.05 DIFFERENTIAL SHADING: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

2.06 THERMAL MOVEMENTS: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

A. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.07 THERMAL AND OPTICAL PERFORMANCE PROPERTIES: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

A. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
B. For laminated-glass lites, properties are based on products of construction indicated.
C. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
D. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
E. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
F. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.08 SAFETY GLAZING: Where safety glass is indicated or otherwise required by the building code or AHJ representatives, provide products which comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for category II materials.

A. PERMANENTLY MARK safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to AHJ representatives.

2.09 GLASS PRODUCTS

A. COMPLY WITH published recommendations of glass product manufacturers and organizations indicated below unless more stringent requirements are indicated. Refer to the following for glazing terms not otherwise defined in this Section or in referenced standards:
    1. AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)
        a. AAMA GDSG-1: “Glass Design for Sloped Glazing”
        b. AAMA TIR A7: “Sloped Glazing Guidelines”
    2. INSULATED GLASS MANUFACTURERS ASSOCIATION (IGMA):
        a. IGMA SIGMA TM-3000: “North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use
        b. IGMA TB-3001: “Guidelines for Sloped Glazing”
    3. GLASS ASSOCIATION OF NORTH AMERICA (GANA):
        a. GANA "Glazing Manual"
        b. GANA "Laminated Glass Design Guide."
B. ANNEALED CLEAR FLOAT GLASS: ASTM C 1036, Type I, Class I (clear), Quality-Q3, unless otherwise indicated,
C. HEAT-STRENGTHENED FLOAT GLASS: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class I (clear) or Class 2 (tinted) as indicated, Quality Q3. Fabricate by horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
D. TEMPERED GLASS: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class I (clear) or Class 2 (tinted) as indicated, Quality-Q3. Fabricate by horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Provide tempered glass permanently marked with certification label of Safety Glazing Certification Council or another certification agency acceptable to AHJ representatives.
    1. Minimum Thickness: 6 mm.
E. GLASS WITH SURFACE FILM:
    1. Glass type (FLM-1): Clear float glass with surface film
    2. Minimum Thickness: 6 mm.
    3. Annealed, heat-strengthened and fully-tempered units are required.
    4. Surface Film: laminated dyed color polyester films
        a. BASIS OF DESIGN:
            (1) Manufacturer: As indicated in drawings.
            (2) Type: As indicated in drawings.
F. LAMINATED GLASS: ASTM C 1172, using materials with a proven record of no tendancy to bubble, discolor, or to lose physical or mechanical properties after fabrication and installation. Fabricate with polyvinyl butyral interlayer (unless otherwise indicated) to comply with interlayer manufacturer’s written instructions, with interlayer in material thickness not less than that needed to comply with requirements, and in clear color unless otherwise indicated. Fabricate laminated glass to produce glass free of foreign substances or air pockets. Laminate lites with polyvinyl

butyral interlayer in an autoclave with both heat and pressure**. Refer to Finish Schedule for Laminated Glass Schedule.**

G. INSULATED-GLASS (IG) UNITS: Factory-assembled, hermetically sealed assembly consisting typically of two (2) each 1/4 inch thick (6 mm) glass sheets with a 1/2 inch thick desicant-filled tubular aluminum perimeter spacer bar frame all around, dual-edge sealed and bonded to both sheets of glass and the spacer bar with manufacturer's standard polysulfide, silicone or hot-melt butyl elastomeric sealant (fabricators option):

1. COLOR OF SPACER BARS & SEALANT: Provide clear anodized spacer bar and clear sealant at adjacent clear anodized aluminum framing and provide black colored spacer bar with black sealant at all other colors of adjacent framing.
2. INTERMEDIATE SPACERS: Provide additional, intermediate spacers to align with surface applied, decorative vertical or horizontal mullions intended to be field-applied to the insulated glass unit.

H. TYPICAL INSULATED GLASS (IG) UNITS: high-performance, clear (non tinted) insulated glass units with the following minimum performance characteristics:

1. BASIS-OF-DESIGN: Exterior Basis of Design for performance insulating glass unit as follows:
   a. Double Glazed Insulate:
      (1) Solarban® 60 Solar Control Low-E Glass as manufactured by VITRO ARCHITECTURAL GLASS .
      (2) Shading Coefficient: 0.44
      (3) Solar Heat Gain Coefficient: 0.37.
      (4) Visible light transmission: 69%
      (5) Outdoor visible light reflectance: 12%
      (6) Winter U-value: 0.29
      (7) Summer U-value: 0.29
   b. Edge Seals:
      (1) ASTM E 2188, with aluminum spacers, dual-sealed with a primary seal of polyisobutylene and a secondary seal of silicone sealant for glass-to-spacer seals.
   c. Sealant:
      (1) Approved by glass manufacturers.
      (2) Refer to Section 08 41 13 for additional sealant requirements not listed here

I. MIRROR GLASS & ACCESSORIES: 1/4 inch (6 mm) thick Quality q2 clear float glass with full silvered, copper and organic coating and finished with "pencil edge" on all sides. Secure to wall substrate with "Palmers" Mirror-Mastic or equal to wall backing and provide satin-finish aluminum "L" bar equal to CRL # L902A Type L-Bar" support at base of mirror typically. **Refer to Finish Schedule.**

J. GLASS FOR FRAMELESS GLASS ENCLOSURES and DOORS: Provide fully tempered, ultraclear (low-iron) glass, tested for surface and edge compression per ASTM C 1048 and **as called for in Drawings and Specification Sections 08 42 13 and 08 44 00.**

2.10 GLAZING SEALANTS:

A. GENERAL: PROVIDE GLAZING SEALANTS that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

1. Sealants used inside the weatherproofing system, must have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Exposed Glazing Sealant Colors: As selected by Architect from manufacturer's full range.

B. GLAZING SEALANT: Elastomeric, neutral-curing silicone sealant complying with ASTM C 920, Type S (single component), Grade NS (nonsag), Class 25, Use NT (non-traffic); specially compounded and tested to show a minimum of 20 years resistance to deterioration in normal glazing applications. Provide at exterior glazing. Subject to compliance with requirements, approved products include the following:

1. Dow Corning Corporation; 790.
2. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
3. Pecora Corporation; 890.
4. Sika Corporation, Construction Products Division; SikaSil-C990.
5. Tremco Incorporated; Spectrem 1.

2.11 GLAZING TAPE: Preformed, back-bedding butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

A. AAMA 804.3 tape, where indicated.
B. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
C. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.12 MISCELLANEOUS GLAZING MATERIALS: Provide cleaners, primers and sealers, setting blocks, spacers and edge blocks of size and shape complying with referenced glazing standards, and with requirements of glass manufacturer for application indicated.

2.13 FABRICATION:

A. FABRICATE GLASS AND OTHER GLAZING PRODUCTS in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing standard, to comply with system performance requirements.

PART 3 - EXECUTION

3.01 EXAMINE FRAMING, glazing channels, and stops, with Installer present, for compliance with the following:

A. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
B. Presence and functioning of weep systems.
C. Minimum required face and edge clearances.
D. Effective sealing between joints of glass-framing members.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. WATERTIGHT AND AIRTIGHT INSTALLATION of each glass product is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors), without failure including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glazing materials and other defects in the work.
B. COMPLY with FGMA "Glazing Manual" and manufacturer’s instructions and recommendations. Use manufacturer's recommended spacers, blocks, primers, sealers, gaskets and accessories.
C. PROVIDE FULLY TEMPERED “SAFETY” GLASS where indicated on the Drawings, in all door units, and within sixty (60) inches horizontally of a door in any position (open or closed), and when a glass lite is within eighteen (18) inches from the finished floor – even if not specifically indicated on the drawings.
D. CLEAN GLAZING CHANNEL and other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to substrate. Remove lacquer from metal surfaces where elastomeric sealants are used.
E. INSTALL glass with uniformity of pattern, draw, bow and roller marks. Install sealants to provide complete wetting and bond and to create a substantial wash away from glass. Install pressurized tapes and gaskets to protrude slightly out of channel, so as to eliminate dirt and moisture pockets.
F. INSTALL INSULATING GLASS UNITS to comply with recommendations by Sealed Insulating Glass Manufacturers Association, except as otherwise specifically indicated or recommended by glass and sealant manufacturers
G. TAPE GLAZING: Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped.
    1. Seal joints in tapes with compatible sealant approved by tape manufacturer.
    2. Do not remove release paper from tape until right before each glazing unit is installed.
    3. Apply heel bead of elastomeric sealant. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops.
    4. Start gasket applications at corners and work toward centers of openings.
    5. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.03 PROTECT EXTERIOR GLASS FROM BREAKAGE immediately upon installation, by use of crossed streamers attached to framing and held away from glass. Do not apply markers to surfaces of glass. Remove nonpermanent labels and clean surfaces. Cure sealants for high early strength and durability.

3.04 REMOVE and replace damaged glass and glazing. Wash and polish glass on both faces not more than 4 days prior to date scheduled for inspections intended to establish date of substantial completion. Comply with glass product manufacturer's recommendations for final cleaning.

END OF SECTION 08 80 00

SECTION 08 90 00 – LOUVERS AND VENTS

PART 1 - WORK INCLUDED: Provide architectural louvers and vents where indicated on the Drawings, as specified herein, and as necessary for complete installation.

1.01 RELATED SECTIONS

A. Section 018113 Certification Requirements.

1.02 STRUCTURAL PERFORMANCE OF LOUVERS: Provide louvers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures must be considered to act on vertical projection of louvers.

A. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq. ft. acting inward or outward.

1.03 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and sealants used to install, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.04 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

B. VOC Emissions Evaluation: For adhesives and sealants used to install, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant.

1.05 SUBMITTALS

A. SUBMIT PRODUCT DATA for each type of product indicated.

B. SUBMIT SHOP DRAWINGS for louvers and accessories, including plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.

1.06 COMPLY WITH SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

PART 2 - PRODUCTS

2.01 GENERAL: A vertically oriented louver with a 5" deep blade design, is AMCA-550 and 540 compliant, while maintaining 54% free area. Designed to fully integrate with curtain wall systems, with a glazing frame option.

2.02 BASIS OF DESIGN:

A. Louver Manufacturer: Construction Specialties, Inc.

B. Product: Architectural Louvers

C. Model(s): RSV-5700

2.03 Manufacturers

A. The louvers and related materials herein specified and indicated on the drawings shall be as manufactured by:
Construction Specialties, Inc.
49 Meeker Avenue
Cranford, New Jersey 07016
Telephone: 800-631-7379

B. Products equal to the CS materials may be offered providing that the manufacturer and materials are submitted and pre-approved by the Architect at least 10 working days before the bid date.

2.04 Materials

A. Aluminum Extrusions: ASTM B211, Alloy 6063-T5, 6063-T6 or 6061-T6.
B. Aluminum Sheet: ASTM B3209, Alloy 1100, 3003 or 5005.

2.05 Fabrication, General

A. Provide CS louver models, bird screens, insulated blank-off panels, structural supports and accessories as specified and/or shown on the drawings. Materials, sizes, depths, arrangements and material thickness to be as indicated or as required for optimal performance with respect to strength; durability; and uniform appearance.
B. Louvers to be mechanically assembled using stainless steel or aluminum fasteners.
C. Include supports, anchorage, and accessories required for complete assembly.

2.06 Louver Performance

A. Material: Heads, sills, jambs and mullions to be one piece structural members of 6063-T6 alloy with integral caulking slot and retaining beads. Blades to be one piece extrusions with reinforcing bosses. All fasteners to be aluminum or stainless steel. All louvers to be furnished with 5/8" (15.87 mm) flattened expanded mesh, aluminum bird screen with a 0.055" (1.40 mm) thick extruded aluminum frame. Screens and screen frames to be standard mill finish.
B. AMCA Performance:
    1. For a 4 Foot by 4 Foot Unit. Tested with mill finish and no screen
    2. Free area = 8.67 ft2 (0.810 m2)
    3. Percent free area = 54.0%
    4. Free area velocity at the point of beginning water penetration (@0.01oz. / ft2 of free area based on a 15 minute interval test) = 1,250 FPM (6.35 m/s)
    5. Maximum recommended air intake velocity = 1,050 FPM (5.3 m/s)
    6. Air volume @ 1,050 FPM free area velocity = 9,104 CFM (4.3 m3/s)
    7. Pressure drop @ 1,050 FPM intake velocity = 0.217 in. H2O (53.9 Pa)
    8. Maximum recommended air exhaust velocity = 1,615 FPM (8.2 m/s)
    9. Air Volume @ 1,615 FPM free area velocity = 14,002 CFM (6.6 m3/s)
    10. Pressure drop @ 1,615 FPM free area velocity = 0.50 in. H2O (124.2 Pa)

2.07 Finishes

A. All louvers shall be finished with C/S Powder Coat, a coating to be 1.5 to 3 mil. Thick full strength 100% resin Flouropolymer coating. Finish to allow zero VOCs to be omitted into facility of application. Finish to adhere to a 4H Hardness rating. All finishing procedures shall be one continuous operation in the plant of the manufacturer. The coating shall meet or exceed all requirements of AAMA specification 2605 "Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels."
B. The louver manufacturer shall supply an industry standard 20-year limited warranty against failure or excessive fading of the Flouropolymer Powder Coat finish. This limited warranty shall begin on the date of material shipment.

2.08 Bird Screens

A. Unless otherwise indicated, all louvers to be furnished with mill finish bird screens.
B. Screens to be 5/8" (15.9mm) mesh, 0.050" (1.27mm) thick expanded and flattened aluminum bird screen secured within 0.055" (1.40mm) thick extruded aluminum frames. Frames to have mitered corners and corner locks.

2.09 Blank Offs and Insulated Blank Offs

A. Furnish where indicated on the drawings blank–off panels fabricated by the louver manufacturer.
B. Blank-off panels to be 2" (50.8mm) thick and to be faced on both sides with 0.032" (0.81 mm) thick aluminum sheet. Panels to be fabricated with a mineral wool core (#6 density) having an R-value of 8 (0F*ft2*h/Btu). Panel perimeter frame to be 0.050" (1.27mm) thick-formed aluminum channels. Panel frame to be mitered at the corners. Panels to be finished black.
C. Complies Fire Performance:
    1. ASTM E136: Non-Combustible
    2. ASTM E84 (UL 723): Flame Spread 0 Smoke Developed 0
    3. Thermal Resistance:
        a. ASTM C518 (C177): R-value/inch @ 75dF: 4.2 hr.ft.F/Btu

2.10 ASSEMBLE UNITS IN FACTORY to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates, without interrupting blade-spacing pattern, where height of louver units exceeds fabrication and handling limitations. Provide horizontal mullions at joints. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

2.11 FABRICATE FRAMES including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints. Provide interior flange, unless otherwise indicated. Include supports, anchorages, and accessories required for complete assembly. Provide subsills made of same material as louvers or extended sills for recessed louvers.

2.12 JOIN FRAME MEMBERS to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.13 PROVIDE FULLY-RECESSED VERTICAL MULLIONS behind louver blades of type and at spacings recommended by manufacturer, or 72 inches o.c., whichever is less. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.

PART 3 - EXECUTION

3.01 EXAMINE SUBSTRATES AND OPENINGS, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 COORDINATE setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.03 LOCATE AND PLACE LOUVERS AND VENTS level, plumb, and at indicated alignment with adjacent work. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection. Form closely fitted joints with exposed connections accurately located and secured. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

3.04 REPAIR FINISHES damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.05 PROTECT GALVANIZED AND NONFERROUS-METAL SURFACES from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

3.06 INSTALL CONCEALED GASKETS, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.07 CLEAN EXPOSED SURFACES of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

3.08 RESTORE LOUVERS AND VENTS DAMAGED during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 90 00

END OF DIVISION 8

END OF DIVISION 08

DIVISION 09 – FINISHES

SECTION 09 05 61 – MOISTURE VAPOR EMISSION CONTROL

SECTION 09 21 16 – GYPSUM BOARD ASSEMBLIES

SECTION 09 21 17 – GYPSUM SHAFT WALL ASSEMBLIES

SECTION 09 22 26 – DRYWALL GRID SUSPENSION SYSTEM

SECTION 09 30 00 – TILING

SECTION 09 51 00 – SUSPENDED ACOUSTICAL CEILINGS

SECTION 09 54 00 – INTEGRATED CEILING ASSEMBLIES

SECTION 09 54 26 – SUSPENDED WOOD CEILINGS

SECTION 09 65 13 – RESILIENT BASE

SECTION 09 66 23 – THIN-SET EPOXY TERRAZZO FLOORING

SECTION 09 68 00 – CARPETING

SECTION 09 72 00 – WALLCOVERING AND WALL GRAPHICS

SECTION 09 84 00 – ACOUSTIC WALL TREATMENTS

SECTION 09 84 33 – SOUND ABSORBING WALL UNITS

SECTION 09 84 53 – ACOUSTIC MULLION TRIM

SECTION 09 91 00 – PAINTING

SECTION 09 96 00 – HIGH PERFORMANCE COATINGS

SECTION 09 24 00 – CEMENT PLASTERING

SECTION 09 05 61 – MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.01 PROVIDE a water based vapor mitigation and alkaline resistant floor treatment under new floor finishes (except sealed concrete) when indicated to be installed over concrete substrates, as indicated herein.

1.02 QUALITY ASSURANCE:

A. VERIFY COMPATIBILITY of materials including surface sealers, if any, with indicated vapor mitigation floor treatment and with the finish flooring products, including adhesives.
B. INSTALLER must be trained, certified or otherwise specifically approved as an applicator by the product Manufacturer in writing.

1.03 SUBMITTALS

A. Product Data: Manufacturer's technical product data including manufacturer's installation instructions.
B. Special Manufacturer Warranty: Copy of specified warranty

1.04 QUALITY ASSURANCE

A. Preinstallation Meeting: Conduct preinstallation meeting prior to commencing work to verify project requirements, substrate conditions and coordination with other building products, and to review manufacturer's installation instructions and manufacturer's warranty requirements.

(1) Representatives of the owner, architect, contractor, flooring installer, and any other parties who are involved in the scope of this installation shall attend the meeting.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.
B. Store materials on elevated platforms, under cover, and in a dry location.

1.06 PROJECT CONDITIONS:

A. Environmental Limitations: Do not install materials until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.07 WARRANTY A. Special Manufacturer Warranties: Furnish manufacturer's standard warranty executed by authorized company official.

A. System Installation Warranty: Materials will be free from manufacturing defects from the time of purchase and conform to manufacturer's written specifications under normal usage for a period of [five] [ten] [twenty-five] years when applied according to manufacturer's written installation instructions and industry standard guidelines. If the nature of the defects of the products specified by this Section warrants, the warranty will include materials and labor for the replacement of the installation. Refer to manufacturer's warranty for specific details.
B. Membrane Only Warranty: Materials will be free from manufacturing defects from the time of purchase and conform to manufacturer's written specification under normal usage for a period of one year when applied according to manufacturer's written installation instructions and industry standard guidelines. If the nature of the defects of the products specified by this Section warrants, the warranty will include materials and labor for the replacement of the installation. Refer to manufacturer's warranty for specific details.

PART 2 - PRODUCT:

2.01 BASIS OF DESIGN MANUFACTURER

A. Manufacturer: Bostik, Inc., 11320 West Watertown Plank Road, Wauwatosa, WI 53226, Telephone : 800.726.7845, Fax: 414.774.8775, Inquiry: inquiry@bostik-us.com, Website: www.bostik.com/us.
B. Other comparably performing manufacturer products will be reviewed by submittal.

2.02 HIGH-PERFORMANCE MOISTURE-VAPOR-MEMBRANE AND PRIMER

A. Product: Roll-Cote™. 1. Description: Water based, one component moisture-vapor-membrane.
B. Physical Properties: nonflammable, low odor formulation.
C. VOC Content: <15g/L as calculated by SCAQMD Rule 1113.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions where materials will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Comply with manufacturer's written instructions, including product technical bulletins and product package instructions.

3.03 INSTALLATION

A. Comply with manufacturer's written instructions, including product technical bulletins and product package instructions.
B. Install materials according to substrate and RH square footage requirement.
C. Mixing: Mix with water only according to manufacturer's written instructions.

D. Procedure:

(1) Ensure substrate is clean of any dust and debris
(2) Grid surface area to ensure proper coverage per coats desired and in following guidelines
(3) Apply materials to achieve thickness recommended by manufacturer.

3.04 PROTECTION

A. Limit foot traffic over installation according to manufacturer's written instructions.

END OF SECTION 09 05 61

SECTION 09 21 16 – GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.01 SECTION includes ALL framing not in Division 05: “Cold-Formed Metal Framing”.

1.02 PROVIDE screw-type gypsum drywall with metal framing system(s), or wood as applicable, where indicated on the drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents.

1.03 PROVIDE SUPPLEMENTARY FRAMING, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

1.04 RELATED SECTIONS include the following:

A. Section 018113 Certification Requirements.
B. Division-05 Section "Cold-Formed Metal Framing" as specified in that section.
C. Division-06 Section "Rough Carpentry" for blocking installed within gypsum board assemblies.
D. Division-07 Section "Building Insulation" for insulation installed in gypsum board assemblies.

1.05 REFERENCED STANDARDS:

A. American Society of Testing Materials International (ASTM):
   1. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
   2. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
   3. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
   4. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard . .
   5. ASTM C1396 - Standard Specification for Gypsum Board.
   6. ASTM C1629 - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels

B. Gypsum Association (GA): www.gypsum.org:
   1. GA-201 - Gypsum Board for Walls and Ceilings.
   2. GA-214 - Recommended Levels of Levels of Gypsum Board Finish.
   3. GA-216 - Specifications for the Application and Finishing of Gypsum Board.
   4. GA-226 - Application of Gypsum Board to Curved Surfaces.
   5. GA-235 - Gypsum Board Typical Mechanical and Physical Properties.
   6. GA-600 - Fire Resistance Design Manual.
   7. GA-801 - Handling and Storage of Gypsum Panel Products: A Guide for Distributors, Retailers, and Contractors

C. Wall and Ceiling Bureau (WCB) - wallandceilingbureau.org: TB-52010 - Control Joints for Gypsum Board
D. UL Fire Resistance Directory (UL): Fire Resistance Volume 1 – with Hourly Ratings for Beams, Floors, Roofs, Columns, Walls and Partitions.
E. United States Gypsum's "Gypsum Construction Handbook."

1.06 DEFINITIONS - GYPSUM BOARD TERMINOLOGY: Refer to ASTM C 1396 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.07 SUBMIT

A. PRODUCT DATA of each type of accessory product required, except for typical gypsum board panels, metal stud framing, and panel fasteners meeting requirements herein.
B. ENGINEERING: Due to height, lateral load requirements and roof deflection of long spans; Contractor shall provide engineered drawings for all walls not engineered by the Structural engineer in the Construction Documents.
   1. This includes, but not limited to
      a. All interior non-loadbearing walls.
      b. Box beam headers

1.08 LEED PERFORMANCE REQUIREMENTS

A. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.
B. VOC Emissions Evaluation: For gypsum board assemblies and any adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers’ or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
C. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

D. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.
E. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.09 LEED DOCUMENTATION REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor. .
C. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
D. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant
E. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.
F. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable

1.10 QUALITY ASSURANCE

A. FIRE-TEST-RESPONSE CHARACTERISTICS: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
B. FIRE-RESISTANCE-RATED ASSEMBLIES: Indicated by design designations from UL's "Fire Resistance Directory."
C. DELIVERY, STORAGE, AND HANDLING
    1. DELIVER MATERIALS in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
    2. STORE MATERIALS inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.
    3. ENVIRONMENTAL LIMITATIONS: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

A. STEEL FRAMING & FURRING:
    1. ClarkDietrich Building Systems.
    2. Consolidated Fabricators Corp
    3. Marino\Ware; Division of Ware Ind.
    4. National Gypsum Company.
    5. Scafco Corporation.
    6. Telling Industries
B. GYPSUM BOARD AND RELATED PRODUCTS:
    1. American Gypsum Co.
    2. CertainTeed Corp
    3. Georgia-Pacific Gypsum (GP - Basis-of-Design Manufacturer)
    4. National Gypsum Company.
    5. PABCO Gypsum
    6. United States Gypsum Co.

2.02 NON-STRUCTURAL METAL FRAMING: Provide ASTM C 645 metal studs of 0.015 minimum base-steel thickness (25 gage) 50 KSI units or “Equivalent Gage (EQ) thickness units with third-party testing verifying compliance with ICC ES AC86, in 1-1/4 inch wide flanges and in 3-5/8 inch depth typical unless otherwise noted or required to meet structural requirements. Provide runners matching studs, of type recommended by stud manufacturer for floor and ceiling support of studs, and for vertical abutment of drywall work at other work. Provide studs in unit size as indicated on the Drawings, and in compliance with the Steel Stud Manufacturer’s Association (SSMA)’s limiting heights table for L/360 deflection at 5 PSF load.

2.03 DRYWALL FURRING CHANNELS: 7/8 inch minimum deep ASTM C-645 hat-shaped rigid units of 0.0312 inch (20 gage) minimum commercial steel sheet with manufacturer's standard corrosion-resistant zinc coating. Provide stud manufacturer's standard clips, shoes, ties, reinforcements, fasteners and other accessories as needed for a complete stud system.

2.04 RESILIENT FURRING CHANNELS: 1/2-inch-deep x 2-5/8 inch wide 22 mil steel sheet members with extra-wide 1-1/2 inch screw flange, designed to reduce sound transmission, in asymmetrical configuration face attached to single flange by a slotted leg (web).

2.05 Z-FURRING CHANNELS: Rigid Z-shaped units of 0.018 inch (25 gage) minimum commercial steel sheet per ASTM C 645 with manufacturer's standard corrosion-resistant zinc coating, with 3/4 inch wide mounting leg, 1-1/4 inch wide flange for screw attachment of gypsum board, and in unit depth as indicated on the Drawings Provide manufacturer's standard clips, shoes, ties, fasteners and other accessories as needed for a complete furring system installation.

2.06 TOP-OF-WALL DEFLECTION TRACK: Provide at all interior non-load bearing partitions to prevent compression of stud framing or cracking of gypsum board resulting from deflection of the structure above. Provide ASTM C 645 steel-sheet top-runner units in base metal thickness of next thicker available metal thickness than metal thickness indicated for the partition's stud framing members.

A. TYPICAL NON-FIRE RATED SLOTTED DEFLECTION TRACK: NOTE: Due to long roof span, track / clips must provide not less than 3.5 inches vertical movement of the structural framing system.

2.07 SUSPENDED CEILING/SOFFIT FRAMING: Comply with ASTM C 754 for conditions indicated, using steel members noted above, and as follows:

A. EXPANSION ANCHOR HANGER ANCHORS TO CONCRETE: Post-installed expansion-anchor type units fabricated from corrosion-resistant materials with holes or loops for attaching hanger wires and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by a qualified independent testing agency.

B. POWDER-ACTUATED HANGER ANCHORS TO CONCRETE: Suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.

C. SUSPENSION WIRE (typical between hangers or structural steel framing units above to CRC's noted below): ASTM A 641/A soft-tempered carbon steel wire with Class 1 galvanized zinc coating, pre-stretched, with yield-stress load of at least four (4) times load of suspended materials, but not less than 0.1620 inch-diameter (# 8 ASWG) wire minimum (for up to 210 lbs material load per wire) – space not more than four (4) feet centers to CRC's below.

D. SPLAY-WIRE BRACES: ASTM A 641/A soft-tempered carbon steel wire with Class 1 galvanized zinc coating, pre-stretched, not less than # 12 ASWG) wire minimum at not more than 45 degree angles from compression stud braces.

E. COMPRESSION STRUTS: Provide at exterior suspension framing typically and at interior seismic braces, when indicated. Assemble from minimum 3-5/8 inch x 0.0312 inch (20 gage) drywall stud minimum parallel with # 8 suspension wire, and with four (4) each spay wires anchored to structure above, to resist uplift wind or seismic pressures

F. COLD ROLLED CHANNELS (CRC's): 0.0538-inch bare steel thickness (16 gage), with minimum 1/2-inch- wide flange, 1-1/2 inch deep or greater if indicated, suspended from above at four (4) feet centers unless otherwise noted.

G. TIE WIRE: ASTM A 641/A (to connect CRC's to furring units), Class 1 zinc coating, soft temper, 0.0625-inch-diameter (# 16 ASWG) wire minimum, or double strand of 0.0475-inch- diameter (# 18 ASWG) wire minimum.

H. ACOUSTIC TIE WIRE ISOLATOR: Provide tie wire isolation as called for and in locations shown in Drawings.

1. Basis-of-Design: "AF Fiberglass Pad Wire-Tie Hanger" by Kinetics Noise Control Inc., or approved equal.
2. Refer to Drawings for all locations that require tire wire to be isolated.

I. FURRING CHANNELS (hat-shaped typically) at 16 inch centers maximum, except where otherwise indicated, or where indicated to be resilient furring channels at acoustical ceiling assemblies.

J. STUD WALL/PARTITION ISOLATOR: Provide stud wall isolation as called for and in locations shown in Drawings.

1. Basis-of Design: "Wallmat Stud Wall Isolator" by Kinetics Noise Control Inc., or approved equal.

2.08 ACOUSTICAL INSULATION: ASTM C 665, Type I sound attenuation blankets (without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag or rock wool.

A. Provide 3-1/2 inch thick units except as otherwise indicated on the Drawings.

2.09 GYPSUM WALLBOARD (GWB) MATERIALS:

A. TYPICAL GYPSUM BOARD: All gypsum board shall be Impact resistant, ASTM C1629/C1629M, 5/8'', ''Type X'' or "Type LWX" unless noted otherwise. Panels with tapered long edges, 4 feet wide x 5/8 inch thick typical except as otherwise indicated on the Drawings, in maximum length available which will minimize end joints.

1. Provide 5/8 inch thickness at drywall ceilings, unless otherwise indicated on the Drawings.
2. Curved walls should use Typical gypsum board specified here unless curve can not be achieved with satisfactory results.

B. FLEXIBLE GYPSUM BOARD: 1/4 inch thick gypsum board panels, specifically manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness:

1. Basis-of-Design: "ToughRock FlexRoc" by GP, or equal

C. GLASS-MAT GYPSUM BOARD (GM-GWB – where indicated): ASTM C 1658 compliant inorganic gypsum board panels with embedded fiberglass mat laminated to both sides, mold resistant per ASTM D 3273 with score of 10 per ASTM D 3274:
   1. Basis-of-Design: “DensArmor Plus Panel” by GP, “Gold Bond eXP Interior Extreme” by National Gypsum, “Sheetrock Glass-Mat Mold Tough Firecode X” panels by USG, or equal

D. GLASS-MAT-REINFORCED, MOLD AND MOISTURE AND IMPACT-RESISTANT BACKING BOARD: ASTM C1278/C1278M, with manufacturer’s standard edges
   1. Basis-of-Design: “Fiberock Aqua-Tough” by USG
      a. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274
      b. Soft-Body Impact: Exceeds BCA Specification C1.8
      c. Edges: Square
      d. Core Thickness:
         (1) 1/2” Typical
         (2) 5/8” Type-X (where required)

E. WATER RESISTANT GYPSUM BOARD: Provide high impact, water-resistant gypsum board at all areas subject to moist conditions that are NOT tiled.(restrooms and Hydro).
   1. Basis of Design: “Gold Bond Hi-Impact XP Gypsum Board” by National Gypsum or equal.
   2. Joint Treatment: Use only ASTM C 1047 plastic trims, set trims and mud joints with 2 inch wide 10x10 fiberglass mesh tape embedded with setting-type waterproof joint compound.

F. TILE-BACKER CEMENT BOARD (Provide behind all wall tile and up 12 inches minimum at tile or resinous floor base):
   1. ASTM C1325 compliant water and mold resistant cement board panels with a fiberglass reinforced core:
   2. Basis-of-Design: “PermaBase” by National Gypsum or equal
   3. Thickness: 5/8-inch
   4. Anchors: Type S-12 bugle head self-tapping, rust-resistant fine-thread panel anchors
   5. Joint Treatment: Use only ASTM C 1047 plastic trims, set with 2 inch wide 10x10 fiberglass mesh tape embedded with setting-type waterproof joint compound. At joints between surfaces, provide silicone joint sealer equal to “Dow Corning 795”, “Pecora 895”, “GE Silpruf” or “Tremco Dymonic” or equal.

G. ACOUSTICAL PLASTER: Provide seamless acoustic plaster ceiling system at locations specified on drawings.
   1. Reference Section 09 54 00: Integrated Ceiling Assemblies.

2.10 TRIM ACCESSORIES:

A. PROVIDE MANUFACTURER'S STANDARD TRIM ACCESSORIES of types indicated for drywall work, formed of galvanized steel unless otherwise indicated, with either knurled and perforated or expanded flanges for nailing and beaded for concealment of flanges in joint compound. Provide corner beads, L-type edge trim-beads, U-type edge trim-beads, special L-kerf-type edge trim-beads. Stapling of trim accessories will not be permitted.

B. TEAR-AWAY EDGE TRIM: Where indicated, provide rigid plastic edge trim with a 5/16 inch high tear-off leg that acts as a guide and a protective mask for taping and mudding, consisting of dent-resistant PVC meeting ASTM D 3678, D 1784, C 1047 with a Class A flame-spread rating:
   1. Basis-of-Design Manufacturer: Trim-Tex, Inc., Lincolnwood IL, P: 800-874-2333, www.trim-tex.com
   2. TEAR-AWAY L-TRIM BEAD: Trim-Tex # 9110 with 5/8 inch leg
   3. TEAR-AWAY FLAT BEAD: Trim-Tex # 9000 Flat Tear Away Bead (no leg)

C. TYPICAL CONTROL JOINT TRIM: Manufacturer’s standard trim unit with 1/8 inch or less exposed joint, or provide two (2) each standard L-type edge trim beads – butted 1/8 inch apart, in lieu of manufacturer's standard one-piece control joint beads.

D. EXTRUDED EDGE TRIM: Whenever a “reveal” profile” is indicated on the Drawings, at locations such as intersections of partitions, at base or top of walls, at door or window frames, and at other locations where indicated, provide trim members of extruded aluminum ally 6063 T5, with a chemical conversion finish coating, and as follows:
   1. Finish Color: clear anodized except as otherwise indicated on the Drawings.
   2. Approved Manufacturer: Fry Reglet Corporation, p: 800-237-9773, website: www.fryreglet.com, or approved equivalent manufacturer:
      a. L-TRIM: Series # DRML, in exposed flange width as indicated on Drawings or to coordinate with the construction indicated
      b. Z-REVEAL TRIM: Series # DRMZ in depth and width of reveal as indicated on the Drawings
      c. F-REVEAL TRIM: Series # DRMF in depth and width of reveal as indicated on the Drawings
      d. PARTITION END-CLOSURE TRIM (to terminate exposed drywall edge): # DMEC-4875 (4-7/8 inch wide) for typical interior drywall partitions with 3-5/8 inch wide metal studs, or # DMEC-7250 (7-1/4 inch wide) for drywall partitions with six (6) inch metal studs.
      e. CEILING EDGE TRIM: for in-plane transition between drywall and acoustical ceilings without a joint: DMPT-75

E. ALUMINUM REVEAL TRIM: Provide flat, 0.032 inch thick prefinished aluminum sheet metal trim mounted behind drywall edge trim, for reveal-joint of width and at locations indicated on the Drawings. Extend metal reveal trim behind gypsum board not less than 1 inch to be secured with drywall edge trim anchorage.

F. COLOR: As indicated on the Drawings, or if not indicated, as selected by Architect from sheet-metal Manufacturer’s full range of both baked-on solid and satin-anodized finishes , including black and metalics.

2.11 WALL AT STOREFRONT TERMINATION: Where a framed wall terminates perpendicular to storefront mullion. In addition to “Partition End Closure Trim” above provide and install Gordon Mullion Mate: Series 40 Plus.

2.12 JOINT TREATMENT: Comply with ASTM C 475, using multi-purpose grade, ready-mixed vinyl-type joint compound, with perforated-type paper joint tape typically.

A. At glass-mat faced gypsum board panels, use fiberglass mesh tape.
B. At water-resistant gypsum board, use fiberglass mesh tape embedded in a waterproof joint compound.

2.13 ACOUSTICAL JOINT SEALANT: ASTM C 834 compliant product with VOC content of 250 or less, that effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90. Subject to compliance with requirements, available products include: “BOSS 824 Acoustical Sound Sealant” by Accumetric LLC; “Acoustical Sealant GSC” by Grabber; “AC-20 FTR” by Pecora; “Smoke N Sound Acoustical Sealant by Specified Technologies Inc.; and “Sheetrock Acoustical Sealant” by USG.

2.14 CEILING ISOLATION HANGERS: “AF Ceiling Isolation Hangers” by Kinetics Noise Control, Inc., www.kineticsnoise.com

2.15 GYPSUM BOARD FASTENERS: Steel Drill Screws meeting ASTM C 1002 unless otherwise indicated.

2.16 MISCELLANEOUS MATERIALS: Provide auxiliary materials for gypsum drywall work of the type and grade recommended by the manufacturer gypsum boards.

PART 3 - EXECUTION

3.01 EXAMINE AREAS AND SUBSTRATES, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SUSPENDED DRYWALL CEILINGS:

A. Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.
B. Furnish concrete inserts and other devises indicated to other trades for installation in advance of time needed for coordination and construction.
C. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
D. INSTALLATION

1. PREPARATION FOR METAL SUPPORT SYSTEMS: Coordinate work with structural ceiling work to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling hangers. Furnish steel deck hanger clips and similar devices to other trades for installation well in advance of time needed for coordination with other work.
2. INSTALLATION OF WALL/PARTITION SUPPORT SYSTEMS: Install supplementary framing, blocking and bracing to support fixtures, equipment, services, heavy trim, furnishings and similar work which cannot be adequately supported on gypsum board alone.
3. ISOLATE STUD SYSTEM from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading. Install runner tracks at floors, ceilings and structural walls and columns where gypsum drywall stud system abuts other work, except as otherwise indicated. Terminate partition stud system at ceilings, except where indicated to be extended to structural support or substrate above.
4. SPACE STUDS 16" O.C., except as otherwise indicated. Provide runner tracks of same material thickness as jamb studs. Space jack studs same as partition studs.
5. DOUBLE STUDS AT DOOR OPENINGS, frame with 2 each 0.032 inch (20 gage) studs extending to or otherwise braced to lateral support above at both jambs, securely attached by screws either directly to door frames or to jamb anchor clips on door frame. Install runner track sections (for jack studs) at head and secure to jamb studs.
6. DOUBLE STUDS AT WALL BACKING where secure attachment of wall mounted items is required to drywall partitions, including but not limited to wall-mounted cabinets, flat-screen monitor units, grab-bars, and wall-stops at doors. Provide back-to-back doubled 0.032 inch (20 gage) studs extending to or otherwise braced to lateral support above, and securely attached by screws together and to the wall backing material.
7. FRAME OPENINGS OTHER THAN DOOR OPENINGS in same manner as required for door openings; and install framing below sills of openings to match framing required above door heads.
8. INSTALL SUPPLEMENTARY FRAMING, runners, furring, blocking and bracing at opening and terminations in the work, and at locations required to support fixtures, equipment, services, heavy trim, furnishings and similar work which cannot be adequately supported directly on gypsum board alone.

3.03 GENERAL GYPSUM BOARD INSTALLATION REQUIREMENTS:

A. INSTALL insulation where indicated, prior to gypsum board unless readily installed after board has been installed. Locate exposed end-butt joints as far from center of walls and ceilings as possible, and stagger not less than 1'-0" in alternate courses of board. Install ceiling boards in the direction and manner which will minimize the number of end-butt joints, and which will avoid end joints in the central area of each ceiling. Stagger end joints at least 1'-0".
B. INSTALL WALL/PARTITION BOARDS vertically to avoid end-butt joints wherever possible. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs.
C. INSTALL EXPOSED GYPSUM BOARD with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1/16" open space between boards. Do not force into place.

D. LOCATE either edge or end joints over supports, except in horizontal applications or where intermediate supports or gypsum board black-blocking is provided behind end joints. Position boards so that both tapered edge joints abut, and mill-cut or field-cut end joints abut. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions.
E. ATTACH gypsum board to framing and blocking as required for additional support at openings and cutouts. Form control joints and expansion joints with space between edges of boards, prepared to receive trim accessories. Cover both faces of steel stud partition framing with gypsum board in concealed spaces (above ceilings, etc.), except in chase walls which are properly braced internally.
F. ISOLATE perimeter of non-load-bearing drywall partitions at structural abutments. Provide 1/4" to ½" space and trim edge with J-type semi-finishing edge trim. Seal joints with acoustical sealant. Do not fasten drywall directly to stud system runner tracks.
G. STC-RATED ASSEMBLIES: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.
H. SPACE FASTENERS in gypsum boards in accordance with referenced standards and manufacturer's recommendations. On partitions/walls apply gypsum board vertically (parallel), unless otherwise indicated, and provide sheet lengths which will minimize end joints. Fasten gypsum board supports with screws.
I. DIRECT-BONDING TO SUBSTRATE: Where necessary to install gypsum board adhered directly to a substrate (other than studs, joints, furring members or base layer of gypsum board), comply with gypsum board manufacturers recommendations, and temporarily brace or fasten gypsum board until fastening adhesive has set.

3.04 INSTALLATION OF DRYWALL TRIM ACCESSORIES: Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges by nailing in accordance with manufacturer's instructions and recommendations. Install metal corner beads at external corners of drywall work.

A. INSTALL METAL EDGE TRIM whenever edge of gypsum board would otherwise be exposed or semi-exposed. Provide type with face flange to receive joint compound. Install L-type trim where work is tightly abutted to other work and install special kerf-type where other work is kerfed to receive long leg of L- type trim. Install U-type where edge is exposed, revealed, gasketed, or sealant-filled (including expansion joints).
B. INSTALL METAL CONTROL JOINTS above both sides of all door frames, and as otherwise required not to exceed a 30'-0" maximum uninterrupted surface.

3.05 INSTALLATION OF DRYWALL FINISHING: Apply treatment at gypsum board joints (both directions), flanges of trim accessories, penetrations, fasteners heads, surface defects and elsewhere as required to prepare work for decoration. Prefill open joints and rounded or beveled edges, using type of compound recommended by manufacturer. Apply joint tape at joints between gypsum boards, except where a trim accessory is indicated. Apply joint compound in three (3) coats (not including prefill of openings in base), and sand between last two (2) coats and after last coat. At water-resistant gypsum board base for ceramic tile, tape and finish joints with two (2) coats water-resistant joint material.

A. PARTIAL FINISHING: Omit third coat (if specified) and sanding on concealed drywall work which is indicated for drywall finishing or which requires finishing to achieve fire resistance rating, sound rating or to act as air or smoke barrier. Refer to sections on painting, coating and wall-coverings in Division 9 for decorative finishes to be applied to drywall work.
B. FINISH GYPSUM BOARD to levels indicated below, according to ASTM C 840, for locations indicated:
C. LEVEL 1 FINISH (typical at concealed areas): Embed tape at joints in ceiling plenum or other concealed areas
D. LEVEL 4: (TYPICAL EXPOSED GYPSUM-BOARD FINISH): Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.
E. LEVEL 5 FINISH where indicated, REQUIRED AT ALL WALLS TO RECEIVE WALL GRAPHICS AND DARK PAINT COLORS. Embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories; and apply two (2) each thin, uniform skim coats of joint compound over entire surface. For skim coats, use joint compound specified for third coat, or a product specially formulated for this purpose and acceptable to gypsum board manufacturer. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects, tool marks, and ridges and ready for decoration.
    1. Alternative Level 5 spray product will be considered by Architect after mockup including finish paint is reviewed and approved.

3.06 PROTECTION OF WORK: Installer must advise Contractor of required procedures for protecting gypsum drywall work from damage and deterioration during remainder of construction period.

END OF SECTION 09 21 17

SECTION 09 21 17 – GYPSUM BOARD SHAFT-WALL ASSEMBLIES

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide gypsum shaft-wall assemblies where indicated on the Drawings, as specified herein, and as necessary for complete installation.

1.02 SUBMITTALS

A. Product Data: For each gypsum board shaft-wall assembly indicated.
B. Fire-Test-Response Reports: From a qualified independent testing and inspecting agency substantiating each gypsum board shaft-wall assembly's required fire-resistance rating. Include data substantiating that elevator entrances and other items that penetrate each gypsum board shaft-wall assembly do not negate fire-resistance rating.

1.03 FIRE-RESISTANCE-RATED ASSEMBLIES: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1.04 DELIVER MATERIALS in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.

1.05 STORE MATERIALS inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat on leveled supports off the ground to prevent sagging.

1.06 PROJECT CONDITIONS: Comply with requirements for environmental conditions, room temperatures, and ventilation specified in Division 9 Section “Gypsum Board Assemblies”.

PART 2 - PRODUCTS

2.01 AVAILABLE MANUFACTURERS: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, G-P Gypsum Corp., National Gypsum Company, and United States Gypsum Co.

2.02 ASSEMBLY MATERIALS

A. PROVIDE MATERIALS AND COMPONENTS complying with requirements of fire-resistance-rated assemblies indicated. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.
B. Steel Framing: ASTM C 645.
C. Protective Coating: manufacturer's standard corrosion-resistant zinc coating.
D. Gypsum Liner Panels: Manufacturer's proprietary liner panels in 1-inch thickness and with moisture-resistant paper faces.
E. Gypsum Wallboard: ASTM C 36, core type as required by fire-resistance-rated assembly indicated.
F. Edges: Tapered and featured (rounded or beveled) for prefilling.
G. Water-Resistant, Gypsum Backing Board: ASTM C 630, core type as required by fire-resistance-rated assembly indicated.
H. Accessories: Cornerbead, edge trim, and control joints of material and shapes specified in Division 9 Section "Gypsum Board Assemblies" that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.
I. Gypsum Wallboard Joint-Treatment Materials: ASTM C 475 and as specified in Division 9 Section "Gypsum Board Assemblies."
J. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
K. Track (Runner) Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
L. Powder-Actuated Fasteners: Provide powder-actuated fasteners with capability to sustain, without failure, a load equal to 10 times that imposed by shaft-wall assemblies, as determined by testing conducted by a qualified independent testing agency according to ASTM E 1190.
M. Acoustical Sealant: As recommended by gypsum board shaft-wall assembly manufacturer for application indicated.
N. Sound Attenuation Blankets: ASTM C 665 for Type I, unfaced mineral-fiber-blanket insulation produced by combining thermosetting resins with mineral fibers manufactured from slag or rock wool.

2.03 GYPSUM BOARD SHAFT WALL

A. Studs: Manufacturer's standard profile for repetitive members and corner and end members and for fire-resistance-rated assembly indicated.
B. Depth: As indicated
C. Track (Runner): Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches, in depth matching studs.
D. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches, in depth matching studs, and not less than 0.0329 thick.
E. Cavity Insulation: Sound attenuation blankets.

PART 3 - EXECUTION

3.01 EXAMINE SUBSTRATES to which gypsum board shaft-wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with

requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. SPRAYED FIRE-RESISTIVE MATERIALS: Coordinate with gypsum shaft-wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft-wall assemblies to comply with requirements specified in Division 7 Section "Sprayed Fire-Resistive Materials."

B. BEFORE SPRAYED FIRE-RESISTIVE MATERIALS ARE APPLIED, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.

C. AFTER SPRAYED FIRE-RESISTIVE MATERIALS ARE APPLIED, remove them only to extent necessary for installation of gypsum board assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.03 INSTALLATION

A. INSTALL GYPSUM BOARD SHAFT-WALL ASSEMBLIES to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:

(1) ASTM C 754 for installing steel framing.
(2) Division 9 Section "Gypsum Board Assemblies" for applying and finishing panels.
(3) Do not bridge building expansion joints with shaft-wall assemblies; frame both sides of joints with furring and other support.
(4) Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
(5) At elevator hoistway door frames, provide jamb struts on each side of door frame.
(6) At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
(7) Isolate gypsum finish panels from building structure to prevent cracking of finish panels while maintaining continuity of fire-rated construction.
(8) Install control joints to maintain fire-resistance rating of assemblies.
(9) Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with manufacturer's written instructions or ASTM C 919, whichever is more stringent.
(10) In elevator shafts where gypsum board shaft-wall assemblies cannot be positioned within 2 inches of the shaft face of structural beams, floor edges, and similar projections into shaft, install 5/8-inch- thick, gypsum board cants covering tops of projections.
(11) Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft-wall framing.
(12) Where steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to the shaft-wall framing.

B. PREPARE all walls for finishes as specified in drawings.

END OF SECTION 09 21 17

SECTION 09 22 26 - DRYWALL GRID SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Metal suspension system for the support of gypsum drywall in ceiling, a soffit installation for interior and exterior finishes.

1.02 RELATED SECTIONS

A. Section 08 44 00 - Curtain Wall and Glazed Assemblies
B. Section 09 51 00 (09510) - Acoustical Ceilings
C. Section 09 20 00 (09250) - Plaster and Gypsum Board
D. Section 09 51 13 Pre-engineered Perimeter Transition System
E. Division 23 Heating Ventilating and Air Conditioning (HVAC)
F. Division 26 Electrical
G. Section 01 81 13 - Sustainable Design Requirements
H. Section 01 81 19 - Indoor Air Quality Requirements

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)
   (1) ASTM A 1008 Standard specification for the Steel, Sheet, Cold Rolled Carbon, Structural, High Strength Low-Alloy and High Strength Low Alloy with Improved Formability
   (2) ASTM A 641 Standard Specification for Zinc Coated (Galvanized) Carbon Steel Wire.
   (3) ASTM C 635 Standard Specification for Metal Suspension Systems
   (4) ASTM C 645-09 - Standard Specification for Nonstructural Steel Framing Members
   (5) ASTM C 754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
   (6) ASTM C841 Standard Specification for Installation of Interior Lathing and Furring
   (7) ASTM C842 Standard Specification for Application of Interior Gypsum Plaster
   (8) ASTM C 847 - Standard Specification for Metal Lath
   (9) ASTM C926 Standard Specification for Application of Portland Cement-Based Plaster
   (10) ASTM C 1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster (Plaster and Stucco Accessories)
   (11) ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Material
   (12) ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
B. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures
C. International Code Council-Evaluation Services - AC 156 Acceptance Criteria for Seismic Qualification Testing of Non-structural Components
D. LEED - Leadership in Energy and Environmental Design is a set of rating systems for the design, construction, operation, and maintenance of green buildings
E. International Code Council Evaluation Service Report ESR-1289 for Drywall Grid
F. IAPMO Evaluation Report for ShortSpan ER0163
G. Miami Dade County, Florida Wind Uplift Compliant
H. International Well Building Standard
I. Mindful Materials
J. Living Building Challenge
K. U.S. Department of Agriculture BioPreferred program (USDA BioPreferred).

1.04 SUBMITTALS

A. Product Data:
   (1) Submit manufacturer's technical data for each type of Metal Framing system required.
B. Samples:
   (1) Metal Framing System, including main runner and 4 foot cross tees.
C. Shop Drawings:
   (1) Layout and details of Metal Framing System. Show locations of items which are to be coordinated with or supported by the metal suspension system.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
B. Pre-installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, and manufacturer's installation instructions.
C. Fire Resistance Characteristics: For fire-resistance-rated assemblies that incorporate Metal framing systems provide materials and construction identical to those tested in fire resistance assembly as indicated in the construction documents and or architectural plans in accordance with ASTM E119.

1.06 SUSTAINABLE MATERIALS

A. Transparency: Manufacturers will be given preference when they provide documentation to support sustainable requirements for the following: Material ingredient transparency, Removal of Red List Ingredients per LBCV3, Life Cycle impact information, Low-Emitting Materials, and Clean Air performance.
   (1) Health Product Declaration. The end use product has a published, complete Health Product Declaration with disclosure at a minimum of 1000ppm of known hazards in compliance with the Health Product Declaration open Standard.
   (2) Declare Label. The end use product has a published Declare label by the International Living Future Institute with disclosure of 100 ppm with a designation of Red List Free or Compliant (less than 1% proprietary ingredients).
   (3) Low Emitting products with VOC emissions data. Preference will also be given to manufacturers that can provide emissions data showing their products meet CDHP Standard Method v1.1 (Section 01350).
   (4) Life cycle analysis. Products that have communicated lifecycle data through Environmental Product Declarations (EPDs) will be preferred.
   (5) End of Life Programs/Recycling: Where applicable, manufacturers that provide the option for recycling of their products into new products at end-of-life through take-back programs will be preferred.
   (6) Products meeting LEED V4 requirements including:
      (a) Storage & Collection of Recyclables
      (b) Construction and Demolition Waste Management Planning
      (c) Building Life-Cycle Impact Reduction
      (d) Building Product Disclosure and Optimization Environmental Product Declarations
      (e) Building Product Disclosure and Optimization Sourcing of Raw Materials
      (f) Building Product Disclosure and Optimization Material Ingredients
      (g) Construction and Demolition Waste Management

1.07 DELIVERY, STORAGE AND HANDLING

A. Protect and store products in manufacturer's unopened packaging until ready for installation.

1.08 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.09 WARRANTY

A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:
   (1) Acoustical Panels: Sagging and warping
   (2) Grid System: Rusting and manufacturer's defects

B. Warranty Period:
   (1) Grid: One (1) year from date of substantial completion

C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Suspension Systems:
   (1) Armstrong World Industries, Inc.

B. Aluminum Custom Perimeter Trim Extruded:
   (1) Armstrong World Industries, Inc.

C. Perimeter Systems:
   (1) Armstrong World Industries, Inc.

2.02 DRYWALL SUSPENSION SYSTEMS

A. Armstrong Drywall Suspension Systems all main beams and cross tees shall be commercial quality hot-dipped galvanized steel

B. Tee: manufactured main beam- 1-1/2" knurled face with ScrewStop™ reverse hem by 1-11/16 inches high. Drywall Main Beams are factory punched with crosstee routs and hanger wire holes and SuperLock™ main beam clip for a strong secure connection and fast accurate alignment. Both ShortSpan and Drywall Main Beams are Heavy-duty performance per ASTM C635
   (1) HD8906 - 12ft HD Drywall Main Beam 1-1/2 in

C. Cross Tees: manufactured main beam- 1-1/2" knurled face with ScrewStop™ reverse hem by 1-1/2 inches high with factory punched cross tee routs and hanger wire holes and XL stake on clip for a strong secure connection.
   (1) XL8945P - 4ft Drywall Cross Tee

D. Wall Molding:
   (1) 7857 - 12ft Reverse Angle Molding

E. Hanger wire: a Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least time three times the design load, but not less than 12-gauge.
F. Accessories:
   (1) DW90C - 90 Degree Drywall Angle Clip
   (2) Material Ingredient Transparency: Health Product Declaration (HPD); Declare Label
   (3) Life Cycle Assessment: Third Party Certified Environmental Product Declaration (EPD)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation, inspect previous work of all other trades. Verify that all work is complete and accurate to the point where this installation may properly proceed in strict accordance with framing shop drawings.
B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
C. Installation: In accordance with all approved plans, details, and manufacturer's installation guidelines located in the Armstrong Drywall Grid Systems and ShortSpan Installation Guides.
   (1) Install seismic components if required by the building code. Seismic components to be specified on the architectural plans by the project engineer or design team.

END OF SECTION 09 22 26

SECTION 09 30 00 – TILING

PART 1 - GENERAL

1.01 PROVIDE TILE WORK where indicated on the Drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents.

1.02 RELATED SECTIONS

A. Section 018113 Certification Requirements.

1.03 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For tiling and any adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

C. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.

1.04 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant

D. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.

1.05 SUBMITTALS

A. PRODUCT DATA: Submit manufacturer's technical information and installation instructions for materials required. Include certifications and other data to show compliance with these specifications.

B. SHOP DRAWINGS: Provide to scale shop drawings with dimensions showing tile cuts around all drains, floor tile layouts, noted critical alignments. Shop drawings to include all associated clearly labeled trims to be used for tile installation.

C. SAMPLES FOR SELECTION: For each type of tile and grout indicated. Include Samples of accessories involving color selection.

1.06 QUALITY ASSURANCE: Provide materials obtained from one source for each type and color of unit, grout, and setting materials.

A. DRY-LAID MOCKUPS: Lay out tiles in dry-laid mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Lay out mockup of each type of ceramic tile installation, utilizing products, materials, including installation accessories (spacers) and techniques, intended for completed Work.
2. Maintain dry-laid mockups in an undisturbed condition until equivalent areas of the completed Work are approved to serve as a quality standard for completed Work.

B. JOB CONDITIONS:

1. PRODUCT HANDLING: Deliver materials in original unopened containers with labels intact and legible at time of use. Store under conditions recommended by the manufacturer. Do not retain at the project site any material which has exceeded the shelf life recommended by its manufacturer.

2. MAINTAIN ENVIRONMENTAL CONDITIONS and protect work during and after installation in accordance with referenced standards and manufacturer's printed recommendations. Provide weatherproof, heated enclosure of the work area when temperatures are lower than that required for installation.
3. SEQUENCE OF FLOOR TILE INSTALLATION: Where integral tile-cove base is indicated, install tile work after installation of gypsum board, base cabinets, or other base substrate as applicable.

C. EXTRA MATERIALS

1. EXTRA STOCK: Upon completion of the work of this Section, deliver to the Owner an extra stock equal to 10 square feet of each color or pattern of material used.

PART 2 - PRODUCTS

2.01 TILE MATERIALS & GROUT COLORS: Refer to the Drawings for tile materials and grout colors.

2.02 TILE TRIM UNITS:

A. Provide units matching characteristics of adjoining flat tile and coordinated with sizes and coursing of adjoining flat tile where applicable. Provide manufacturer's standard shapes, including but not limited to coved base units, wainscot caps, external corner units and other trim units as applicable.
B. Cove base is required at all tile wall to tile floor conditions.

2.03 WATERPROOFING & CRACK-SUPPRESSION MEMBRANE (fluid applied): Fluid-Applied Waterproofing and Crack Isolation Membrane System: Provide continuous and seamless waterproofing and crack isolation system, including premixed or single-component self-curing liquid-latex rubber or elastomeric-polymer membrane; complying with ANSI A118.10 for waterproofing and ANSI A118.12 for crack isolation; ASTM C627 Extra Heavy Service Rating; IAPMO-Approved as shower pan line, and recommended by the manufacturer for the application indicated.

A. Basis-of-Design: “RedGard Waterproofing and Crack Prevention Membrane” as manufactured by Custom Building Products, or equal.
B. Alternate Manufacture:

1. “Hydro Ban” by Laticrete Internation, Inc.
2. “Mapelastic Aqua Defense’ by Mapei Corporation

C. Pre-treat control joints and cracks in accordance with membrane manufacturer’s instructions.
D. Provide reinforcement and accessories as recommended by manufacturer for complete system.

2.04 WATERPROOFING SHEET MEMBRANE (for use on potentially “wet” elevated floors): Non-plasticized, chlorinated polyethylene sheet (CPE) faced on both sides with high-strength, nonwoven polyester fabric, meeting ANSI A118.10 and manufactured specifically for adhering to latex-Portland cement mortar; 60 inches wide by 0.030-inch nominal thickness.

A. Basis-of-Design: “NobleSeal TS” as manufactured by The Noble Company, or equal.

2.05 SHOWER-PAN WATERPROOFING LINER SHEET (for use at thick-set shower pans): Non-plasticized, high-grade chlorinated polyethylene sheet (CPE) faced on both sides with high-strength, nonwoven polyester fabric, meeting ANSI A118.10 and manufactured specifically for adhering to latex-Portland cement mortar; in up to 72 inch width by 0.040-inch nominal thickness. Where applicable, comply with manufacturer’s recommendations for spanning shower pans over structural joints in concrete structure.

A. Basis-of-Design: “Chloraloy” as manufactured by The Noble Company, or equal.

2.06 WALL WATERPROOFING SHEET MEMBRANE (for wet-walls including showers and tub-surrounds): PVC sheet with polyester fabric laminated to both sides and manufactured specifically for adhering to latex-Portland cement mortar at interior locations; 72 inch wide by 0.025-inch nominal thickness.

A. Basis-of-Design: “Wall Seal” as manufactured by The Noble Company, or equal.

2.07 TILE-EDGE TRIM AT CONCRETE FLOORING: Satin anodized aluminum trim in height required to match tile thickness and with minimum 0.75 inch transition leg. Provide typically at edge of tile abutting exposed concrete or resilient flooring.

A. Basis-of-Design: “Reno-V – AEVT/B” as manufactured by Schluter, or equal.

2.08 TILE TRANSITION TRIM - AT CARPET or WOOD FLOORING (provide typically where tile edge transitions to adjacent carpeting or wood flooring): Brushed stainless steel unit in height required to match tile thickness:

A. Basis-of-Design: “Schiene-EB” as manufactured by Schluter, or equal.

2.09 TILE TRANSITION TRIM - AT CONCRETE OR RESIL / RESINOUS FLOORING: Schluter “Reno-Ramp” series (brushed anodized aluminum), ADA compliant sloping “ramp” profile – in height required to match tile thickness. Provide typically where tile edge transitions to adjacent exposed concrete or thin-flooring finishes.

A. Basis-of-Design: “Reno-Ramp” as manufactured by Schluter, or equal.

2.10 CEMENT BOARD UNDERLAYMENT: 0.42 inch thick ASTM C 1288 and ANSI A 118.9 compliant board with 6,500 PSI compressive strength, consisting of 90% Portland Cement and sand with selected additives, without asbestos, formaldehyde, gypsum, paper facing, or abrasive aggregates:

A. Basis-of-Design: “HardieBacker 500 Cement Board” by James Hardie (1-800-9-HARDIE) or approved equal.
B. Fasteners: minimum 1-3/4 inch long No. 8 x 0.375-inch HD self-drilling corrosion-resistant ribbed waferhead screws.
C. Mortar: ANSI A 118.1 dry-set mortar (between subfloor and cement board)
D. Joint Tape: Manufacturer’s standard 2-inch minimum width high-strength alkali-resistant glass fiber tape.

2.11 WATERPROOFING INSTALLATION:

A. Waterproofing Installation: Install waterproofing membrane to comply with ANSI A108.13, ANSI A108.17 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.
   1. Do not install tile or setting materials over waterproofing membrane until membrane has cured and been tested to determine that it is watertight.
   2. Pre-treat control joints and cracks in accordance with membrane manufacturer's instructions.
      a. Apply extra fabric-reinforcing at control joints and cracks.
   3. Apply liquid waterproofing membrane full height of shower walls.

B. At showers: Apply two separate layers. Apply first layer to cover base floor substrate below mortar bed continuous from drain and covering entire wall surface to ceiling on each wall. Second layer is applied over the mortar bed and in continuous overlapping into drain and extending 2-feet above water line onto vertical wall surface.

2.12 ACCEPTABLE MANUFACTURERS FOR TILE SETTING MATERIALS: Subject to compliance with requirements, provide tile-setting products as manufactured by one of the following:

A. Custom Building Products (Basis-of-Design Manufacturer): P: 800-272-8786, www.custombuildingproducts.com
B. Laticrete International Inc.
C. Mapei Corporation.
D. H. B. Fuller Construction Products Inc. / TEC

2.13 TYPICAL THIN-SET MORTAR: ANSI A118.4 latex modified, Portland cement mortar consisting of prepackaged dry-mortar mix combined with acrylic resin liquid-latex additive. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4:

A. Basis-of-Design: "Porcelain Tile Fortified Thin-Set Mortar", "VersaBond Flex Fortified Thin-Set Mortar", or "VersaBond-LFT (as applicable), by Custom Building Products, or equal.

2.14 CRACK-PREVENTION THIN-SET MORTAR (for use over plywood / wood substrate): ANSI A118.4, Premium quality polymer-modified mortar with exceptional flexibility and bond strength for use over difficult surfaces, including plywood or wood substrates:

A. Basis-of-Design: "FlexBond" by Custom Building Products, or equal

2.15 STAIN-RESISTANT GROUT (for typical floor or wall surfaces): ANSI A118.7, single component stain resistant preixed grout. Provide sanded grout for joints over 1/8 inch – unsanded grout for joints 1/8 inch and less:

A. Basis-of-Design: "Fusion Pro" by Custom Building Products, or equal

2.16 EPOXY GROUT (at Kitchen and Showers): ANSI A118.3 two-part epoxy for extra heavy commercial use and stain resistance:

A. Basis-of-Design: "CEG-IG 100% Solids Industrial Grade Epoxy Grout" by Custom Building Products, or equal.

2.17 LATEX-PORTLAND CEMENT MORTAR (THIN SET): ANSI A118.4, consisting of prepackaged dry-mortar mix combined with acrylic resin liquid-latex additive. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.

A. Basis-of-Design: TEC "Super Flex Ultra-Premium Thin Set Mortar"

2.18 TYPICAL THIN-SET LATEX-MODIFIED GROUT: ANSI A118.7, either ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix:

A. Basis-of-Design: TEC "Power Grout" # 550

2.19 TILE GROUT SEALER: "Auqa-Mix Sealer's Choice 15 Gold" penetrating sealer or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION & INSPECTION: Examine areas and conditions under which the Work of this Section will be performed. Do not proceed if conditions exist that are detrimental to proper and timely completion. Commencement of this Work will be construed as acceptance of existing conditions or prior work by others, and assumption of responsibility for satisfactory installation.

A. Verify that substrates for setting tile are firm and dry, and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
B. Deflection of substrate: not to exceed 1/360th of the span (1/2 inch in 15 feet) in accordance with ANSI A108.01-2.3. Allow for live and impact load as well as dead load weight of tile and setting bed.
C. Verify that installation of electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
D. Verify that joints in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 COMPLY WITH MANUFACTURER'S instructions for mixing and installation of materials. Protect existing adjacent surfaces before beginning tile installation Work.

3.03 EXTEND tile work into recesses and under or behind equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disrupting pattern or joint alignments.

3.04 PREPARATION

A. REMOVE COATINGS, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
B. BLENDING: For tile exhibiting color variations within ranges selected during Sample submittals, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.05 TILE INSTALLATION

A. ANSI STANDARDS: Comply with applicable requirements of ANSI's "Standard Specifications for the installation of Ceramic Tile" except as otherwise indicated.
B. TCA INSTALLATION GUIDELINES: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
C. TERMINATE WORK NEATLY at obstructions, edges, and corners without disrupting pattern or joint alignments.
D. ACCURATELY FORM intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
E. JOINTING PATTERN: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths as follows, unless otherwise indicated. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
F. CONTROL JOINTS: Provide a joint in tile where tile overlays a control joint in concrete slab, typ. Joint should be finished with color match sealant to match grout. Cut joint in a straight line directly over concrete control joint. Tile joint width should match tile spacing if on pattern, or width of tile saw blade.
G. WHERE STAGGERED (brick) joints are indicated for tile over 12" in size, provide joints at 33.3% of the tile, per TCNA. E.G. "1/3rd overlap"
H. INSTALL TYPES OF TILE designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.
I. GROUT TILE TO COMPLY WITH requirements of ANSI A108.10.
J. GROUT SEALER: Apply grout sealer to cementitious grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.06 CLEANING AND PROTECTING

A. CLEANING: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
B. REMOVE LATEX-PORTLAND CEMENT GROUT RESIDUE from tile as soon as possible.
C. CLEAN GROUT SMEARS AND HAZE FROM TILE according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. flush surfaces with clean water before and after cleaning.
D. APPLY COAT OF NEUTRAL PROTECTIVE CLEANER to completed tile work, if recommended by tile manufacturer.
E. FINISHED TILE WORK: Leave finished installation clean and free of cracked, chipped, broken un-bonded, or otherwise defective tile work.
F. PROTECTION: When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with Kraft paper or other heavy covering during construction period to prevent damage and wear. Prohibit foot and wheel traffic from using tiled floors for at least three (3) days after grouting is completed.
G. BEFORE FINAL INSPECTION remove protective coverings and rinse neutral cleaner from tile surfaces.

PART 4 - TILE INSTALLATION SCHEDULE

4.01 TYPICAL INTERIOR WALL TILE (limited-wet areas, including toilets):

A. Installation Standard: Comply with TCA Method # W242 and as follows:
B. Wall Tile grouted with typical polymer modified Portland cement grout, on
C. Thin-set Portland cement mortar, over
D. Water Resistant Gypsum Tile Backer Board on metal studs.

4.02 TYPICAL INTERIOR FLOOR TILE (not on elevated floor slabs):

A. Installation Standard: Comply with TCA Method # F113 and as follows:
B. Floor tile grouted with latex modified Portland Cement grout, on
C. Latex-Portland cement mortar bond coat, on
D. Well-cured, clean concrete slab, without curing compounds (wet-cured)

4.03 WET-AREA WALL TILE (at showers)

A. Installation Standard: Comply with TCA Method # W245 and as follows:
B. Wall tile grouted with latex modified Portland cement grout, on
C. Latex-modified Portland cement mortar bond coat, on
D. Wall-type Waterproof membrane set in latex Portland cement mortar bond-coat, lapping over membrane at floor base of showers by minimum 4 inches, over cement backer board substrate (as specified in other Division-09 Sections)

4.04 WET AREA FLOOR TILE ON CONCRETE (at shower areas on slab or on elevated floors):

A. Installation Standard: Comply with TCA Method # F122, and as follows:
B. Floor tile with latex modified grout, set in latex-modified Portland cement mortar, over
C. Shower-Pan type waterproof membrane set in latex Portland cement mortar bond-coat – extend membrane up minimum of six (6) inches behind tile base at all walls, partitions and penetrations, as applicable, over
D. Well-cured, clean concrete substrate

END OF SECTION 09 30 00

SECTION 09 51 00 – SUSPENDED ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide acoustical ceilings as shown on the drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents.

1.02 RELATED SECTIONS

A. Section 018113 Certification Requirements.

1.03 LEED PERFORMANCE REQUIREMENTS

A. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material must be within 100 miles of project site for credit.
B. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.
C. VOC Emissions Evaluation: For acoustical and metal ceilings, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
D. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.
E. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.04 LEED DOCUMENTATION REQUIREMENTS

A. Complete provided Product Data Reporting Form and provide the following:
B. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material (this includes components of the mix design). Include distance to Project and cost for each regional material.
C. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide material costs excluding labor itemized.
D. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
E. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.
F. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable

1.05 QUALITY ASSURANCE

A. INSTALLER: Firm with no less than three (3) years of successful experience in installation of acoustical ceilings similar to requirements for this project and which is acceptable to manufacturer of acoustical units, as shown by current written statement from manufacturer.

1.06 SUBMITTALS:

A. PRODUCT DATA: Manufacturer's product specifications and installation instructions for each acoustical ceiling material required, and for each suspension system, including certified laboratory test reports and other data as required to show compliance with these specifications.
B. INCLUDE manufacturer's recommendations for cleaning and refinishing acoustical units, including precautions against materials and methods which may be detrimental to finishes and acoustical performance.
C. DELIVER MATERIALS in original unopened containers and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination or other causes.

1.07 JOB CONDITIONS:

A. SPACE ENCLOSURE: Do not install interior acoustical ceilings until space enclosed and weatherproof, and until wet-work in space is completed and nominally dry, and until work above ceilings is completed, and until ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.
B. MAINTENANCE STOCK: At time of completing installation, deliver stock of maintenance material to Owner. Furnish full size units matching units installed, packaged with protective covering for storage, and identified with appropriate labels. Furnish amount equal to 2.0% of each type of the total acoustical panels installed.

PART 2 - PRODUCTS:

2.01 REFER TO DRAWINGS for ceiling panel materials and suspension grids, and as follows:

A. CEILING SYSTEMS:

1. Refer to drawings; Finish Schedule
2. All materials to be HRC for LEED points.

B. CEILING SUSPENSION MATERIALS: Comply with ASTM C 635, as applicable to type of suspension system required for type of ceiling units indicated. Coordinate with other work supported by or penetrating through ceilings, including light fixtures, HVAC equipment, and partition system (if any).

C. ATTACHMENT DEVICES: Size for five (5) times design load indicated in ASTM C 635, Table 1, Direct Hung.

D. HANGER WIRES: Galvanized carbon steel, ASTM A 641, soft temper, pre-stretched, yield-stress load of at least three (3) times design load, but not less than 12 gage (0.106").

E. EDGE MOLDINGS: Manufacturer's recessed channel molding for edges and penetrations of ceiling, with single flange of molding exposed, baked enamel finish to match balance of grid.

F. METAL TRIM: Provide extruded metal edge trim at locations called for in Drawings.

1. Basis-of-Design: “Axiom Classic Trim” and “AX2CUR” by Armstrong Ceiling and Wall Solutions.

G. EXPOSED SUSPENSION SYSTEM: Manufacturer's standard exposed runners, cross-runners and accessories, of types and profiles indicated, with exposed cross-runners coped to lay flush with main runners. Provide uniform factory-applied finish on exposed surfaces of ceiling suspension system, including moldings, trim, and accessories, in manufacturer's baked enamel finish, to match type of ceiling.

PART 3 - INSTALLATION:

3.01 MEASURE EACH CEILING AREA and establish layout of acoustical units to balance border widths at opposite edges of each ceiling, except as otherwise indicated on the Drawings. Avoid use of less-than-half width units at borders, and comply with reflected ceiling plans wherever possible.

3.02 COMPLY with manufacturer's printed instructions, and with governing regulations, fire-resistance rating requirements and with industry standards applicable to the Work.

3.03 ARRANGE acoustical units and orient directionally-patterned units in the manner shown by reflected ceiling plans, with pattern running in one direction.

3.04 INSTALL SUSPENSION SYSTEM to comply with ASTM C 636, with hangers supported only from building structural members. Locate hangers not less than 6" from each end and space 4'-0"; along each carrying channel or direct-hung runner. Secure wire hangers by looping and wire tying, either directly to structures or to inserts, eye-screws, or other devices which are secure and appropriate for substrate.

3.05 INSTALL EDGE MOLDINGS at perimeter of acoustical ceiling area and at locations where necessary to conceal edges of acoustical units. Screw-attach moldings to substrate at levels not over 16" o.c. and not more than 3" from ends, leveling with ceiling suspension system to tolerance of 1/8" to 12'-0". Miter corners accurately and connect securely.

3.06 INSTALL ACOUSTICAL PANELS with undamaged edges throughout and fitted accurately into suspension system runners and edge moldings, with unfinished edges fully concealed by support of suspension members. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

3.07 AT CUT EDGES of reveal-edged panels exposed after installation, trim cut edges to match profile of un-cut edges, and paint exposed surfaces using coating recommended for this purpose by acoustical panel manufacturer.

3.08 INSTALL PANEL HOLD-DOWN CLIPS where indicated or as required for fire-resistance ratings, and in all vestibules with acoustical ceilings, and within a twenty (20) foot radius of any exterior door.

3.09 ADJUST AND CLEAN EXPOSED SURFACES of acoustical ceilings, including trim, edge moldings, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 00

SECTION 09 54 00 – INTEGRATED CEILING ASSEMBLIES

PART 1 - General

1.01 1.1 RELATED DOCUMENTS

A. Drawings and general conditions of Contract, including General and Supplementary Conditions and Divisions-1 Specification sections apply to work of this section.

1.02 1.2 SUMMARY

A. Section Includes

1. Acoustical ceiling panel
2. Wire hangers, fasteners, main runners, cross tees, and wall angle moldings
3. Perimeter Trim

B. Related Sections

1. Section 09 51 00 - Acoustical Ceiling Suspension Assemblies
2. Section 09 20 00 - Plaster and Gypsum Board
3. Section 01 81 13 - Sustainable Design Requirements
4. Section 01 81 19 - Indoor Air Quality Requirements
5. Section 02 42 00 - Removal and Salvage of Construction Materials
6. Divisions 23 - HVAC Air Distribution
7. Division 26 - Electrical

C. Alternates

1. Prior Approval: Unless otherwise provided for in the Contract documents, submit proposed product substitutions no later than FIVE (5) working days prior to the date established for receipt of bids. Acceptability of a proposed substitution is contingent upon the Architect's review and acceptance. Approved products will be set forth by the Addenda. If a substitution is included in a Bid and is not approved by an Addendum, the specified products shall be provided as in place of the substitute without additional compensation.
2. Submittals that do not provide adequate data for the product evaluation will not be considered. The proposed substitution must meet all requirements of this section, including but not necessarily limited to, the following: Single source materials suppliers (if specified in Section 1.5); Underwriters' Laboratories Classified Acoustical performance; Panel design, size, composition, color, and finish; Suspension system component profiles and sizes; Compliance with the referenced standards.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM A 1008 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
2. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
3. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
4. ASTM C 645 Standard Specification for Metal Suspension Systems
5. ASTM C 636 Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
6. ASTM C754 AND C1858 All installations should be in compliance with these tests.
7. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
8. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
9. ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
10. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
11. ASTM E 1414 Standard Test Method for Airborne Sound Attenuation between Rooms Sharing a Common Ceiling Plenum
12. ASTM E 1264 Classification for Acoustical Ceiling Products
13. ASTM E3090 All references to suspension component property testing per this test method.

B. International Building Code
C. ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality
D. NFPA 70 National Electrical Code
E. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures
F. International Code Council-Evaluation Services - AC 156 Acceptance Criteria for Seismic Qualification Testing of Non-structural Components
G. International Code Council-Evaluation Services Report - Seismic Engineer Report

1. ESR 1289 - Armstrong Suspension Systems

H. California Department of Public Health CDPH/EHLB Emission Standard Method Version 1.1 2010
I. LEED - Leadership in Energy and Environmental Design is a set of rating systems for the design, construction, operation, and maintenance of green buildings
J. International Well Building Standard
K. Mindful Materials
L. Living Building Challenge

1.04 SYSTEM DESCRIPTION

A. Continuous/Wall-to-Wall or Cloud installation

1.05 LEED PERFORMANCE REQUIREMENTS

A. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material must be within 100 miles of project site for credit.
B. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.
C. VOC Emissions Evaluation: For integrated ceiling assemblies, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
D. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.
E. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.06 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material (this includes components of the mix design). Include distance to Project and cost for each regional material.
C. Recycled Content:Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.
D. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
E. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.
F. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable.

1.07 SUBMITTALS

A. Shop Drawings: Layout and details of ceilings. Show locations of items that are to be coordinated with, or supported by the ceilings.
B. Installation Instructions: Submit manufacturer's installation instructions as referenced in Part three, Installation.
C. Product Data: Submit manufacturer's technical data for each type of ceiling unit and suspension system required.
D. Samples: Minimum 6 x 6 inch samples of specified panel; 8 inch long samples of exposed wall molding and suspension system, including main runner and 4 foot cross tees.
E. Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards.
F. Non-Conformance: All products not conforming to the requirements of this specification and or the manufacturer's published values are to be disposed. The Contractor performing the work will replace with approved product at their expense.

1.08 SUSTAINABLE MATERIALS

A. Transparency: Manufacturers will be given preference when they provide documentation to support sustainable requirements for the following: Material ingredient transparency, Removal of Red List Ingredients per LBCV3, Life Cycle impact information, Low-Emitting Materials, and Clean Air performance.
    1. Health Product Declaration. The end use product has a published, complete Health Product Declaration with disclosure at a minimum of 1000ppm of known hazards in compliance with the Health Product Declaration open Standard.
    2. Declare Label. The end use product has a published Declare label by the International Living Future Institute with disclosure of 100 ppm with a designation of Red List Free or Compliant (less than 1% proprietary ingredients).
    3. Low Emitting products with VOC emissions data. Preference will also be given to manufacturers that can provide emissions data showing their products meet CDHP Standard Method v1.1 (Section 01350).
    4. Life cycle analysis. Products that have communicated lifecycle data through Environmental Product Declarations (EPDs) will be preferred.
    5. End of Life Programs/Recycling: Where applicable, manufacturers that provide the option for recycling of their products into new products at end-of-life through take-back programs will be preferred.
    6. Products meeting LEED V4 requirements including:
        a. Storage & Collection of Recyclables
        b. Construction and Demolition Waste Management Planning
        c. Building Life-Cycle Impact Reduction

d. Building Product Disclosure and Optimization Environmental Product Declarations
e. Building Product Disclosure and Optimization Sourcing of Raw Materials
f. Building Product Disclosure and Optimization Material Ingredients
g. Construction and Demolition Waste Management

1.09 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.
B. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
C. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 Classification.
D. Acoustical Panels: As with other architectural features located at the ceiling that may obstruct or skew the planned fire sprinkler pattern through possibly delay or accelerate the activation of the sprinkler or fire detection systems by channeling heat from a fire either toward or away from the device. Designers and installers are advised to consult a fire protection engineer, NFPA 13, or their local codes for guidance where automatic fire detection and suppression systems are present.
E. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers. ACOUSTIBuilt Panels are 7/8" thick.
F. Installer Qualification: Subcontractor is an experienced Installer that has reviewed and understands the system installation instructions thoroughly. Subcontractor will follow written installation instructions and utilize approved equipment and procedures for finishing installation.

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content. Store all material within temperature limits required by manufacturer.
C. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

1.11 PROJECT CONDITIONS

A. Space Enclosure:
1. Building areas to receive ceilings shall be free of construction dust and debris. ACOUSTIBuilt panels should be installed in areas where the building is enclosed, and the HVAC is continuously functioning. This product is not recommended for exterior applications, where standing water is present, or where moisture will come into direct contact with the ceiling.
a. HVAC should be designed, installed, and operated in accordance with ASHRAE Standard 62.1. It is also necessary for the area to be enclosed, for the HVAC systems to be functioning, and in continuous operations for the life of the product. Product is not intended for use where natural ventilation is part of the ventilation strategy and not recommended in areas where a differential plenum pressure exists.

1.12 ALTERNATE CONSTRUCTION WASTE DISPOSAL

A. Reclaimed ceiling material must be kept dry and free from debris.
B. Contact the Armstrong Recycle Center a consultant will verify the condition of the material and that it meets the Armstrong requirements for recycling. The Armstrong consultant with provide assistance to facilitate the recycling of the ceiling.
C. Recycling may qualify for LEED Credits:
1. LEED 2009 - Category 4: Material and Resources (MR)
a. Credit MRc2: Construction Waste Management
D. LEEDv4 - MRp2 - Construction Waste Management Planning Qualifies as a material stream (non-structural) targeted for diversion. Ceilings will be source-separated and diverted through the Armstrong Ceiling Recycling Program.
1. LEEDv4-MRc5 -
a. Option 1: Divert ceilings to qualify for one of the 3 material streams (50%)
b. Option 2: Divert ceilings to qualify for one of the 4 material streams (75%)

1.13 WARRANTY

A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:
1. Acoustical Panels: Manufacturer's defects in material
2. Grid System: Rusting and manufacturer's defects
B. Warranty Period:
1. Acoustical panels: Ten (10) years from date of substantial completion
2. Suspension: Ten (10) years from date of substantial completion
C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.14 MAINTENANCE

A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
   1. Acoustical Ceiling Units: Furnish quality of full-size units equal to 5.0 percent of amount installed.
   2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design ACOUSTIBuilt:
   1. Armstrong World Industries, Inc.
   2. Finish
      a. Joint Compound Finish by Others
      b. Spray Applied Finish by Armstrong World Industries, Inc.
   3. Suspension Systems and Washers
      a. Armstrong World Industries, Inc.
   4. Perimeter Systems
      a. Armstrong World Industries, Inc.

2.02 ACOUSTICAL CEILING UNITS

A. Acoustical Panels
   1. Surface Texture: Fine
   2. Composition: Mineral Fiber
   3. Color: White (Fine Texture Finish for ACOUSTIBuilt panels)
   4. Size: 48 in x 72 in x 7/8 in - Item #2604
   5. Edge Profile: Tapered edges four sides
   6. Noise Reduction Coefficient (NRC): ASTM C 423; Panel 0.80 (UL), System up to 0.70
   7. Ceiling Attenuation Class (CAC): ASTM C 1414; Panel 46 (UL), System up to 48
   8. Sabin: N/A
   9. Articulation Class (AC): ASTM E 1111
   10. Flame Spread: ASTM E 1264; Class A
   11. Light Reflectance (LR) White Panel: ASTM E 1477; 0.87
   12. Dimensional Stability: HumiGuard Plus
   13. Recycle Content: Post-Consumer and Pre-Consumer – up to 75%
   14. Material Ingredient Transparency: Health Product Declaration (HPD); Declare Label
   15. Life Cycle Assessment: Third Party Certified Environment Product Declaration (EPD)
   16. Acceptable Product: ACOUSTIBuilt panels #2604 No added formaldehyde as manufactured by Armstrong World Industries
   17. Contact your local Armstrong Representative for required installation training at least 4-6 weeks before ordering materials and scheduling installation.

B. Finish
   1. Joint Compound
      a. Setting Compound: Lightweight setting-type drywall joint compound, Ultra lightweight drying-type drywall joint compound
      b. Joint Tape: Self-Adhesive mesh drywall joint tape
   2. Spray Applied Finish – Required Product: #2605WH Fine Texture Finish for ACOUSTIBuilt panels – White as manufactured by Armstrong World Industries.

C. Suspension Systems and Washers
   1. Armstrong Drywall Suspension Systems all main beams and cross tees shall be commercial quality hot-dipped galvanized steel
      a. Main beam: manufactured main beam- 1-1/2" knurled face with ScrewStop™ reverse hem by 1-11/16 inches high. Drywall Main Beams are factory punched with cross tee routs, hanger wire holes, and SuperLock™ main beam clip for a strong secure connection and fast accurate alignment. Both ShortSpan and Drywall Main Beams are Heavy-duty performance per ASTM C635
      b. HD8906 - 12ft HD Drywall Main Beam 1-1/2 in
   2. Cross Tees: manufactured cross tee- 1-1/2" knurled face with ScrewStop™ reverse hem by 1-1/2 inches high with factory punched cross tee routs and hanger wire holes and XL stake on clip for a strong secure connection.
      a. XL8945P - 4ft Drywall Cross Tee
      b. XL8965 – 6ft Drywall Cross Tee
   3. Hanger wire: a Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least time three times the design load, but not less than 12-gauge.
   4. Fasteners (for Panel attachment)
      a. #6 x1-1/4” Fine thread or sharp point self-drilling drywall screws
      b. Grip-Plate Washer for ACOUSTIBuilt panels (1-1/4”diameter) - #2119
   5. Perimeter Systems

a. Commercial quality extruded aluminum alloy 6063 trim channel, factory finished in baked polyester paint. Commercial quality galvanized steel unfinished T-bar connection clips; galvanized steel splice plates.
   (1) Color: White
   (2) Size: 120 in X 4 in (also available in 6")
   (3) Recycle Content: Post-Consumer - 50% Pre-Consumer - 0%
   (4) Acceptable Product: AXIOM One Piece for Drywall, 4in Straight – AX1PC4STR or Curved AX1PC4CUR as manufactured by Armstrong World Industries

b. Axiom Trim Channel:
   (1) AX4STR 4in Axiom Classic Straight
   (2) AX1PC4STR 4IN One –Piece Drywall Trim

c. Axiom Bottom Trim with taping flange
   (1) AXBTASTR – Bottom Trim for ACOUSTIBuilt (also available in curved)

d. Axiom Accessories:
   (1) AXSPLICE - Splice Plate

D. Material Ingredient Transparency: Health Product Declaration (HPD); Declare Label
E. Life Cycle Assessment: Third Party Certified Environmental Product Declaration (EPD)

PART 3 - EXECUTION

3.01 Prior to installation, contact your Armstrong Installation Systems Specialist (ISS). Before installation, inspect previous work of all other trades. Verify that all work is complete and accurate to the point where this installation may properly proceed in strict accordance with framing shop drawings.

3.02 If framing preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.03 The system installation is similar to a conventional drywall installation. However, there are key differences in both material substrate and methods of finishing and installation that make this system unique. Installers should review and follow all written directions of the installation instructions and view the installation video. Click to follow to video access.

3.04 Installation: In accordance with all approved plans, details, and manufacturer's installation guidelines located in the Armstrong ACOUSTIBuilt Assembly and Installation Instructions (BPLA-299099) Click to follow to ACOUSTIBuilt Installation Instructions, and Drywall Grid Systems Hanging and Framing Flat Ceilings Installation Guides (BPCS3539) Click to follow to Hanging and Framing Flat Drywall Instructions.

A. Install seismic components if required by the building code. Seismic components to be specified on the architectural plans by the project engineer or design team.
B. Suspend main beam from overhead construction with hanger wires spaced 4-0 ft. or 6-0 ft. on center along the length of the main runner. Install hanger wires plumb and straight.
C. Cross tees shall be installed 16" on center
D. Install wall moldings/perimeter trim at intersection of suspended ceiling and vertical surfaces
E. Main runners and cross tees shall be attached at perimeter conditions
F. When determining the grid layout, consider the long edges of the boards must run parallel with the cross tees.
G. This system relies on a square grid system to ensure panel edges align at centers of cross tees. If the installation does not meet these squareness requirements, the panel edges may run off the grid system.
H. The system must be square to within 1/8" over a 48" x 48" module.
I. The suspension system must be leveled to within 1/4" in 10'.
J. Floating perimeters must be trimmed with either Axiom® One-Piece Drywall Trim or Axiom® Classic with Bottom Trim for ACOUSTIBuilt™. Refer to the installation instructions for integration with ACOUSTIBuilt installations.

3.05 PREPARATION

A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.
B. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.
C. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

3.06 INSTALLATION

A. Follow manufacturer installation instructions. Armstrong ACOUSTIBuilt Assembly and Installation Instructions (BPLA-299099)
B. Controls joints are required following the standards used for gypsum board listed in ASTM C840, Section 20
   1. Ceilings with perimeter relief cannot exceed 50 LF and 2500 SF between control joints
   2. Ceilings without perimeter relief cannot exceed 30 LF and 900 SF between control joints
C. Panel joints and fasteners are finished with tape and compound to create a flat surface. While the materials used to finish ACOUSTIBuilt panels are also used to finish drywall, the procedure has unique requirements.
D. Joint compound coverage shall be limited to preserve the acoustical performance of the panels. Compound at panel joints shall not exceed 8 inch widths. Compound applied to field fasteners shall not exceed 4 inch by 4-inch areas. All compound shall be smooth and free of tool marks and ridges. Panels are to be finished with taping knives. Production tools, including boxes, are not permitted.

E. Sanding and inspection: Throughout the sanding process, inspect the surface frequently for flatness. Direct a light across the ceiling to highlight unevenness that requires attention.
F. Fine Texture Finish shall be applied in 4 coat process (additional coat may be used to achieve the desired finish) as called out in the installation instructions. Fine Texture Finish for ACOUSTIBuilt is applied in multiple coats, layered to achieve a uniform appearance and acoustical performance. It is strongly encouraged to practice spraying to ensure proper calibration and technique are achieved. Refer to the installation video.
    1. Must be applied with an air assist spray system (refer to manufacturers installation instructions for required equipment). The Fine texture finish is not intended for use with airless spay or to be manually applied by rolling.
    2. See Manufactures installation instructions for correct pressure settings for spray system, finish preparation, spray calibration and spray procedure and technique.

3.07 ADJUSTING AND CLEANING

A. To remove soot, dirt, and dust use a vacuum operating at low power with a soft brush or use a dry soot cleaning sponge.
B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any ceiling products that cannot be successfully cleaned and or repaired. Replace with attic stock or new product to eliminate evidence of damage.
C. Before disposing of ceilings, contact the Armstrong Recycling Center at 877-276-7876, select option #1 then #8 to review with a consultant the condition and location of building where the ceilings will be removed. The consultant will verify the condition of the material and that it meets the Armstrong requirements for recycling. The Armstrong consultant with provide assistance to facilitate the recycle of the ceiling.

END OF SECTION 09 54 00

SECTION 09 54 26 – SUSPENDED WOOD CEILINGS

PART 1 - GENERAL

1.01 Work Included: Provide suspended panelized wood slat ceilings as shown on drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents.

1.02 SECTION INCLUDES

A. Panel Grill Ceiling Panels

1.03 RELATED SECTIONS

A. Section 21 00 00 Fire Suppression
B. Section 26 50 00 Interior Lighting

1.04 REFERENCES

A. ASTM E 84 – TITLE; 2001
B. FSC STD-01-001 – FSC Principals and Criteria for Forest Stewardship
C. FSC STD-40-004 – FSC Standard for Chain of Custody Certification
D. U.S. Green Building Council, LEED Building Design and Construction (BD+C), Version 4.0 Rating System (LEED v4.0)

1.05 DESIGN AND PERFORMANCE REQUIREMENTS

A. Suspension System: Rigidly secure acoustic ceiling system including integral mechanical and electrical components with maximum deflection of 1:360.
B. Wood is a natural product that will undergo changes with variations in the environment. Therefore, all dimensional tolerances are plus or minus 1/8 inch (3 mm).
C. Fire Performance Characteristics: Suspended wood ceilings shall conform to Class 1, or A flame spread rating, tested according to ASTM E 84; Flame Spread: 25 or less. Smoke Developed: 450 or less.
D. Certified Wood: Suspended wood ceilings shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification

1.06 LEED PERFORMANCE REQUIREMENTS

A. Regional Materials: Location of manufacturer and point of extraction, harvest, or recovery for each raw material must be within 100 miles of project site for credit.
B. Recycled Content: Provide materials with a minimum of 10% recycled or reused content.
C. VOC Emissions Evaluation: For integrated ceiling assemblies, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
D. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.
E. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.07 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Regional Materials: For regional materials, indicate location of material manufacturer and point of extraction, harvest, or recovery for each material (this includes components of the mix design). Include distance to Project and cost for each regional material.
C. Recycled Content:Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide itemized material costs excluding labor.
D. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
E. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.
F. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable.

1.08 SUBMITTALS

A. Certified Wood: Suspended wood ceilings shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
C. Shop Drawings: Provide layout of suspended wood ceiling and T-rails coordinated with other trades that will penetrate the wood ceiling or interfere with the installation and recessed or surface mounted devices located within the ceiling panels. Indicate method of suspension where interference exists.
D. LEED Submittals: Provide documentation of how the requirements of Credit will be met:
   1. LEED v4.0: Suspended wood ceilings may contribute as required to the following LEED v4 credits: MR BPD&O - Sourcing of Raw Materials, MR BPD&O - Material Ingredients, EQ Low-Emitting Materials, EQ Minimum Acoustic Performance.
E. Selection Samples: For each finish product specified, two complete sets of color brochures representing the manufacturer's full range of available colors and patterns.
F. Verification Samples: For each finish product specified, two samples, minimum size 12 inches (305 mm) square, representing actual product, color, and patterns.
G. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
H. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic checking and adjustment and periodic cleaning and maintenance of all components.

1.09 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
B. Installer Qualifications: Minimum 2 years documented experience installing projects of similar size and complexity.
C. Provide seismic design of suspended ceiling under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location as requried.
D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish areas designated by Architect.
   2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
   3. Refinish mock-up area as required to produce acceptable work.
   4. Accepted mock-ups shall be comparison standard for remaining Work
E. Pre-Installation Conference: Convene minimum two weeks prior to starting work of this section. Agenda shall include project conditions, coordination with work of other trades, and layout of items that penetrate ceilings.

1.10 DELIVERY, STOARGE, AND HANDLING

A. Deliver material in the manufacturer's original, unopened, undamaged containers with identification labels intact.
B. Store products off the floor in manufacturer's unopened packaging protected from exposure to harmful environmental conditions and at temperature and humidity conditions as recommended by the manufacturer.
C. A minimum of 72 hours prior to ceiling installation, suspended wood ceilings shall be stored in the room in which they will be installed. Temperature and humidity of the room during this period shall closely approximate those conditions that will exist when the building is occupied.
D. Handle materials to avoid damage.

1.11 SEQUENCING

A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.
B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.12 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
B. Plenums have proper ventilation, especially in high moisture areas with no excessive buildup of heat in the ceiling areas.
C. Space shall be fully enclosed with all exterior windows and doors in place, glazed, and weather-stripped. Roof is to be watertight, and all wet trades' work is to be completed, and thoroughly dry.
D. Mechanical, electrical, and other utility services above the ceiling plane shall be completed. No materials should rest against, or wrap around, the ceiling suspension components or connecting hangers.
E. Install only when the temperature and humidity closely approximate the interior conditions that will exist when the building is occupied. Heating and cooling systems shall be operating before, during, and after installation, with the humidity of the interior spaces maintained between 25 and 55 percent, and a temperature between 60 to 90 degrees F.

1.13 COORDINATION

A. Coordinate layout and installation of the wood slats ceiling systems with other work penetrating the ceiling including light fixtures, HVAC equipment, and fire suppression system components.

1.14 EXTRA MATERIALS

A. See Section 01 60 00 - Product Requirements.
B. Deliver materials for Owner's use in maintenance.

1. Provide 2% percent of each type actually installed including suspension system components for use by owner in building maintenance and repair.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Panel Grille as manufactured by Rulon International or an approved equal systems by one of the following manufacturers:

1. Architectural Ceiling Group (ACGI)
2. Armstrong
3. 9wood
    a. Requests for substitutions will be considered in accordance with provisions of Section 01 25 00.

2.02 MATERIALS – GENERAL

A. Wood is a natural product that will undergo changes with variations in the environment. Therefore, all dimensional tolerances are plus or minus 1/8 inch (3 mm).

2.03 PANEL GRILL CEILING PANELS

A. General: Standard Panel Grilles are 1 foot (305 mm) wide and in nominal lengths of 2 feet (610 mm) to 10 feet (3048 mm) in 1 inch (305 mm) increments. Actual lengths are 1 inch (25 mm) shorter to allow for a reveal between panels. Wood strips are fabricated without finger-joints, and fastened together with black dowels or woodbackers, depending on panel design. Dowels or woodbackers are positioned 5-1/2 inches (140 mm) from the ends and 12 inches (305 mm) on center, with interconnecting male-to-female dowel attachment or with overlapping woodbackers, depending on panel design for support of the system.

1. Profiles: Panel Size: As indicated on the Drawings
    a. Size:
        (1) Number of Blades per foot: _2___
        (2) Blade Thickness: __1 5/16”__
        (3) Depth of the Blades: _5 ¼”___
2. Doweled and wood-backed Panel Grilles
    a. Grilles consist of individual wood strips assembled in 12 inch widths in lengths up to 10 feet. Wood strips are drilled 12 inches on center, beginning 5-1/2 inch from each end. Woodbackers are attached to the back of grilles 12 inches on center, beginning 5-1/2 inch from each end. Dowels and woodbackers are positioned perpendicular to the wood strips. Panel Grilles are 1 inch under an even foot length. Dowels and woodbackers are generally furnished black to be hidden from view. Woodbacker clips are used to snap the Panel Grilles into place.
3. Blade Design: Standard Square Cut
4. Wood Species:
    a. WD GRL-1
        (1) Refer to Finish Schedule
    b. WD GRL-2
        (1) Refer to Finish Schedule
5. Finish:
    a. WD-GRL-1
        (1) Baffle: Refer to Finish Schedule
    b. WD GRL-2
        (1) Baffle: Refer to Finish Schedule

2.04 ACCESSORIES

A. Woodbacker Clips: Clips are spring-steel with phosphate pre-treatment and corrosion-resistant coating and are attached by fitting around the woodbacker and attaching to the grid system.
B. Sound Attenuation: Provide a flexible fiberglass wrapped duct liner with reinforced coating system as shown in Drawings as part of this system
    1. Basis-of-Design: “Linacoustic RC insulation, by Johns Mansville or equal

2.05 SUSPENSION SYSTEMS

A. Main Tees: Standard heavy duty 15/16 inch (24 mm) T-rail specified in Section 09 51 00 – Suspended Acoustical Ceilings.
B. Hangers; shall Suspend ceiling panels from T-rail using torsion springs, C-hangers, or direct screw attachment, as recommended by the manufacturer.

2.06 FABRICATION

A. Edges, borders, and perimeter trims shall be indicated on the Drawings in accordance with the manufacturer's standard design details. All suspended wood ceiling products specified shall be supplied by the wood slat ceiling manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.
B. Verify that T-rail carriers specified in Section 09 22 26 - Suspension Systems are in place, suspended and leveled in a direction perpendicular to the wooden strip direction of the wood panels.
C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.
B. Work shall not begin until the space is fully enclosed and glazed and all wet work is completed and dried out to the satisfaction manufacturer.
C. Temperature shall be at least 65 degrees Fahrenheit during the installation and thereafter.
D. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent construction, including the following:
    1. Comply with ASTM C 636 and seismic design requirements indicated.
    2. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
    3. Additional Hanger Wires: Wrapped tightly 3 full turns to structure and component at locations where imposed loads could cause deflection exceeding 1/360 span or tolerances specified below.
B. Use a laser leveling device to lay out and install the perimeter trim as specified.
C. Suspend panels from the T-rail carrier system as indicated.
D. Make final adjustments to level or contours as required.

3.04 ADJUSTMENTS AND CLEANING

A. Clean exposed surfaces of ceiling panel in accordance with manufacturer's instructions.
B. Remove and replace panels and tiles, which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.05 PROTECTION

A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

3.06 SCHEDULES

A. WD-GRL-1:
    1. Species: Refer to Finish Schedule
    2. Finish: Refer to Finish Schedule
    3. Wood Backing, Dowels and Wood Backer Clips: Refer to Finish Schedule
B. WD-GRL-2:
    1. Species: Refer to Finish Schedule
    2. Finish: Refer to Finish Schedule
    3. Wood Backing, Dowels and Wood Backer Clips: Refer to Finish Schedule

END OF SECTION 09 54 26

SECTION 09 65 13 – RESILIENT BASE AND ACCESSORIES

PART 1 - PROVIDE resilient base, where noted on the drawings and as specified herein.

1.01 RELATED SECTIONS

A. Section 018113 Certification Requirements.

1.02 LEED PERFORMANCE REQUIREMENTS

A. All hard flooring components must be FloorScore Certified.
B. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
C. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.
D. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan
E. Purchase product that has a Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, meets ANSI ANSI/BIFMA e3 Furniture Sustainability Standard, declared Manufacturer Inventory (MI), or Product Lens Certification.

1.03 LEED DOCUMENTATION REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Provide Floorscore Certificates for all flooring components.
C. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
D. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant
E. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.
F. Provide manufacturers Health Product Declaration (HPD), Cradle to Cradle certificate, Declare label, ANSI ANSI/BIFMA e3 Furniture Sustainability Standard documentation, Manufacturer Inventory (MI) documentation, or Product Lens Certification, as applicable.

1. FIRE PERFORMANCE CHARACTERISTICS: Provide resilient flooring materials meeting the following requirements as tested by UL or other testing agency acceptable to AHJ representatives, in accordance with the following ASTM requirements:
2. CRITICAL RADIANT FLUX: 0.45 watts per square CM or more per ASTM E 648.
3. SMOKE DENSITY: less than 450 per ASTM E 662.

1.04 PRODUCT DATA SUBMITTAL: Submit sample, specifications, installation instructions, and general recommendations from the manufacturer.

PART 2 - PRODUCTS

2.01 RESILIENT BASE:

A. 4" high rubber meeting ASTM F-1861, Group 1 –Type TP (thermoplastic rubber) with color uniform throughout the entire thickness of the material, flat, topset, type as required for compatibility with flooring material
B. Base color as selected by Architect from manufacturer's full range of color options and as called for in the Finish Schedule, and as manufactured by **ALL** the following manufacturers:

1. Basis of Design:

a. Johnsonite Monument Rubber Wall Base, by Johnson Rubber Co, Inc.
b. VPI Rubber Wall Base, by VPI Flooring Corp.

c. Burkebase Premium TS Molded Wall Base, by Mannington Commercial
d. Approved Manufacturer and Product substitution requests will be as called for in Section 01 25 00 and must include color matched samples for selected colors as called for in the Finish Schedule and to include any other specifications criteria called for in this Section.

2. All resilient base styles shall be Straight with no cove and as indicated in the Finish Schedule.

2.02 RESILIENT STAIR ACCESSORIES:

A. Rubber Stair Treads shall be homogeneous in construction of first quality materials, properly vulcanized, and shall be smooth and free of imperfections which detract from its appearance and contain no asbestos fiber. The Rubber Stair Tread shall conform fully to all the requirements of Standard Specification ASTM F-2169, Type TS.
B. Base color as noted on Finish Legend or as selected by the Architect from manufacturer's full range of color options:
1. Basis of Design:
a. Roppe Corporation, USA
b. Nosing Type: #15 double flange carpet stair nosing with smooth surface and 3/8" bugging gauge

2.03 ADHESIVES (Cements): Latex water-resistant type or as recommended by recommended by base manufacturer to suit resilient base products and substrate conditions indicated.

PART 3 - EXECUTION

3.01 EXAMINE AREAS where installation of resilient base will occur, with Installer present, to verify that substrates and conditions are satisfactory for resilient base installation and comply with tile manufacturer's requirements and those specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARE SUBSTRATES according to Manufacturer's instructions to ensure proper adhesion of resilient wall base.

3.03 FILL CRACKS, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

3.04 MOVE RESILIENT PRODUCTS AND INSTALLATION MATERIALS into spaces where they will be installed at least 48-hours in advance of installation.

A. Vacuum clean substrates to be covered by resilient products immediately before installation.

3.05 INSTALLATION OF BASE: Apply wall base to walls, columns, pilasters, casework and other permanent fixtures in rooms or areas where base is required as shown on Drawings and as follows:

A. Install base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
B. Do not stretch resilient base during installation.
C. Inside and Outside Corners:
1. Manufactured or Pre-formed Corners:
a. Install manufactured or pre-formed corners before installing straight pieces if available.
2. Job-Formed corners:
a. Outside Corners: Form by bending without producing discoloration (whitening) at bends.
b. Inside Corners: Butt one piece to corner and then carefully scribe the next piece to fit without any gaps.
D. Tightly bond base to substrate throughout length of each piece.

3.06 INITIAL CLEANING: Immediately after completing tile installation remove visible adhesive and other surface blemishes using cleaner recommended by manufacturers. Remove any excess adhesive or other surface blemishes, using appropriate cleaner recommended by manufacturer.

END OF SECTION 09 65 13

SECTION 09 66 23 – THIN SET EPOXY TERRAZZO FLOORING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Thin-set epoxy terrazzo flooring including preparation of substrates.
2. Thin-set precast epoxy terrazzo tread or tread & riser units.
3. Thin-set precast epoxy terrazzo wall base units.
4. Related accessories.

B. Related Sections:

1. Section 03300, Cast In Place Concrete.
2. Section 04200, Unit Masonry.
3. Section 05510, Metal Stairs.
4. Section 07260, Under-slab Vapor Retarder/Barrier.
5. Section 07900, Joint Sealants.
6. Section 09900, Painting.
7. PREINSTALLATION MEETINGS

1.03 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: Resinous Flooring products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For resinous flooring products, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Paints and Coatings Applications, as per the California Air Resource Board (CARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings or South Coast Air Quality Management District (SCAQMD) Rule 1113, effective February 5, 2016. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints and coatings.

1.04 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 -2010 or CDPH Standard Method v1.2-2017.

C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealants.

1.05 SUBMITTALS, SHOP DRAWINGS , AND SAMPLES

A. Product Data: For each type of product.

B. Include terrazzo installation requirements. Include plans, elevations, sections, component details and attachments to other work. Show layout of the following:

1. Divider strips.
2. Control and expansion joint strips.
3. Base and border strips.
4. Abrasive strips.
5. Stair treads, risers and landings.
6. Pre-cast terrazzo jointing and edge configurations including anchorage details.
7. Terrazzo patterns.

C. Samples for initial selection from Terrazzo & Marble Supply color plates, or approved equal, showing the full range of colors and patterns available for each terrazzo type indicated.

D. Samples for Verification: Match architect's samples for each type, material, color and pattern of terrazzo and accessory required showing the full range of color, texture and pattern variations expected. Label each terrazzo sample to identify Terroxy Resin System's, or approved equal, matrix color and aggregate types, sizes and

proportions. Prepare samples of same thickness and from same material to be used for the work in size indicated below:

1. Epoxy terrazzo: minimum 6” x 6” (152.4 mm x 152.4 mm) sample of each color and type of terrazzo.
2. Precast epoxy terrazzo: minimum 6” x 6” (152.4 mm x 152.4 mm) sample of each color and type of terrazzo.
3. Accessories: 6” length (152.4 mm) of each kind of divider strip, stop strip and control joint strip required.
4. Stair Treads: 12” length (304.8 mm) wide sample combination tread/riser with cast-in nosing.

E. MANUFACTURER EXPERIENCE

1. Submit proof of associate membership to NTMA.
2. Furnish a list of at least five (5) epoxy terrazzo projects using material being submitted for this project installed during the last five (5) years of the same scope, complexity and at least 50 percent of the square footage.
3. Engage an epoxy manufacturer with at least ten (10) years experience.

F. QUALIFICATION DATA FOR QUALIFIED INSTALLER

1. Submit proof of contractor membership in NTMA.
2. Furnish a list of at least five (5) epoxy terrazzo projects using material being submitted for this project installed during the last five (5) years of the same scope, complexity and at least 50 percent of the square footage.

G. MATERIAL TEST REPORTS

1. Provide test results for moisture and/or relative humidity of substrate prior to installation.

H. MAINTANENCE DATA

1. Submit 10 copies of NTMA maintenance recommendations and copies of manufacturer’s instructions.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who is acceptable to architect and epoxy terrazzo manufacturer to install manufacturer’s products.

a. Engage a terrazzo contractor with at least five (5) years of satisfactory experience in installation of epoxy terrazzo. Terrazzo contractor shall demonstrate experience during last five (5) years of at least five (5) projects of comparable scope and complexity of at least 50 percent of the total square footage of this project
b. Engage an installer who is a contractor member of NTMA.

B. Source Limitations:

a. Obtain primary Epoxy Terrazzo Flooring System materials including moisture treatment, membranes, primers, resins and hardening agents from a single manufacturer with proof of NTMA associate membership.
b. Obtain aggregates, divider strips, sealers and cleaners from source recommended by primary materials manufacturer.
c. Engage an epoxy manufacturer with at least ten (10) years experience as a NTMA associate member.

C. Pre-installation Conference: Conduct conference at project site to comply with requirements in Section 01200

1. – Project Meetings. Review methods and procedures related to terrazzo including, but not limited to, the following:

a. Inspect and discuss installation procedures, joint details, job site conditions, substrate specification, vapor barrier details and coordination with other trades.
b. Review and finalize construction schedule and verify availability of materials, installer’s personnel, equipment and facilities needed to make progress and avoid delays.
c. Review special terrazzo designs and patterns.
d. Review plans for concrete curing and site drying to enable timely achievement of suitable slab moisture conditions.

D. NTMA Standards: Comply with NTMA’s “Terrazzo Specifications and Design Guide” and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.

E. Mock-ups: Build mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mock-ups for terrazzo including accessories.

(1) Size: Minimum 100ft^2 (9.3m^2) of typical poured-in-place flooring and base condition for each color and pattern in locations directed by architect.

2. Approved mockups may become part of the completed work if undisturbed at time of substantial completion.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to project site in supplier’s original wrappings and containers labeled with source’s or manufacturer’s name, material or product brand name and lot number if any.

B. Store materials in their original, undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures and humidity.

1. Storage temperatures should be between 50ºF to 90ºF (10.0ºC to 32.2ºC).

1.08 PROJECT CONDITIONS

A. Prior to surface preparation, terrazzo contractor shall:

1. Evaluate slab condition, including slab moisture content and extent of repairs required, if any.

2. Maintain the ambient room and floor temperature at 60-90ºF (15.5-32.2ºC)or above for a period extending 72 hours before, during and after floor installation. Concrete to receive epoxy terrazzo shall have cured for at least 28 days and be free of all curing compounds. Test concrete substrate to determine acceptable moisture levels prior to installation. Testing should be conducted according to ASTM F2170 (determining relative humidity in concrete slabs using in situ probes). Proceed with installation only after substrates have a maximum relative humidity measurement reading less than 80%. If relative humidity measurement reading is greater than or equal to 80%, moisture vaport treatment is required. Apply to terrazzo substrates according to Manufacturer Data Sheets. An effective in situ probe for relative humidity testing is the RH BluePeg.

B. Prior to and during each day of installation, the terrazzo contractor shall verify that the dew point is at least 5ºF (-15ºC) less than the slab and air temperature.

C. Acceptable Substrates:

1. Level tolerance: Concrete sub-floor shall be level with a maximum variation from level of 1/4" in 10 feet (6.4 mm in 3.1m). Any irregularity of the surface requiring patching and/or leveling shall be done using manufacturer fills and selected aggregates as recommended by the Manufacturer's system.
2. Concrete floor shall be prepared mechanically by shot blasting in accordance with ICRI Guideline No. 03732. Specifically, surface preparation results should achieve a CSP3-CSP5 profile.
3. A light steel trowel is needed to provide an acceptable surface with minimum laitance.
4. Concrete shall be cured a minimum of 28 days. No curing agents are to be used in areas to receive terrazzo.
5. Concrete slab on grade shall have an efficient moisture vapor barrier (suggested minimum: 15 mils (.4 mm thickness)) directly under the concrete slab. Reference ASTM Methods E1745 Class A and installed in accordance with E1643. Moisture barrier shall NOT be punctured.
6. Saw cutting of control joints must be done between 12 and 24 hours after placement of the structural concrete and at a frequency compatible to ACI recommendations.

D. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

E. Provide protection from other trades prior to final acceptance by owner.

PART 2 - PRODUCTS

2.01 EPOXY TERRAZZO

A. Products: Systems Overview: The basis of design is Terroxy Resin Systems Epoxy Matrix by Terrazzo & Marble Supply Companies, Wheeling, IL (www.tmsupply.com).

1. Substitutions approved per Section 01 25 00, manufacturer's ability to meet all the requirements herein and ability to provide color matched samples matching basis-of-design samples.

B. Materials:

1. Primer: Terroxy Primer or Terroxy Moisture Vapor Treatment (for slabs on-grade, light weight concrete and green concrete).
   a. Physical properties of moisture mitigating primer shall have a maximum of 0.3 perms with 100% RH.
2. Flexible Reinforcing Membrane: Terroxy Iso-Crack Epoxy Membrane, for substrate crack preparation and reflective crack reduction.
   a. Reinforcement: Terroxy fiberglass scrim (optional).
3. Epoxy Matrix: Terroxy Epoxy Matrix and in color required for mix indicated.
   a. Physical properties without aggregates. All specimens cured for 7 days at 73-77ºF (22.8-25ºC) and 50 percent plus or minus 2 percent RH. This product shall meet the following requirements:

Property	Test Method	NTMA (TTMAC - Canada)	Terroxy Thin-set Epoxy Terrazzo
Hardness	ASTM D-2240 using Shore-D	60-85	75-85
Tensile Strength	ASTM D-638	3,000 a)	4,800 psi min. (33.1 MPa)
Compressive Strength	ASTM D-695 Specimen B cylinde	(68.9 MPa)	12,000 psi min. (82.7 MPa)
Flexural Strength	ASTM D-790	cified	4,500 psi min. (31.7 MPa)
Chemical Resistance	ASTM D-1308 seven room temperat immersion	No deleterious effects: • Distilled Water • Mineral Oil • Isopropanol • Ethanol • 0.025 Detergent Solution • 1% Soap Solution • 10% Sodium Hydroxide • 10% Hydrochloric Acid • 30% Sulfuric Acid • 5% Acetic Acid	No deleterious effects: • Distilled Water • Mineral Oil • Isopropanol • Ethanol • 0.025 Detergent Solution • 1% Soap Solution • 10% Sodium Hydroxide • 10% Hydrochloric Acid • 30% Sulfuric Acid • 5% Acetic Acid

FINAL MATRIX T.B.D.

b. Physical properties with aggregates. For Epoxy Matrix blended with three volumes of Valders marble blended 60% #1 chip and 40% #0 chip, ground and grouted with epoxy resin according to Installation Specifications, finishing to a nominal 3/8" (9.5 mm) thickness. All specimens cured for 7 days at 73-77ºF (22.8-25ºC) and 50 percent RH plus or minus 2 percent RH. This finished Epoxy Matrix shall meet the following requirements:

c.

Property	Test Method	NTMA (TTMAC - Canada) Requirements	Terroxy Thin-set Epoxy Terrazzo Typical Results
Flammability	ASTM D-635	Self extinguishing, extent of burning 0.25" (6.4 mm) max.	Self extinguishing, extent of burning 0.25" (6.4 mm) max
Thermal Coefficient of Linear Expansion	ASTM D-696	25x10-6 inches per inch per deg to 140ºF (11.4x10-7 cm	x10-6 inches per inch per degrees 40ºF (11.4x10-7 cm per cm per ºC to 60ºC
Bond Strength	ACI COMM 403, Bulletin 59-43 (pages 1139 1141)	300 oncrete	300 psi (2.1 MPa) -100% concrete failure
Critical Radiant Flux	ASTM		1.0 watts/cm²
Fire Rating - Test for Surface Burning Characteristics of Flooring	CAN/ULC S102.2-10 Tunnel Test		Smoke Developed Classification (SDC) - 175 Flame Spread Rating (FSR) - 5

FINAL MATRIX T.B.D.

4. Aggregates complying with NTMA gradation standards for mix indicated and containing no deleterious or foreign matter.
   a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131.
   b. 24-Hour Absorption Rate: Less than 0.74 percent.
   c. Dust Content: Less than 1.0 percent by weight.
   d. Pre-Consumer or Post-Consumer Recycled Content: <Insert Value> percent.
5. Finishing Grout: Terroxy Epoxy Matrix or Terroxy Clear Resin with a broadcast of filler as recommended by Terroxy Resin Systems.

C. Mix: Comply with NTMA's (TTMAC - Canada)"Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and aggregate proportions and mixing.
   1. Color and pattern schedule: Where the following designations are indicated, provide specified terrazzo matrices matching architect's samples:
      a. TRZ-1: Refer to Drawings

2.02 STRIP MATERIALS

A. Thin-set Divider Strips: L-type.
   1. Material selected from Domus Terrazzo full range.
   2. Guide for commonly used L-type divider strips for Thin-set Epoxy Terrazzo Systems:

System Height	Strip Height	Strip Width
3/8" System	3/8"	16 gauge 1/8" 1/4"

System Height	Strip Height	Strip Width
9.5 mm System	9.5 mm	16 gauge 3.2 mm 6.4 mm

2.03 MISCELLAENOUS ACCESSORES

A. Strip Adhesive: 100% solids epoxy resin adhesive recommended by Terroxy Resin Systems.
   1. Use adhesive that has a VOC content of 50g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Construction joints, contraction joints (Saw Cuts), isolation joints and cracks shall be detailed in accordance with NTMA technical bulletin T24

C. Patching and Fill Material: Terroxy Fill and selected aggregates as recommended by Terroxy Resin Systems.

D. Joint Compound: Terroxy Joint Filler Hardener to be used with Terroxy Resin Matrix Part A. Color to be selected by architect to match/compliment terrazzo flooring.

E. Cleaner: A neutral cleaner with pH factor between 7 & 10 specifically designed for terrazzo.
F. Surface Finish System: Level of polish to be specified by architect in accordance with desired appearance and level of reflectivity.
G. Sealer: Slip and stain-resistant sealer that is chemically neutral with a pH factor between 7 and 10, that meets a standard coefficient of friction of 0.5 or higher, as measured by the James Machine (ASTM D-2047 Test Method), does not affect physical properties of terrazzo and complies with NTMA's (TTMAC - Canada)" Terrazzo Specifications and Design Guide."
    1. T-Rx, high performance, high gloss, chemical-resistant urethane sealer.

2.04 PRECAST TERRAZO

A. Precast Terrazzo Units: Precast epoxy terrazzo stair tread units, and other locations as indicated in Drawings.
    1. All precast components to utilize products from single source manufacturer for fabrication to ensure color consistency with the poured in place flooring.
    2. Manufacturers: Subject to compliance with requirements, provided products acceptable to architect.
    3. Basis-of-Design Manufacturer: Terroxy Resin Systems or approved equal.
B. Terrazzo Cove Base:
    1. Terroxy Resin Systems Epoxy Matrix poured-in-place cover base with 3/8" (9.5mm) radius, 3/8", 4" (101.2 mm) high
C. Precast Terrazzo Stair Treads: Thickness indicated with cast-in nosing.
    1. Color and Pattern: Match architect's approved Terroxy Resin Systems Sample

PART 3 - EXECUTION

3.01

A. Examine substrates and areas, with Terrazzo Contractor present, for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions, including level tolerances, have been corrected.

3.02 PREPARATION

A. Clean substrates of substances, including oil, grease and curing compounds, that might impair terrazzo bond. Provide clean, dry and neutral substrate for terrazzo application.

B. Concrete Slabs:
    1. Provide sound concrete surface free of laitance, glaze, efflorescence, curing compounds, form- release agents, dust, dirt, grease, oil and other contaminants incompatible with terrazzo.
        a. Prepare concrete mechanically by shot blasting. Surface preparation results should achieve a CSP3-CSP5 profile according to International Concrete Repair Institute Guideline No. 03732.
        b. Repair or level damaged and deteriorated concrete according to Terroxy Resin Systems Technical Bulletin 008 Substrate Leveling Requirements for Terroxy Thin-set epoxy terrazzo.
        c. Repair cracks and non-expansion joints greater than 1/16" (1.6mm) wide according to NTMA Technical Bulletin T26 Crack Detailing and Joint Treatments for Terroxy Resin Thin-set epoxy terrazzo.
    2. Verify that concrete substrates are visibly dry and free of moisture.
    3. Moisture Testing:
        a. Test for moisture according to ASTM F2170 (determining relative humidity in concrete slabs using in situ probes). An effective in situ probe for relative humidity testing is the Blue Peg available from Terrazzo & Marble Supply.
        b. Proceed with installation only after substrates have a maximum relative humidity measurement reading less than 80%. If relative humidity measurement reading is greater than or equal to 80%, Terroxy Moisture Vapor Treatment is required. Apply to terrazzo substrates according to Terroxy Resin Systems Moisture Vapor Treatment Product Data Sheet.
C. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.
    1. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.03 EPOXY TERRAZZO INSTALLATION

A. General:
    1. Comply with NTMA's written recommendations for terrazzo and accessory installation.
    2. Place, rough grind, grout, cure grout, fine grind and finish terrazzo according to Terroxy Resin Systems Epoxy Matrix Product Data Sheet and NTMA's (TTMAC - Canada) "Terrazzo Specifications and Design Guide."
    3. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
    4. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
B. Thickness: [3/8" (9.5 mm)]

C. Flexible Reinforcing Membrane
   1. Membrane application for extensive cracking or crack prevention. Route out all cracks and fill with primer. Apply iso-crack epoxy membrane (spread at 40 mils = 1.0 mm thickness) over prepared substrate to produce full substrate coverage in areas to receive terrazzo.

D. Primer: Apply to terrazzo substrates according to Manufacturer's Product Data Sheet.

E. Strip Materials:
   1. Divider and Accessory Strips:
      a. Install strips in adhesive setting bed without voids below strips.
      b. Construction joints, contraction joints (Saw Cuts), isolation joints and cracks shall be detailed in accordance with NTMA technical bulletin T24.

F. Placing Terrazzo:
   1. Mix epoxy matrix with chips and fillers in ratios directed by Manufacturer.
   2. Trowel apply terrazzo mixture over epoxy primer to provide a dense flat surface to top of divider strips. Allow to cure per Manufacturer's recommendations before rough grinding.

G. Rough Grinding: Grind with 24 grit silicon carbide or 24 grit turbo diamonds until all terrazzo strips and marble chips are uniformly exposed.

H. Grouting:
   1. Cleanse floor with clean water and rinse.
   2. Remove excess rinse water by wet vacuum, dry and fill voids with Terroxy Resin Systems Epoxy Matrix or Clear Resin with a broadcast of filler.
   3. Allow grout to cure. Grout may be left on terrazzo until other trades work is completed.

I. Polishing: Polish with 120 grit T&M Resin Pads or equivalent stones until all grout is removed from surface. Produce surface with a minimum of 70 percent aggregate exposure.

3.04 PRECAST TERRAZZO INSTALLATION

A. Install precast units using method recommended by NTMA (TTMAC - Canada) and manufacturer unless otherwise indicated.

B. Seal joints between units with joint sealants.

3.05 CLEANING AND PROTECTION

A. Cleaning: Remove grinding dust from installation and wash all surfaces with a neutral cleaner with a pH factor between 7-10. .

B. Sealing: Apply TRx sealer that is chemically neutral with a pH factor between 7 and 10, that meets a standard coefficient of friction of 0.5 or higher, as measured by the James Machine (ASTM D-2047 Test Method), does not affect physical properties of terrazzo and complies with NTMA's

C. Protection: Upon completion, the work shall be ready for final inspection and acceptance by the owner or his agent. Provide final protection and maintain conditions, in a manner acceptable to terrazzo contractor, that ensure terrazzo is without damage or deterioration.

END OF SECTION 09 66 23

SECTION 09 68 00 – CARPETING

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide carpeting, and all accessory materials, where indicated in the Drawings, as required herein, and as necessary for a complete and proper installation. The Work includes leveling and patching of concrete floors, procurement and installation of carpeting, providing carpet cushion and adhesive for double-stick glue-down installation, and providing associated carpet accessories.

1.02 REFERENCED STANDARD: "Carpet Specifiers' Handbook" by The Carpet and Rug Institute; complete with recommendations which can be reasonably applied to types of carpeting work required.

1.03 RELATED SECTIONS

A. Section 018113 Certification Requirements.

1.04 LEED PERFORMANCE REQUIREMENTS

A. All flooring components must be CRI Green Label Plus.
B. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
C. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.
D. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.

1.05 LEED DOCUMENTATION REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. Provide CRI Green Label Plus Certificates for all flooring components.
C. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
D. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant
E. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan..

PART 2 - PRODUCTS

2.01 CARPET MATERIAL: Refer to Drawings for manufacturers, product/series, and colors

A. Substitutions for products and manufacturers called for in Drawings approved only per Section 01 25 00.

2.02 CARPET-TILE MARKING: Mark each carpet tile according to style, color, pattern, pile direction and dye lot. Registration shall be precise so that no pattern mismatch is evident after installation. Definition of pattern shall be sharp with no halo or bleeding of color; match definition quality of accepted samples. Consistency shall be such that any tile shall be interchangeable with any other tile, within a dyelot, with no visual difference in color of base shade or overprint.

2.03 RELATED CARPET ACCESSORIES:

A. RESILIENT CARPET EDGE: Refer to Drawings and Specifications Section 09 65 13 for manufacturers, product/series, and colors.
   1. Substitutions for products and manufacturers called for in Drawings approved only per Section 01 25 00.
B. METAL CARPET EDGE: Refer to Drawings for manufacturers, product/series, and colors.
   1. Substitutions for products and manufacturers called for in Drawings approved only per Section 01 25 00.
C. LEVELING COMPOUND: Latex type as recommended by carpet manufacturer compatible with adhesive and curing/sealing compound on concrete.

D. INSTALLATION ADHESIVE: Water-resistant, non-staining as recommended by carpet manufacturer, which complies with flammability requirements for installed carpet.
E. CARPET CUSHION ADHESIVE: Use adhesives for carpet pads that have a VOC content less than 50 g/L (per 40 CFR 59, Subpart D - EPA Method 24).
   1. Double-stick Carpet Adhesive (except as otherwise required by manufacturer):
      a. “SS-5” ("Safe-Set"), by Chicago Adhesive Products, Co. (800-621-0220)
      b. “Parabond” Dubl-Stik DS-902, by Para-Chem, Inc. (800-763-7272)
      c. “ECO 220”; by Mapei Corp. (800-426-2734)
F. SEAMING CEMENT: Hot-melt seaming adhesive or similar product recommended by carpet manufacturer, for taping seams and butting cut edges at backing to form secure seams and prevent pile loss at seams.
G. MISCELLANEOUS MATERIALS: As recommended by manufacturers of carpet, cushions and other carpeting products; selected by Installer to meet project circumstances and requirements.

PART 3 - INSTALLATION

3.01 PRE-INSTALLATION REQUIREMENTS AND PREPARATORY WORK:

A. MEASURE CAREFULLY AND CHECK DIMENSIONS and other field conditions to insure proper fit in the areas designated. Examine areas and conditions under which the Work of this Section will be performed. Do not proceed if conditions exist that are detrimental to proper and timely completion. Commencement of this Work will be construed as acceptance of existing conditions or prior work by others, and assumption of responsibility for satisfactory installation.
B. EXAMINE CONCRETE SUBFLOORS to verify that concrete slabs comply with ASTM F 710 and the following:
   1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet[cushion] manufacturer.
   2. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
C. EXAMINE WOOD SUBFLOORS to verify that the underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
D. SURFACE PREPARATION AND PATCHING: All surfaces to receive carpet shall be clean and dry. Cracks 1/16" or more, holes, unevenness and roughness must be filled, leveled and made smooth with a compatible latex floor patching compound. Prior to filling, the floor must be swept clean. Feather a minimum of 4'-0" where filling or leveling is required. After filling allow filler to dry. Damp mop the floor with warm water and allow to dry. Vacuum after mopping.

3.02 GENERAL INSTALLATION: Comply with manufacturer's recommendations for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. Provide cut-outs where required, and bind cut edges properly where not concealed by protective edge guards or overlapping flanges. Extend carpet under open-bottomed obstructions and under removable flanges and furnishings, and into alcoves and closets of each space. Install carpet edge guard where edge of carpet is exposed; and anchor guards to substrate. At doors, center seams under doors; do not place seams in traffic direction at doorways. Do not bridge building expansion joints with continuous carpeting – provide for building movement.

A. VACUUM FLOORS again immediately before installation of carpeting. Check concrete surfaces to insure that no "dusting" through installed carpet will occur.
B. GLUE-DOWN INSTALLATION:
   1. COMPLY WITH CRI 104 and the carpet and carpet cushion manufacturers' written installation instructions for the following:
      a. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."
      b. Double-Glue-Down Installation: Comply with CRI 104, Section 10, "Double Glue-Down Installation."
      c. Stretch-in Installation: Comply with CRI 104, Section 12, "Stretch-in Installation."
      d. Stair Installation: Comply with CRI 104, Section 13, "Carpet on Stairs" for direct glue-down installation.
C. SEAM LOCATIONS: Layout cushion seams to be at right angle to carpet seams, or if not practical, shift cushion so that cushion joints are not less than one (1) foot from carpet seams. All cushion joints must be taped. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
D. APPLY ADHESIVE UNIFORMLY to substrate in accordance with manufacturer's instructions. Butt carpet edges tightly together to form seams without gaps. Roll entire carpet area lightly to eliminate air pockets and ensure uniform bond. Remove any adhesive promptly from face of carpet by method which will not damage carpet face.

3.03 CARPET-TILE INSTALLATION:

A. CUT AND INSTALL CARPET TILE in accordance with the manufacturer's recommendation, using the tools designed for the carpet being installed. Butt edges together with the proper pressure to produce the tightest joint possible without distortion. Align all carpet tiles where they meet and use leveling compound where necessary. Within each continuous carpet area, install tiles from same dye lot. After installation, any carpet tiles within a continuous carpet area exhibiting a difference in appearance due to color or light reflectance variation will be rejected.
B. INSTALL ALL CARPET TILE with pile lay in the same direction – with the arrows in one direction, as applicable.
C. TOLERANCE: The accumulated space gained as a result of loose joints shall not be greater than 1/4 inch measured over eleven (11) tiles.
D. LOCATE central point of the room in both width and length measured from the principle walls. Lay out a grid system parallel to the partitions for control grid anchor lines. Lines of the control grid system shall be at right angles and

shall be checked as specified by the carpet manufacturer's installation requirements. Spacing of the control grid system shall be determined by the carpet manufacturer for the use expected in the carpet area. Carpet tiles shall be installed with adhesive at the control grid anchor lines as recommended by the carpet manufacturer showing recommended control grid anchor areas and carpet starting point (minimum at all column center lines).

E. INSTALL CARPET TILES in the following locations with 100% adhesive coverage:
   1. Perimeters of spaces.
   2. All cut tiles.
F. APPLY ADHESIVE STRIP along each side of feeder duct covers to anchor carpet tiles adjacent to cover plates.
G. SPREAD ADHESIVE using a roller with 1 inch nap or with trowel as applicable.
H. CHECK TIGHTNESS of the joints as work progresses and adjust as necessary. Align and butt joints according to carpet manufacturer's instructions.

3.04 CLEANING AND PROTECTION:

A. ON COMPLETION of the installation in each area, all dirt, carpet scraps, etc., must be removed from the surface of the carpet. Any soiling spots or excessive adhesive on the carpet shall be removed with the proper spot remover.
B. DO NOT walk on or move furniture onto carpet surface until installed area has all carpet tiles anchored at the perimeter and control grid lines.
C. DO NOT allow construction traffic, other than as may be required to fit up specific carpeted areas, to traverse the completed work.
D. REMOVE DEBRIS, sorting pieces to be saved from scraps to be disposed of.
E. VACUUM CARPET using commercial machine with face-beater element. Remove spots and replace carpet where spots cannot be removed.
F. PROTECT CARPETING against damage during construction. Cover with 6-mil thick polyethylene covering with taped joints during the construction period, wherever protection is required, so that carpet will be without any indication of deterioration, wear, or damage at the time of acceptance. Damaged carpeting will be rejected. As the carpet is laid, remove all trimmings, excess pieces of carpet and laying materials from each area as it is completed.
G. PROTECT PATHS used for installation of fixtures and furnishings with tempered hardboard panels.
H. MAINTENANCE MATERIALS: Deliver specified extra stock and usable scraps of carpet to Owner's designated storage space, properly packaged (paper wrapped) and identified. Dispose of smaller pieces as "construction waste".
I. REMOVE debris, and sort pieces to be saved from scraps to be disposed of.
J. IMMEDIATELY PRIOR TO SUBSTANTIAL COMPLETION, vacuum carpet using commercial pile lifter of type recommended by carpet manufacturer. Remove spots and replace carpet where spots cannot be removed. Remove rejected carpeting and replace with new carpeting.

END OF SECTION 09 68 00

SECTION 09 72 00 – WALLCOVERING AND WALL GRAPHICS

PART 1 - GENERAL

1.01 THE WORK INCLUDES preparation of wall surfaces for installation of wallcovering, and installation of wallcovering materials, as specified herein and as needed for a complete and proper installation.

1.02 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants. .

1.03 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant

1.04 SUBMITTALS

A. SUBMIT PRODUCT DATA to include manufacturer's specifications and installation instructions for wallcovering and related items specified.

B. SUBMIT SAMPLES of each type of wallcovering required, in each specified pattern, color and construction.

C. SUBMIT MAINTENANCE INSTRUCTIONS as part of Operations and Maintenance manuals, including information needed for removal of common stains from each type of wallcovering required. Refer to Division-1 Sections for requirements of Operations and Maintenance Manuals.

1.05 DELIVER materials to project site in original packages or containers clearly labeled to identify manufacturer, brand name, quality or grade, and fire hazard classification.

1.06 EXTRA STOCK: Provide not less than 6 linear yards of each type of wallcovering installed. Furnish replacement materials from same production run as materials installed. Deliver extra stock and usable scraps of wallcovering to Owner's designated storage space, properly packaged and identified. Dispose of small pieces as "construction waste".

PART 2 - PRODUCTS

2.01 WALL COVERING MATERIALS: Refer to Drawings for manufacturer, materials and colors to be provided.

2.02 ADHESIVE: Provide manufacturer's recommended adhesive, primer, and/or sealer, produced expressively for use with selected wallcovering on existing substrate. Provide materials which are mildew resistant and non-staining to wallcovering.

PART 3 - EXECUTION

3.01 EXAMINATION & INSPECTION: Examine areas and conditions under which the Work of this Section will be performed. Do not proceed if conditions exist that are detrimental to proper and timely completion. Commencement of this Work will be construed as acceptance of existing conditions or prior work by others, and assumption of responsibility for satisfactory installation.

3.02 PREPARATION: Acclimatize wall covering materials by removing from packaging in area of installation not less than 24 hours before application. Remove switchplates, wall plates, and surface-mounted fixtures in areas where wallcovering is to be applied.

3.03 PRIME AND SEAL substrates in accordance with wall covering manufacturer's recommendations for type of substrate. Apply surface sealer to gypsum drywall which will permit subsequent removal of wall covering without damage to paper facing.

3.04 WALL COVERING INSTALLATION: Place wallcovering panels consecutively in order cut from rolls, including filling of spaces above or below openings. Hang by reversing alternate strips if necessary, except on match patterns. Apply adhesive to back of wallcovering and place in accordance with manufacturer's instructions. Install seams plumb, and at least 6" away from corners. Horizontal seams are not permitted. Overlap seams and double-cut to assure tight closure. Roll, brush, or use broad knife to remove air bubbles, wrinkles, blisters, and other defects. Cut wallcovering evenly to edges of wall penetrations. Trim salvages as required to assure color uniformity and pattern match.

3.05 CLEAN-UP: Remove excess adhesive along finished seams while it is still wet using warm water and clean sponge, and wipe dry. Replace removed plates and fixtures; verify cut edges of wall coverings and completely concealed. Remove surplus materials, rubbish, and debris resulting from wall covering installation upon completion of Work, and leave areas of installation in neat clean condition.

END OF SECTION 09 72 00

SECTION 09 84 00 – ACOUSTICAL WALL TREATMENT

PART 1 - GENERAL

1.01 PROVIDE Acoustical Wall Panels as shown on the drawings, as specified herein, and as needed to meet the requirements of the construction indicated in the Contract Documents.

1.01 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants used for installation, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.02 LEED DOCUMENTATION REQUIREMENTS

A. Complete the provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant

1.03 SUBMITTALS

A. SUBMIT PRODUCT DATA for each type of panel edge, core material, and mounting indicated.

B. SUBMIT SHOP DRAWINGS with dimensioned plans and elevations and large scale details to show the scope and extent of the Work. Indicate mounting details and devices; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Include elevations showing panel sizes and direction of fabric weave and pattern matching. Indicate panel edge and core materials. Show intersections with wall base, door / storefront / window frames, electrical outlets, switches, and other adjacent work

C. SAMPLES FOR VERIFICATION: Prepare 12 x 12 inch assembled sample panels of each color or panel type to be provided, complete with fabric finish(s), core material with edge treatment, and mounting devices to be used.

D. SUBMIT MAINTENANCE DATA to include in maintenance manuals, with fabric manufacturers' written cleaning and stain-removal recommendations.

1.04 QUALITY ASSURANCE

A. MANUFACTURERS QUALIFICATIONS

(1) Materials and systems shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least two (2) consecutive years and which can show evidence of those materials being satisfactorily used on at least three (3) projects of similar size, scope and location. At least three (2) of the projects shall have been successful for use two (2) years or longer.

(2) Manufactured panels must be produced from a minimum of 50% post-industrial recycle content.

(3) Manufacturer must offer a documented reclaim process that will take back, at the manufacturers cost, panels that are at their end-of life cycle.

B. FABRICATOR QUALIFICATIONS: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

C. SOURCE LIMITATIONS: Obtain acoustical wall panels through one source from a single manufacturer.

D. FIRE-TEST-RESPONSE CHARACTERISTICS: Provide acoustical wall panels with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to AHJ representatives:

(1) Flame-Spread Index: 25 or less.

(2) Smoke-Developed Index: 450 or less.

E. MOCKUP: Build mockup of each type or color of acoustical wall panel to be provided, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials, fabrication, and installation. Install mockup in the location and of the size indicated or, if not indicated, as directed by Architect. Undamaged mockups may be maintained as a part of the Work if approved by Architect.

1.05 DELIVERY, STORAGE, AND HANDLING

A. COMPLY WITH FABRIC AND ACOUSTICAL WALL PANEL MANUFACTURERS' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. DELIVER MATERIALS AND PANELS in unopened bundles and store in a temperature-controlled dry place with adequate air circulation. Protect panel edges from crushing and impact.

(1) Do not deliver Acoustic Finishes, components and accessories to Project site until areas are ready for installation.
(2) Store materials in a flat orientation in a dry place that is not exposed to exterior elements.
(3) Handle materials to prevent damage to finished surfaces. Provide protective coverings to prevent damage or staining following installation for duration of project.

C. ENVIRONMENTAL LIMITATIONS: Do not install acoustical wall panels until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

(1) Before installing Acoustic Finishes, permit them to reach room temperature.

1.06 FIELD MEASUREMENTS: Verify locations of acoustical wall panels by field measurements before fabrication and indicate measurements on Shop Drawings.

1.07 SPECIAL MANUFACTURER'S PRODUCT WARRANTY: Manufacturer's Special Warranty on polymer panel system: Manufacturer's standard form agreeing to repair or replace units that fail in material or workmanship within the specified warranty period.

A. Warranty Period: 1 year after the date of substantial completion.

B. The warranty shall not deprive the owner of other rights or remedies the Owner may have under other provisions of the Contract Documents and is in addition to and runs concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.08 FURNISH EXTRA MATERIALS as described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

A. Fabric: For each fabric, color, and pattern installed, provide length equal to10 percent (10%) of amount installed, but no fewer than 5 yards.

B. Acoustical Wall Panel Mounting Devices: Full-size units equal to 5 percent (5%) of amount installed, but no fewer than 25 attachment devices.

PART 2 - PRODUCTS

2.01 ACOUSTICAL WALL PANELS: Custom fabricated sound absorbing felt made from 50% minimum post-consumer recycled PET with textured 3d pattern(s):

A. MANUFACTURERS:

(1) **PET-1**: EZOBORD Acoustic PET Panels (www.ezobord.com)
(2) **PET-2**: AUTEX Industries Limited Acoustic PET Panel with overlay (https://www.autexacoustics.com/)
(3) **PET-3**: ACOUFELT Acoustic PET Panels (https://www.acoufelt.com/)

B. MATERIALS

(1) As indicated in Drawings with minimum performance requirements as follows:

(a) Recycled Rigid PET Felt
(b) Size: Various
(c) Thickness: 3/8"
(d) Substituitions: Products from other manufacturers must be approved by the Architect or Designer prior to bidding in accordance with the Instructions to Bidders and Section 01 60 00 "Product Requirements".

(2) Sheet minimum performance attributes:

(a) Noise Reduction Coefficient (ASTM C423) – 0.35
(b) Dynamic environmental testing (ASTM standards D 5116 and D 6670). Panels must not have detectable VOC off-gassing agents and must be have Greenguard™ Indoor Air Quality certified.
(c) Panels must be produced from a minimum of 50% post-industrial recycle content.

C. MISCELLANEOUS MATERIALS

(1) General: Provide products of material, size, and shape required for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
(2) Cleaner: Type recommended by manufacturer.

2.02 FABRICATE PANELS with pattern as specified in the drawings.

2.03 MOUNT using manufacturer provided installation system.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions where installation of Acoustic Finishes will occur, with Installer present, for compliance with manufacturer's requirements. Verify that substrates and conditions are satisfactory for installation and comply with requirements specified.

3.02 INSTALLATION

A. General: Comply with manufacturer's written instructions for the installation of Acoustic Finishes.
B. Utilize fasteners provided by manufacturer.
C. Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
D. We recommend that installation is completed by a 3form Certified Installer. Contact 3form for more information or to get a quote.

3.03 PROTECTION: Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that acoustical wall panels are without damage or deterioration at time of Substantial Completion.

3.04 REPLACE ACOUSTICAL WALL PANELS that cannot be cleaned and repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 09 84 00

SECTION 09 84 33 – SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

1.01 SUMMARY:

A. Section Includes:

(1) Sound-absorbing wall panels.

1.02 DEFINITIONS:

A. NRC: Noise Reduction Coefficient.
B. SAA: Sound absorption Average.

1.03 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project Site.

1.04 REFERENCES:

A. ASTM E 84 - Title; 2001.
B. FSC STD-01-001 - FSC Principles and Criteria for Forest Stewardship
C. FSC STD-40-004 - FSC Standard for Chain of Custody Certification
D. U.S. Green Building Council, LEED Building Design and Construction (BD+C)Version 4.0 Rating System. (LEED v4.0)

1.05 ACTION SUBMITTALS:

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

(1) Include fabric facing, panel edge, core material, and mounting indicated.
(2) Preparation instructions and recommendations.
(3) Storage and handling requirements and recommendations.
(4) Installation methods.

B. Shop Drawings:

(1) For sound-absorbing wall unit assembly and installation.

(a) Include plans, elevations, sections, and mounting devices and details.
(b) Include details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge profile and core materials.
(c) Include details at cutouts and penetrations for other work.
(d) Include direction of fabric weave and pattern matching.

(2) For flat veneer wall panel unit assembly and installation.

(a) Provide layout of wood wall panels, z-clips, and furring strips coordinated with other trades that will penetrate the wood walls or interfere with the installation and recessed or surface mounted devices located within the wall panels. Indicate method of attachments where interference exists.

C. Samples for Verification:

(1) For the following sound-absorbing wall unit products:

(a) Fabric: Full-width by approximately 36-inch long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
(b) Panel Edge: 12-inch- long Sample(s) showing each edge profile, corner, and finish.
(c) Core Material: 12-inch- square Sample at corner.
(d) Mounting Devices: Full-size Samples.
(e) Assembled Panels: Approximately 36 by 36 inches, including joints and mounting methods.

(2) For the following flat veneer panel products:

(a) For each finish product specified, two samples, minimum size 12 inches (305 mm) square, representing actual product, color, and patterns.
(b)

1.06 INFORMATION SUBMITTALS:

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

(1) Electrical outlets, switches, and thermostats.
(2) Items penetrating or covered by units including the following:

(a) Lighting fixtures.
(b) Air outlets and inlets.
(c) Speakers.
(d) Alarms.
(e) Sprinklers.
(f) Access panels.

(3) Show operation of hinged and sliding components covered by or adjacent to units.

B. Product Certificates: For each type of unit.
C. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
D. Sample Warranty: For specified special warranty.
E. LEED Submittals: Provide documentation of how the requirements of Credit will be met:
   (1) LEED v4.0: Wood wall panels may contribute as required to the following LEED v4 credits: MR BPD&O - Sourcing of Raw Materials, MR BPD&O - Material Ingredients, EQ Low-Emitting Materials.

1.07 CLOSEOUT SUBMITTALS:

A. Maintenance Data:
   (1) For each type of unit to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.
   (2) Provide manufacturer's maintenance instructions that include recommendations for periodic checking and adjustment and periodic cleaning and maintenance of all components.

1.08 MAINTENANCE MATERIAL SUBMITTALS:

A. See Section 01 77 00 “Closeout Procedures” for submission of maintenance material items.
B. For fabric unit products:
   (1) Extra Stock Material: Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      (a) Fabric: For each fabric, color, and pattern installed, provide length equal to 10 percent of amount installed, but no fewer than 10 sq. yd., full width of bolt.
      (b) Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than 5 devices, including unopened adhesives.
C. For flat veneer panel products:
   (1) Provide 5 percent of each type actually installed for use by owner in building maintenance and repair.

1.09 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
B. Installer Qualifications: Minimum 2 years documented experience installing projects of similar size and complexity.
C. Provide seismic design of suspended wall under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.10 DELIVERY, STORAGE, AND HANDLING:

A. For fabric unit products:
B. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
C. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.
D. For wood panel unit products:
   (1) Deliver material in the manufacturer's original, unopened, undamaged containers with identification labels intact.
   (2) Store products off the floor in manufacturer's unopened packaging protected from exposure to harmful environmental conditions and at temperature and humidity conditions as recommended by the manufacturer.
   (3) A minimum of 72 hours prior to wall installation, wood wall panels shall be stored in the room in which they will be installed. Temperature and humidity of the room during this period shall closely approximate those conditions that will exist when the building is occupied.
   (4) Handle materials to avoid damage.

1.11 FIELD CONDITIONS:

A. For sound-absorbing wall unit products:
   (1) Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
   (2) Lighting: Do not install units until a permanent level of lighting is provided on surfaces to receive the units.
   (3) Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.
   (4) Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication and indicate them on Shop Drawings.
B. For flat veneer panel products:
   (1) Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
   (2) Space shall be fully enclosed with all exterior windows and doors in place, glazed, and weather-stripped. Roof is to be watertight, and all wet trades' work is to be completed, and thoroughly dry.
   (3) Mechanical, electrical, and other utility services behind the wall plane shall be completed. No materials should rest against, or wrap around, the wall attachment components or connecting z-clips.
   (4) Install only when the temperature and humidity closely approximate the interior conditions that will exist when the building is occupied. Heating and cooling systems shall be operating before, during, and after installation,

with the humidity of the interior spaces maintained between 25 and 55 percent, and a temperature between 60 to 90 degrees F.

1.12 SEQUENCING:

A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.

B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.13 COORDINATION:

A. Coordinate layout and installation of the wood wall panels with other work penetrating the wall including light fixtures, HVAC equipment, and fire suppression system components.

1.14 WARRANTY:

A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.

(1) Failures include, but are not limited to the following:

(a) Acoustical performance.
(b) Fabric sagging, distorting, or releasing from panel edge.
(c) Warping of core.

B. Warranty Period: Manufacturers standard from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS:

A. Regional Materials: Verify materials were manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.

2.02 PERFORMANCE REQUIREMENTS:

A. Fire-Test-Response Characteristics: Units to comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

(1) Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

(a) Flame-Spread Index: 25 or less.
(b) Smoke-Developed Index: 450 or less.

(2) Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested in accordance with NFPA 265 Method B Protocol or NFPA 286.

B. Wood is a natural product that will undergo changes with variations in the environment. Therefore, all dimensional tolerances are plus or minus 1/8 inch (3 mm).

C. Fire Performance Characteristics: Wood wall panels shall conform to Class 1, or A flame spread rating, tested according to ASTM E 84; Flame Spread: 25 or less. Smoke Developed: 450 or less.

D. Certified Wood: Wood wall panels shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification

2.03 SOUND-ABSORBING WALL UNITS:

A. Sound-Absorbing Wall Panels: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back edge border of core.

B. Sound-Absorbing Wall Unit Type: PET-2.

(1) Basis-of-Design Product: Subject to compliance with requirements, provide Autex Acoustics; Quietspace Panel.

(a) Panel Shape: Flat.
(b) Mounting:
(i) Edge mounted with splines secured to substrate.
1. Finish Color at Exposed Edges: Match color of facing material.
(ii) Back mounted with manufacturer's standard metal clips.
(c) Core: Manufacturer’s standard.
(d) Edge Construction: Manufacturer's standard chemically hardened core with no frame.
(e) Edge Profile: Square.
(f) Corner Detail in Elevation: Square with continuous edge profile indicated.
(g) Reveals between Panels: Recessed.
(h) Fabric Facing: As indicated on Drawings.
(i) Acoustical Performance: Sound absorption NRC of not less than 0.85 in accordance with ASTM C423 for Type A mounting in accordance with ASTM E795.
(j) Nominal Overall Panel Thickness: 1 inch.
(k) Panel Width: As indicated on Drawings.
(l) Panel Height: As indicated on Drawings.

C. Sound-Absorbing Wall Unit Type: PET-3.

(1) Basis-of-Design Product: Subject to compliance with requirements, provided Acoufelt; Panel.

(a) Panel Shape: Facture, Diagonal.
(b) Mounting: Edge mounted with splines secured to substrate.
(c) Core: Manufacturer's standard.
(d) Edge Profile: Square.
(e) Corner Detail in Elevation: Square with continuous edge profile indicated.
(f) Panel Width: As indicated on Drawings.
(g) Panel Height: As indicated on Drawings.

2.04 FLAT VENEER WALL PANELS: WD-3.

A. Manufacturer: Rulon International, which is located at: 2000 Ring Way Rd.; St Augustine, FL 32092; Toll Free Tel: 800-227-8566; Tel: 904-584-1400; Fax: 904-584-1499; Email: request info (info@rulonco.com); Web:rulonco.com
B. Substitutions: Not permitted.
C. Materials, General: Wood is a natural product that will undergo changes with variations in the environment. Therefore, all dimensional tolerances are plus or minus 1/8 inch (3 mm).
D. Flat Veneer Panels are made with a face veneer applied to a 3/4 inch (19 mm) thick core material.

(1) Panel Size: As indicated on Drawings.
(2) Trim and Border Treatment: Provide end caps or junction trims as indicated.
(3) Veneer Species: As indicated in Finish Legend on Drawings.
(4) Finish: As indicated in Finish Legend on Drawings.

E. Accessories:

(1) Z-Clips: Male/female aluminum attachment clips, similar to a French cleat but with a thinner profile, used to hang wood wall panels on furring strips.

F. Attachment Systems:

(1) Furring Strips: Thin strips of fire-treated plywood or other non-combustible or limited combustible material shall be used in conjunction with fire treated or other non-combustible or limited combustible shims to level or raise z-clip attachment points so that, when installed, wood wall panels are flush and plumb.

2.05 FABRIC FACINGS:

A. Fabric from same dye lot; color and pattern as indicated on Drawings.
B. Fabric Facings Type: PET-2.
C. Basis-of-Design Product: Subject to compliance with requirements, provide Autex Acoustics, Vertiface.

(1) Color: As indicated on Drawings.
(2) Fiber Content: 100 percent polyester fibre.
(3) Width: As indicated on Drawings.

D. Fire-Test-Response Characteristics: Units to comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

(1) Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

(a) Flame-Spread Index: 25 or less.
(b) Smoke-Developed Index: 450 or less.

E. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested in accordance with NFPA 265 Method B Protocol or NFPA 286.

2.06 MATERIALS:

A. Verify wall materials comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
B. Recycled Content: per Division 1 LEED requirements.
C. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
D. Certified Wood: Verify product is certified as "FSC Pure" in accordance with FSC STD and FSC STD-40-004.
E. Core Materials: Manufacturer's Standard.
F. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:

(1) Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

2.07 FABRICATION:

A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
B. Edge Hardening: For glass-fiber board and mineral-fiber board cores, chemically harden core edges and areas of core where mounting devices are attached.

C. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.
   (1) Square Corners: Tailor corners.
   (2) Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

D. Edges, borders, and perimeter trims shall be indicated on the Drawings in accordance with the manufacturer's standard design details. All wood wall panel products specified shall be supplied by the wood wall panel manufacturer.

E. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:
   (1) Thickness.
   (2) Edge straightness.
   (3) Overall length and width.
   (4) Squareness from corner to corner.
   (5) Chords, radii, and diameters.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.
B. Verify that furring strips are in place, attached and shimmed in a direction parallel to the floor.
C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
D. Do not begin installation until substrates have been properly prepared. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Clean surfaces thoroughly prior to installation.
B. Work shall not begin until the space is fully enclosed and glazed and all wet work is completed and dried out to the satisfaction manufacturer.
C. Temperature shall be at least 65 degrees Fahrenheit during the installation and thereafter.
D. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION OF SOUND-ABSORBING WALL UNITS:

A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
C. Align fabric pattern and grain as indicated on Drawings.

3.04 INSTALLATION OF FLAT VENEER WALL PANELS:

A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent construction, including the following:
   (1) Comply with ASTM C 636 and seismic design requirements indicated.
B. Install furring strips attached and shimmed in a direction parallel to the floor.
C. Suspend panels from the z-clips as indicated.
D. Make final adjustments to level or contours as required.

3.05 INSTALLATION TOLERANCES:

A. Variation from Plumb and Level: Plus or minus 1/16 inch in 48 inches, noncumulative.
B. Variation of Joint Width: Not more than 1/16-inch in 48 inches, noncumulative.

3.06 FIELD QUALITY CONTROL OF FLAT VENEER WALL PANELS:

A. Technical Service: Manufacturer shall provide a local Technical Service Representative for on-site training and assistance during the installation process.
B. Environmental Monitoring: Manufacturer shall provide a temperature and humidity sensor to actively monitor the room in which the wood wall panels shall be installed for a minimum of one week before and up to two weeks after installation has been completed including all of the weeks in between.
C. Upon completion of wall installation, the owner's representative shall inspect all finished surfaces to ensure that the work has been completed in a manner satisfactory to the owner. Any deficiencies in the install of the wall shall be corrected prior to substantial completion.

3.07 CLEANING, ADJUSTMENTS, AND PROTECTION:

A. Clip loose threads; remove pills and extraneous materials.
B. Clean panels on completion of installation to remove dust and other foreign materials in accordance with manufacturer’s written instructions.
C. Protect installed products until completion of project.

D. Touch-up, repair or replace damaged products before Substantial Completion.
E. Clean exposed surfaces of wall panels in accordance with manufacturer's instructions.
F. Remove and replace panels and tiles, which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 84 33

SECTION 09 84 53 – ACOUSTICAL MULLION TRIM

PART 1 - GENERAL

1.01 PROVIDE sound-barrier mullion trims between drywall and curtainwall or storefront window framing, where indicated on the Drawings, as specified herein, and as needed to meet the requirements of the construction indicated in the Contract Documents. The Work of this Section includes:

A. Aluminum sound-barrier mullion trim caps

1.02 SUBMITTALS

A. SUBMIT PRODUCT DATA for each type of unit required.
B. SUBMIT SHOP DRAWINGS showing dimensioned cross-section(s) of required installation locations where drywall partition terminate at the curtainwall or storefront window framing, indicating mounting and other installation details required to maintain the rated sound tested assembly.

1.03 QUALITY ASSURANCE

A. SOURCE LIMITATIONS: Obtain units through one source from a single manufacturer.
B. MANUFACTURER QUALIFICATIONS: An entity producing aluminum extrusions and applying anodized finishes that is ISO-9001 Certified.
C. INSTALLER QUALIFICATIONS: An entity employing installers and supervisors who are trained and approved for use by the system Manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. DO NOT DELIVER units until spaces to receive them are clean, dry, and ready for their installation.
B. STORE UNITS in original undamaged packaging inside A well-ventilated area, protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.05 MANUFACTURER'S SPECIAL PRODUCT WARRANTY: Provide manufacturer's special warranty agreeing to repair or replace units that fail in materials or workmanship within the following time period. This warranty does not cover adjacent products or materials.

A. Warranty Period: Ten years limited warranty from date of Substantial Completion

PART 2 - PRODUCTS

2.01 ACOUSTIC MULLION TRIM: Provide an acoustically tested sound-barrier mullion trim system with capability to accommodate variations in adjacent surfaces, in sufficient additional length to allow for field trimming to required length to match variations in construction tolerances of adjacent systems.

A. Aluminum extrusions: 0.125 inch thick minimum in manufacturer's standard system profile to allow solid attachment and fastening to the partition wall framing.
B. Sound Absorbing Foam: resistant to smoke, flame and microbial growth, meeting ASTM E 84 Class 1 fire rating, and zero (0) rated fungi growth per ASTM G 21 testing.
C. Fasteners: self-tapping or appropriate threaded fasteners, compatible with all materials fasteners so not to cause galvanic corrosion.

2.02 BASIS-OF-DESIGN: "STC 55 Classic Mullion and Wide No-Mullion Trim Cap" – double sided, as manufactured by MULL-it-OVER Products, p: 616-730-2162, website: www.mullitoverproducts.com

A. Tested Acoustical Performance: Minimum tested STC rating of 55 for double-sided installation
B. Provide fire rated trim assembly as required.

2.03 Finish Color: match finish type and finish color of adjacent aluminum storefront or curtainwall framing.

PART 3 - EXECUTION

3.01 EXAMINE SUBSTRATES AND CONDITIONS with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance and installation of sound-absorbing ceiling units. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Measure and cut sound barrier wall end cap to proper lengths.
B. Notch around horizontal mullions, sills, or other obstructions leaving appropriate gap for differential movement between the sound barrier wall end cap and the obstruction.
C. Apply continuous bead of acoustical sealant to the acoustical foam surface that will be in contact with the drywall edge.
D. Place sound barrier wall end cap on the vertical surface of the drywall partition wall and loosely install fasteners in the top and bottom slotted holes of the wall end cap.
E. Plumb the wall end cap leaving recommended gap spacing between the interior glass surface and the wall end cap. Foam gasket to be in contact with glass.
F. Tighten top and bottom fasteners to secure end cap.
G. Install additional fasteners at 12 inches on center, minimum.
H. Install snap cover to conceal fasteners.
I. Apply sealant at all joints of dissimilar materials.

3.03 CLEANING: Clean units upon completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.

3.04 REPLACE UNITS that cannot be cleaned and repaired, in a manner approved by Architect. Protect units from damage during remaining construction operations, until Substantial Completion.

END OF SECTION 09 84 53

SECTION 09 91 00 – PAINTING

PART 1 - GENERAL

1.01 THE WORK INCLUDES surface preparation and painting or finishing of surfaces exposed to view, throughout the Project and in accordance with requirements herein. Paint or otherwise field-finish all exposed material surfaces throughout the project unless otherwise indicated to have no finish, or when materials are pre-finished or integrally-finished. Finish all exposed surfaces even if not specifically indicated on the Drawings.

A. Where items or surfaces are not specifically mentioned, paint the same as similar adjacent materials or areas.
B. Finish closets, alcoves, aisles, hallway and recessed areas without a room number with the same finishes as in the adjoining rooms or spaces.
C. Paint finish structural elements including columns, beams, joists, braces and decking - including applied fire-protection materials when applicable – except when concealed by ceilings, soffits, chases or other finished construction elements.
D. Paint finish mechanical and plumbing components when exposed to view, including HVAC units, ductwork, devices piping and valves – except when located within a mechanical room.
E. Paint finish exposed electrical & control panel enclosures of mechanical or electrical equipment and exposed conduits when not located within electrical or mechanical rooms.
F. Paint finish exposed concrete housekeeping pads and equipment bases with sealer and min 2-coat semi-gloss enamel paint, unless otherwise indicated.
G. Paint finish exposed metal including doors and frames, metal trim & guards, handrails & railings, bollards, equipment supports and similar items.

1.02 PAINTING NOT REQUIRED: Unless otherwise indicated, painting is not required on plastic laminate, prefinished sheet metal, plumbing fixtures, electrical equipment (excluding exposed distribution cabinet(s) or electrical devices. Painting is not required on surfaces such as walls or ceilings in concealed or inaccessible areas. Metal surfaces of anodized aluminum, stainless steel, chromium plate and similar finished materials will not require finish painting, except as otherwise indicated in the finish hardware schedule. Do not paint over code-required labels or equipment identification labels.

1.03 RELATED SECTIONS

A. Section 01 81 13 Certification Requirements.

1.04 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For paints and coatings, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
B. VOC content requirements for wet-applied products: For paints and coatings, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Paints and Coatings Applications, as per the California Air Resource Board (CARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings or South Coast Air Quality Management District (SCAQMD) Rule 1113, effective February 5, 2016. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints and coatings.
C. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.

1.05 LEED DOCUMENTATION REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant
D. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan..

1.06 SUBMITTALS

A. PRODUCT DATA: For each paint system specified. Include block fillers and primers associated with finish products.

B. MATERIAL LIST: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
C. MANUFACTURER'S INFORMATION: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
D. VOC CERTIFICATION: Certification by the manufacturer that products supplied comply with local regulations and LEED requirements controlling use of volatile organic compounds (VOCs).
E. SAMPLES FOR INITIAL SELECTION: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated. After color selection, the Architect will approve contractor provided color chips for surfaces to be coated.
F. SAMPLES FOR VERIFICATION: Of each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
    1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
    2. Provide a list of materials and applications for each coat of each sample. Label each sample for location and application.
    3. Submit Samples on the following substrates for the Architect's review of color and texture only:
    4. Ferrous Metal: Provide two 4-inch- square samples of flat metal and two 8-inch- long samples of solid metal for each color and finish.
G. LIST OF MOCKUP MATERIALS: List manufacturer’s product/color names, finishes, and other information as required to identify materials used. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents, unless such deviations are specifically brought to the attention of the Architect and approved in writing.
H. QUALIFICATION DATA: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.07 QUALITY ASSURANCE

A. PRODUCT STANDARDS: Comply with Master Painters Institute (MPI) standards indicated and provide products as listed in "MPI Approved Products List" available at www.paintinfo.com. Provide best quality grade of various types of coatings indicated as regularly manufactured by listed paint materials manufacturers. Materials not displaying manufacturers identification as a standard, best-grade product will not be acceptable.
    1. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.
B. SOURCE LIMITATIONS: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.
C. FINAL APPROVAL of colors will be from job-applied samples.
D. MOCKUP: Provide materials for construction of a field mockup of each different color and finish indicated. Before execution of the Work of this Section, finish the mockup to verify selections made under sample submittals and to demonstrate aesthetic effects. Refer to Division-01 Section Quality Requirements for general requirements of Mockup.
E. PROVIDE PRIMERS and undercoat paints produced by the same manufacturer as the finish coats. Use only thinners approved by paint manufacturer and use only within recommended limits.
F. PREPARE surfaces and apply coatings in strict accordance with the coating manufacturer's recommendations.
G. USE ONLY SKILLED painters for mixing and applying paint. Quality workmanship is required. In the acceptance or rejection of finish painting, no allowance will be made for the painters' lack of skill or in adequate lighting during painting operations.
H. DELIVER MATERIALS to job site in original, new and unopened packages and containers bearing manufacturer's name and label. Store materials not in actual use in tightly covered containers. Maintain containers used in storage of paint in a clean condition, free of foreign materials and residue. Keep storage area neat and orderly. Remove rags and water daily. Take all precautions to ensure that workmen and Work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.
I. JOB CONDITIONS: Apply paints only when temperature of surfaces to be painted and surrounding air temperatures are within recommended range permitted by the paint manufacturer's printed instructions. Do not apply paint when relative humidity exceeds 85%, or to damp or wet surfaces.
J. FURNISH EXTRA PAINT MATERIALS from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.
K. QUANTITY: Furnish the Owner with an additional 5 percent, but not less than 1 gal. or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.01 PAINT TYPES: Refer to Paint Schedule at end of this Section for material specifications per applications involved and refer to Drawings for paint colors to be provided.

2.02 MATERIAL COMPATIBILITY: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.03 MATERIAL QUALITY: Provide best quality grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturers identification as a standard, best-grade product will not be acceptable.

PART 3 - EXECUTION

3.01 EXAMINE SUBSTRATES, AREAS, AND CONDITIONS, with the Applicator present, under which painting will be performed for compliance with paint application requirements.

3.02 DO NOT BEGIN TO APPLY PAINT until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.03 COORDINATION OF WORK: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

3.04 NOTIFY THE ARCHITECT about anticipated problems using the materials specified over substrates primed by others.

3.05 PREPARATION

A. SURFACE PREPARATION: Clean surfaces of dirt, rust, scale, grease, moisture, or other conditions otherwise detrimental to formation of a durable paint film. Perform preparation and cleaning procedures in accordance with paint manufacturer's printed instructions for each particular substrate condition.

B. REMOVE hardware, accessories, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.

C. PROVIDE BARRIER COATS over incompatible primers or remove and reprime.

D. CLEAN WOOD SURFACES of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer before application of primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.

E. PRIME, STAIN, OR SEAL WOOD to be painted immediately upon delivery. Prime edges, ends, faces, undersides, and backsides of wood, including cabinets, counters, cases, and paneling. When transparent finish is required, backprime with spar varnish. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately upon delivery or after installation, if unit is cut in the field.

F. FERROUS METALS: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.

1. Blast steel surfaces clean as recommended by paint manufacturer and according to requirements of SSPC-SP 10.
2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
3. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.

G. GALVANIZED SURFACES: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

H. TOUCH UP SHOP-APPLIED PRIME COATS that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.

3.06 MATERIALS PREPARATION:

A. CAREFULLY MIX AND PREPARE PAINT MATERIALS in accordance with manufacturer's directions. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using. Use only thinners approved by the paint manufacturer, and only within recommended limits.

B. TINTING: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.07 APPLICATION:

A. APPLY PAINT according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied. Paint colors, surface treatments, and finishes are indicated in the drawings.

B. DO NOT PAINT OVER dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

C. PROVIDE FINISH COATS that are compatible with primers used.

D. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.

E. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

F. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.

G. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
   1. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
   2. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
   3. Sand lightly between each succeeding enamel or varnish coat.
   4. Provide painting at all exterior exposed unsightly pipes, conduits panels, as specified by Owner or Architect.

3.08 SCHEDULING PAINTING: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

3.09 THE NUMBER OF COATS AND THE FILM THICKNESS required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.

3.10 OMIT PRIMER ON METAL SURFACES that have been shop primed and touchup painted.

3.11 IF UNDERCOATS, STAINS, OR OTHER CONDITIONS SHOW THROUGH final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

3.12 ALLOW SUFFICIENT TIME BETWEEN SUCCESSIVE COATS to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

3.13 APPLICATION PROCEDURES: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

A. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
B. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
C. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

3.14 MINIMUM COATING THICKNESS: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

3.15 MECHANICAL AND ELECTRICAL WORK: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces. Refer to Sections 15 and 16.

3.16 BLOCK FILLERS: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

3.17 PRIME COATS: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others.

3.18 RECOAT PRIMED AND SEALED SURFACES where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

3.19 PIGMENTED (OPAQUE) FINISHES: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

3.20 APPLY STAINS in accordance with the stain and substrate manufacturer's recommendations (when applicable) to ensure proper penetration of the stain, and to produce an even, consistent, color that enhances the natural characteristics of the substrate material. Apply with spray and brush applicators using means and techniques best suited for the substrate and the type of stain being applied. Provide a consistent application of stain without color irregularities, brush marks, or other surface irregularities not inherent with the substrate material. Stain edges and ends of boards, and brush out excess stain that collects in surface textures or joints, as applicable. Do not apply stain on surfaces that are not sufficiently dry, or that are in direct sunlight.

3.21 TRANSPARENT (CLEAR) FINISHES: Use multiple coats to produce a glass-smooth surface film of even luster. Lightly sand the surface between each successive coat. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections. Typically, provide satin finish for final coats, unless noted otherwise.

3.22 COMPLETED WORK: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.23 FIELD QUALITY CONTROL: The Owner reserves the right to engage the services of an independent testing laboratory to sample the paint material being used. Samples of material delivered to the project may be taken, identified, sealed, and certified in the presence of the Contractor. The testing laboratory will perform appropriate tests as required by the Owner. If test results show material being used does not comply with specified requirements, the Contractor may be directed to stop painting, remove noncomplying paint, pay for testing, repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are noncompatible.

3.24 CLEAN-UP: During the progress of the Work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day. Upon completion of painting Work, clean window glass and other paint-spattered surfaces. Remove spattered paint or otherwise damage finish surfaces. Touchup and restore all damaged or defaced painted surfaces after completion of Work of other trades.

3.25 PROTECT work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Owner. Provide "wet paint" signs to protect newly painted finishes.

Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

PART 4 - PAINT MATERIALS SCHEDULE:

4.01 RE: www.paintinfo.com for MPI's "Approved Product List" – except as indicated below

4.02 EXTERIOR FINISHES:

A. EXTERIOR NATURAL-FINISHED WOOD (AND DECKING): SEMI-TRANSPARENT OIL/ALKYD STAIN FINISH:
   1. Two (2) Finish Coats: "Penofin Verde (low VOC), Natural by Sikkens

B. EXTERIOR PAINTED DRYWALL CEILING AND SOFFITS: FLAT ACRYLIC LATEX:
   1. Primer: MPI # 6 X-Green - Primer, Latex for Exterior Wood
   2. 2 Finish Coats: MPI # 10 - Latex, Exterior flat (MPI Gloss Level 1-2)

C. EXTERIOR MASONRY OR CMU WALLS: SATIN ELASTOMERIC COATING (AT UTILITY CONNECTOR):
   1. Block Filler / Primer: Masonry primer or acrylic block filler
      a. Benjamin Moore:
         (1) Moore's High Build Acrylic Masonry Primer 068 or
         (2) Latex Block Filler M88
      b. Pittsburgh Paints;
         (1) PERMA-CRETE High Build Acrylic Primer, 4-2 or
         (2) PERMA-CRETE LTC Concrete Block/Masonry Surfacer, 4-100
      c. Sherwin Williams;
         (1) PrepRite Masonry Primer or
         (2) PrepRite Block Sealer
   2. Two (2) Finish Coats: Low-Luster water-based elastomeric paint:
      a. Benjamin Moore; Moorlastic Acrylic Elastomeric Waterproof Coating - Low Lustre 055
      b. Pittsburgh Paints; PERMA-CRETE PITT-FLEX Elastomeric Coating
      c. Sherwin Williams; Sherlastic Elastomeric Coating Series A5-100

D. EXTERIOR CMU WALLS: SATIN/EGGSHELL ENAMEL:
   1. Block Filler: MPI # 4 X-Green - Block Filler, Latex, Interior/Exterior
   2. Primer: MPI # 6 X-Green - Primer, Latex for Exterior Wood
   3. 2 Finish Coats: MPI # 15 - Latex, Exterior, Low Sheen (MPI Gloss Level 3-4)

E. EXTERIOR CMU WALLS: SEMI-GLOSS ACRYLIC LATEX ENAMEL:
   1. Block Filler: MPI # 4 X-Green - Block Filler, Latex, Interior/Exterior
   2. Primer: MPI #6 X-Green - Primer, Latex for Exterior Wood
   3. 2 Finish Coats: MPI # 11 - Latex, Exterior Semi-Gloss (MPI Gloss Level 5)

F. EXTERIOR FERROUS METAL: SEMI-GLOSS ALKYD
   1. Primer: MPI # 23 - Primer, Metal, Surface Tolerant (w/ SSPC SP1 + SP 2 or SP3 prep)
      a. Note: Primer not required to be applied in field on pre-primed items – verify compatibility
   2. 2 Finish Coats:
      a. MPI # 94 - Alkyd, Exterior, Semi-Gloss (MPI Gloss Level 5), or
      b. MPI # 81 - Alkyd, Quick Dry, Semi-Gloss

G. EXTERIOR ZINC-COATED (GALVANIZED) METAL: SEMI-GLOSS ALKYD:
   1. Primer: MPI # 134 - Primer, Galvanized, Water Based
   2. 2 Finish Coats:
      a. MPI # 94 - Alkyd, Exterior, Semi-Gloss (MPI Gloss Level 5), or
      b. MPI # 81 - Alkyd, Quick Dry, Semi-Gloss

4.03 INTERIOR FINISHES:

A. INTERIOR DRYWALL: EGGSHELL/SATIN LOW-VOC LATEX
   1. Primer Coat: MPI # 149 X-Green - Primer Sealer, Interior, Institutional Low Odor/VOC
   2. 2 Finish Coats: MPI # 44 X-Green - Latex, Interior, (MPI Gloss Level 2)
   3. Apply finish coats with roller, unless otherwise indicated

B. INTERIOR DRYWALL: WASHABLE (USDA COMPLIANT) WATER-BASED SATIN EPOXY
   1. Primer Coat: "Rust-Oleum" – Zinsser Bulls-Eye Zero VOC water based Primer – 1.0 to 1.5 DFT minimum
   2. 2 Finish Coats: Rust-Oleum" – Sierra # S60/S62 Series "Satin Gloss" Water-Based Epoxy – 2.0 to 3.0 DFT per coat
   3. Apply with brush or roller

C. INTERIOR DRYWALL: WASHABLE, WATER-BASED SEMI-GLOSS EPOXY
   1. Primer Coat: MPI # 45 Primer Sealer, Alkyd, Interior, or as otherwise recommended by finish coat manufacturer
   2. 2 Finish Coats: MPI # 215 –Two component water-based semi-gloss epoxy – 2.5 to 4.0 DFM per coat

3. Basis-of-Design: Sherwin Williams Tile-Clad High Solids – with MR (mildew resistant) hardener
4. Apply finish coats with spray or roller

D. INTERIOR DRYWALL: GLOSS EPOXY

1. Surface Preparation: Clean and Dry
2. Primer Coat: Tnemec Series 201 at 4.0 to 6.0 mils DFT
3. Intermediate Coat: Tnemec Series 280 at 6.0.0 to 8.0 mils DFT
4. Finish Coat: Tnemec Series 297 Ceramic-Modified Waterborne Aliphatic Polyurethane at 3.0 to 4.0 mils DFT
5. Basis-of-Design: Tnemec as indicated.
6. Apply coatings per manufacturers recommendations to achieve proper adhesion and thickness.

E. INTERIOR METAL: **BOTH EXPOSED AND CONCEALED**, SATIN EPOXY

1. Surface Preparation: SSPC-SP10 Commercial Blast Cleaning
2. Primer Coat: Tnemec Series 90-97 Aromatic Urethane, Zinc-Rich at 2.5 to 3.5 mils DFT
3. Intermediate Coat: Tnemec Series N69 Polyamidoamine Epoxy at 3.0 to 4.0 mils DFT
4. Finish Coat: Tnemec Series N69 Polyamidoamine Epoxy at 3.0 to 4.0 mils DFT
5. Basis-of-Design: Tnemec as indicated.
6. Apply coatings per manufacturers recommendations to achieve proper adhesion and thickness.

F. INTERIOR METAL SEMI-GLOSS ALKYD ENAMEL

1. First Coat: MPI # 107 - Primer, Rust-Inhibitive, Water Based
2. Note: Primer not required on pre-primed items but coordinate compatibility requirements of finish coat
3. 2nd & 3rd. Coats: MPI # 54 X-Green - Latex, Interior, Semi-Gloss (MPI Gloss Level 5)
4. Brush apply finish coats unless otherwise indicated

G. INTERIOR LATEX CHALKBOARD PAINT

1. Apply to primer as indicated above for substrate and per manufacturer's requirements
2. Use the following material in lieu of finish costs where indicated to be "chalkboard" painted:
3. 2nd & 3rd Finish Coats: Rust-Oleum Chalkboard Brush-On paint
4. Manufacturer's standard flat green or black color as selected by Architect

H. INTERIOR EXPOSED STRUCTURE: DRY-FALL FLAT LATEX

1. Note: Primer not required to be applied in field on pre-primed items
2. Verify compatibility of finish with existing primer(s) and adjust if necessary
3. 2 Coats: MPI # 118 – Dry Fall Latex flat

I. PAINTED WOOD: EGGSHELL ALKYD ENAMEL

1. Prime Coat: MPI # 45 - Interior Alkyd Primer Sealer
2. 2nd & 3rd Coats: MPI # 51 - Interior Alkyd, Eggshell
3. Brush apply finish coats unless otherwise indicated

J. INTERIOR WOOD TRIM: GLOSS LATEX

1. First Coat: MPI # Prime Coat: MPI # 39 – Interior Latex Primer for Wood
2. Note: Primer not required to be applied in field on pre-primed items
3. 2nd & 3rd. Coats: MPI # 114 Latex Interior Gloss
4. Brush apply finish coats unless otherwise indicated

K. INTERIOR CMU WALLS: SEMI-GLOSS LATEX

1. Block Filler & Primer Coat: MPI # 4 latex block filler
2. Primer Coat: MPI # 149 X-Green - Primer Sealer, Interior, Institutional Low Odor/VOC
3. 2 Finish Coats: MPI # 54 X-Green - Latex, Interior, Semi-Gloss (MPI Gloss Level 5)

L. PAINTED WOOD: EGGSHELL ALKYD ENAMEL

1. Prime Coat: MPI # 45 - Interior Alkyd Primer Sealer
2. 2nd & 3rd Coats: MPI # 51 - Interior Alkyd, Eggshell
3. Brush apply finish coats unless otherwise indicated

M. INTERIOR WOOD TRIM: GLOSS LATEX

1. First Coat: MPI # Prime Coat: MPI # 39 – Interior Latex Primer for Wood
2. Note: Primer not required to be applied in field on pre-primed items
3. 2nd & 3rd. Coats: MPI # 114 Latex Interior Gloss
4. Brush apply finish coats unless otherwise indicated

N. PAINTED WOOD: SEMI-GLOSS ALKYD ENAMEL

1. Prime Coat: MPI # 45 - Interior Alkyd Primer Sealer
2. 2nd & 3rd Coats: MPI # 54 X-Green - Latex, Interior, Semi-Gloss (MPI Gloss Level 5)
3. Brush apply finish coats unless otherwise indicated

O. INTERIOR "NATURAL-FINISHED" STAINED HARDWOOD: EGGSHELL SHEEN (Level 3) WATER-BASED SYSTEM

1. Tinted-paste filler coat: MPI # 91
2. (omit on close-grained woods)
3. Stain coat(s): MPI # 90 color/intensity per sample
4. 1st, 2nd & 3rd Finish Coat: Eggshell (Gloss Level 3) water-based varnish - MPI # 181

P. INTERIOR "NATURAL-FINISHED" STAINED HARDWOOD: SATIN SHEEN - WATER-BASED SYSTEM
   1. Tinted-paste filler coat: MPI # 91
   2. (omit on close-grained woods)
   3. Stain coat(s): MPI # 90 color/intensity per sample
   4. 1st, 2nd & 3rd Finish Coat: Satin water-based varnish - MPI # 128

Q. INTERIOR "NATURAL-FINISHED" STAINED HARDWOOD – CONVERSION VARNISH FINISH:
   1. Apply in fabricator's shop to minimize VOC's on-site
   2. Basis-of-Design approved finish system manufacturer:
      a. AcromaPro (AP) – a division of Sherwin-Williams - www.acromapro.com
   3. Solvent-based stain coat(s): "Aqua Chroma Wiping Stain Base", color/intensity to match Architect's sample
   4. 1st & 2nd Sealer Coat: AP's "Care Seal" HS two-pack solvent born sealer
   5. Sand with 320 grit or finer sandpaper after both sealer coats
   6. 3rd & 4th Finish Coat: AP's "Amerivar 20" (satin sheen) # DM5361, two component clear conversion varnish
   7. Sand with 1500 and then 2000 grit sandpaper successively after finish coat application
   8. Paste Wax all surfaces on site prior to Substantial Completion

R. INTERIOR "SATIN OPAQUE" WOODWORK FINISH – CONVERSION VARNISH FINISH:
   1. Apply only to "Medex" waterproof particleboard substrate
   2. Apply in fabricator's shop to control airborne surface contaminates and VOC's
   3. Basis-of-Design approved finish system manufacturer:
      a. AcromaPro (AP) – a division of Sherwin-Williams - www.acromapro.com
   4. 1st & 2nd Sealer Coats: AP's "Bernyl Unisurfacer", post-catalyzed primer
   5. Sand with 320 grit or finer sandpaper after both sealer coats
   6. 3rd & 4th Finish Coat: AP's "Matador 20" (satin sheen) # DH560001X, post-catalyzed coating – pigmented to match Architect's color sample

S. INTERIOR "GLOSS OPAQUE" (AUTOMOTIVE LIKE) WOODWORK FINISH – OPAQUE CONVERSION VARNISH FINISH:
   1. Apply only to "Medex" waterproof particleboard substrate
   2. Apply in fabricator's shop to control airborne surface contaminates and VOC's
      a. Basis-of-Design approved finish system manufacturer:
   3. AcromaPro (AP) – a division of Sherwin-Williams - www.acromapro.com
   4. 1st & 2nd Sealer Coats: AP's "Bernyl Unisurfacer", post-catalyzed primer
   5. Sand with 320 grit or finer sandpaper after both sealer coats
   6. 3rd, 4th & 5th Finish Coat: AP's "Matador 80" (gloss sheen) # DH560001X, post-catalyzed coating – pigmented to match Architect's color sample
   7. Buff finish with 3M's "Perfect-It" paint finishing system, consisting of successive surface buffing using 3M's "EX Rubbing Compound", then 3M's "Machine Polish", and finally 3M's "Ultrafine Machine Polish" until a smooth, consistent mirror-like gloss luster is achieved.

T. INTERIOR NATURAL-FINISHED STAINED HARDWOOD: ALKYD VARNISH SYSTEM
   1. Tinted-paste filler coat: MPI # 91 (omit on close-grained woods)
   2. Oil/Alkyd-based stain coat(s): MPI # 90 color/intensity per sample
   3. Alkyd-based clear wood sanding sealer: MPI # 102 (lightly sanded)
   4. First Finish Coat: MPI # 75 Alkyd Varnish - gloss (lightly sanded)
   5. Second Finish Coat: MPI # 73 Alkyd Varnish - satin (lightly sanded)
   6. Paste Wax (OPTIONAL)

END OF SECTION 09 91 00

SECTION 09 96 00 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes surface preparation and the application of high-performance coating systems[**.**][**on the following substrates:**]

1. Interior Substrates:

a. Steel.

B. Related Requirements:

1. Section 050300 "Structural Steel Framing" for shop priming of structural steel with primers specified in this Section.
2. Section 099100 "Exterior Painting" for general field painting.
3. Section 09900 "Interior Painting" for general field painting.

1.03 LEED REQUIREMENTS

A. VOC Emissions Evaluation: For paints and coatings, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For paints and coatings, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Paints and Coatings Applications, as per the California Air Resource Board (CARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings or South Coast Air Quality Management District (SCAQMD) Rule 1113, effective February 5, 2016. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints and coatings.

C. 3. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.

1.04 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

1. 1. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
2. 2. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant.
3. 3. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a a compliant embodied carbon optimization report or action plan.

1.05 DEFINITIONS

A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.06 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Sustainable Design Submittals:

1. See Section 09 91 00 Painting

C. Samples for Initial Selection: For each type of topcoat product indicated.
D. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.
   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Apply coats on Samples in steps to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.
E. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[**, from the same product run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Coatings: **5** percent, but not less than **1 gal. (3.8 L)** of each material and color applied.

1.08 QUALITY ASSURANCE

A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Architect will select one surface to represent surfaces and conditions for application of each coating system.
      a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
      b. Other Items: Architect will designate items or areas required.
   2. Final approval of color selections will be based on mockups.
      a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.10 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Tnemec Company, Inc.
B. Peacock Laboratories, Inc.
C. Products: Subject to compliance with requirements, provide products (but are not limited to these products) listed in the Exterior High-Performance Coating Schedule or Interior High-Performance Coating Schedule for the coating category indicated.
   1. Exterior High-Performance Coatings:
      a. Series 94-H20 (Steel Prime Coat), by Tnemec
   2. Interior High-Performance Coatings:
      a. Series 10V, by Tnemec
      b. Series L69, by Tnemec
      c. Permalac NT Matt, by Peacock Laboratories
      d. Series 201, by Tnemec
      e. Series 280, by Tnemec
      f. Series 1081, by Tnemec
   3. Interior Radio Frequency Paints: At locations called for in Drawings
      a. GK5 Primer, by YShield
      b. HSF54 RF Paint, by YShield

2.02 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:
   1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
   3. Products shall be of same manufacturer for each coat in a coating system.

C. Colors: As selected by Architect from manufacturer's full range.

2.03 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
   1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
   2. Testing agency will perform tests for compliance with product requirements.
   3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   2. Fiber-Cement Board: 12 percent.
   3. Masonry (Clay and CMUs): 12 percent.
   4. Wood: 15 percent.
   5. Gypsum Board: 12 percent.
   6. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Plaster Substrates: Verify that plaster is fully cured.

E. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

F. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer**, but not less than the following:**
   1. SSPC-SP 11.
   2. SSPC-SP 5/NACE No. 1.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

G. Wood Substrates:
   1. Scrape and clean knots. Before applying primer, apply coat of knot sealer that is recommended in writing by topcoat manufacturer for coating system indicated.
   2. Sand surfaces that will be exposed to view and dust off.
   3. Prime edges, ends, faces, undersides, and backsides of wood.

4. After priming, fill holes and imperfections in the finish surfaces with filler that is recommended in writing by topcoat manufacturer for coating system indicated. Sand smooth when dried.

3.03 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.04 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.05 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.06 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Structural Steel - Exterior:

1. Urethane System:
   a. Prime Coat: Aromatic Urethane, Zinc-Rich.
      (1) Series 94-H20

3.07 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Structural Steel – Interior (Concealed Spaces):

1. Alkyd System:
   a. Prime and Top Coat: Modified Alkyd.
      (1) Series 10V by Tnemec
   b. Top Coat: Modified Alkyd
      (1) Series 10V by Tnemec

B. Structural Steel – Interior (Exposed Spaces Not Receiving Top Coat):

1. Modified Epoxy System
   a. Prime and Top Coat: Polyamidoamine Epoxy
      (1) Series L69 by Tnemec
         1. Color shall be from Tnemec Chromacolor Chart

C. Steel – Interior (Atrium Rails and Stair Components):

   a. Top Coat (Bare Steel): Acrylic Lacquer
      (1) Permalac NT Matte by Peacock Laboratories
         1. Color: Transparent Bronze Matte

D. Glass-Mat Reinforced, Mold and Moisture, and Impact Resistant Gypsum Board Substrates:

1. Epoxy System:
   a. Prime Coat: Modified Polyamine Epoxy, interior.
      (1) Series 201 Epoxoprime by Tnemec: Applied by roller to 150 sqft/galloon.
   b. Intermediate Coat: Modified Polyamine Epoxy.
      (1) Series 280 Tneme-Glaze by Tnemec: Applied at a rate of 125 sqft/gallon.
   c. Topcoa 1t: Aliphatic Acrylic Polyurethane, semi-gloss.

(1) Series 1081 Endura-Shield WB: Applied to achieve 2.0-3.0 mils dry film thickness.

d. Topcoat 2: Aliphatic Acrylic Polyurethane, semi-gloss.

(1) Series 1081 Endura-Shield WB: Applied to achieve 2.0-3.0 mils dry film thickness..

E. RF Shield Paint:

1. Prime Coat: Acrylic Binder
   a. GK5, by YShield: Applied per manufacture's instructions
2. Intermediate Coat: Carbon-based Acrylic
   a. HSF54, by YShield: Applied per manufacture's instructions
3. Top Coat: Water-based Latex
   a. As Scheduled. Refer to Drawings.

END OF SECTION 09 96 00

SECTION 09 24 00 – CEMENT PLASTERING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

(1) Two-coat polymer-modified portland cement plaster system consisting of a trowel-applied base coat, reinforcing mesh, and textured finish coat, installed directly over cement board substrate on exterior wall assemblies (no metal lath).
(2) Cement board substrate serving as the exterior-rated base for the plaster system.
(3) Drainage mat and coordination of the air/water-resistive barrier between vertical wall sheathing and the cement board substrate.
(4) Accessories, including starter track, casing beads, corner beads, control joints, and reinforcing mesh at joints and openings.

B. Related Requirements:

(1) Section 06 16 00 - Sheathing: Exterior-rated wall sheathing (glass-mat gypsum or exterior-grade plywood/OSB) receiving the air/water-resistive barrier.
(2) Section 07 25 00 - Weather Barriers: Air and water-resistive barrier coating or membrane applied over wall sheathing, where not furnished as an integral component of this Section's system.
(3) Section 07 92 00 - Joint Sealants: Sealants at terminations, control/expansion joints, and penetrations through the plaster system.
(4) Section 09 26 00 - Veneer Plastering: Interior gypsum veneer plaster system; not for exterior use.

1.02 REFERENCES

A. ASTM International:

(1) ASTM C926 - Standard Specification for Application of Portland Cement-Based Plaster.
(2) ASTM C1325 - Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cement Substrate Sheets (cement board).
(3) ASTM C1177 - Standard Specification for Glass Mat Gypsum Substrate Used as Sheathing.
(4) ASTM C150 - Standard Specification for Portland Cement.
(5) ASTM C297 - Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions (basis for base/finish coat tensile adhesion criteria).
(6) ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
(7) ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
(8) ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls (referenced for wall assembly wind-load testing).
(9) ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls.
(10) ASTM E2178 - Standard Test Method for Air Permeance of Building Materials.
(11) ASTM E2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.

B. International Building Code (IBC): Chapter 14 - Exterior Walls; Chapter 25 - Gypsum Board and Plaster.
C. ICC Evaluation Service (ICC-ES) or applicable regional code approval (e.g., Miami-Dade NOA): Current code-compliance documentation for the proprietary two-coat cement plaster system provided, where required by authorities having jurisdiction.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's product data for the air/water-resistive barrier, drainage mat, cement board, base coat, reinforcing mesh, primer, finish coat, and accessories, including physical properties, ASTM compliance, and installation instructions.
B. Samples: Submit two 12 by 12 inch samples of finished plaster illustrating each specified texture and color for Architect's selection and approval.
C. Shop Drawings: Submit control joint and expansion joint layout, cement board panel layout, accessory locations, and flashing details at penetrations and terminations, coordinated with wall framing and openings.
D. Manufacturer's Installation Instructions: Submit printed installation instructions for the complete system, including coat thicknesses, cure times, and maximum uncovered exposure time for the drainage mat/air barrier prior to cement board installation.
E. Test and Code Reports: Submit current ICC-ES Evaluation Report or applicable code approval, and structural/wind-load test data (per ASTM E330) for the fastening pattern and system configuration proposed for the Project.
F. Qualification Data: Submit evidence of Installer qualifications specified in Section 1.04.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Firm regularly engaged in exterior cement plaster installation, with minimum 5 years' experience on projects of similar scope and exposure, and certified/trained by the system manufacturer in the specified two-coat cement board stucco system.
B. Mockups: Prior to full installation, apply mockup panel not less than 4 feet by 4 feet on the actual wall assembly (sheathing, air/water-resistive barrier, drainage mat, cement board, base coat, and finish coat) illustrating texture, color, and a representative control joint and termination condition.

(1) Locate mockup where directed by Architect; obtain Architect's approval before proceeding with remaining Work.

(2) Approved mockup may remain as part of completed Work if undisturbed and undamaged at Substantial Completion.

C. Preinstallation Conference: Prior to commencing Work of this Section, conduct conference with Installer, sheathing installer, air/water-resistive barrier installer, and sealant applicator to coordinate sequencing, flashing, and terminations at openings.

D. Wind Load Compliance: Confirm the manufacturer's published fastening schedule and tested system configuration meet or exceed the Project's design wind pressures per ASCE 7 and the structural engineer's requirements. <Verify with structural engineer prior to construction.>

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened packaging, labeled with manufacturer name, brand name, and material type.

B. Store cementitious materials off the ground, under cover, in a dry location protected from moisture until time of use; discard materials that have been exposed to moisture or have exceeded manufacturer's shelf life.

C. Store cement board panels flat and fully supported, protected from moisture and damage.

1.06 FIELD CONDITIONS

A. Environmental Requirements:

(1) Do not apply base coat or finish coat when ambient or surface temperature is below 40 degrees F (4 degrees C); maintain minimum 40 degrees F (4 degrees C) during application and for not less than 24 hours after application of each coat.

(2) Protect plaster from direct sun, wind, and rapid moisture loss during application and curing.

(3) Do not leave drainage mat/air barrier assembly exposed and uncovered by cement board longer than the manufacturer's maximum stated exposure period (typically 30 days).

B. Height and Construction-Type Limitations: The basis-of-design system is limited by the manufacturer to a maximum height above grade on noncombustible construction per its current code listing; verify the specified system's height and construction-type limitations against the Project's building height and construction type before issuing for construction. <Verify.>

C. Do not install below grade, at roofs, or on horizontal surfaces; provide minimum 6 inch clearance above grade, increased as required in freeze-thaw climates.

D. Protect adjacent finish materials, glazing, and dissimilar materials from contact with, and staining by, plaster materials during application.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Drawings and this Section are based on the Sto Corp two-coat cement board stucco system (StoQuik Silver DrainScreen system, or equivalent current Sto system). Subject to compliance with requirements, provide the basis-of-design system indicated, or a comparable two-coat cement plaster system over cement board by one of the following:

(1) Sto Corp.
(2) Parex USA, Inc.
(3) BASF Wall Systems (Master Wall).
(4) Omega Products International.
(5) [Approved equal].

B. Substitutions: Refer to Section 01 25 00 - Substitution Procedures for products by manufacturers not listed above.

C. System Compatibility: Provide air/water-resistive barrier, drainage mat, cement board fasteners, reinforcing mesh, base coat, primer, and finish coat as components of a single manufacturer's tested and warranted system; do not intermix components of different manufacturers' systems.

2.02 AIR AND WATER-RESISTIVE BARRIER (AWRB)

A. AWRB: Fluid-applied or self-adhered air and water-resistive barrier over wall sheathing, compatible with the cement board stucco system, complying with ASTM E2178 (air permeance) and ASTM E2357 (assembly air leakage), and water-vapor permeable per ASTM E96.

(1) Basis of Design: Sto Gold Coat (brush, spray, or roller-applied coating), or Sto RapidGuard / StoShield self-adhered membrane, per manufacturer's system requirements.

(2) Coordinate with Section 07 25 00 where the AWRB is furnished under a separate section; where furnished as an integral component of this system, apply per manufacturer's instructions at minimum wet-film thickness required for the substrate.

2.03 DRAINAGE MAT

A. Drainage Mat: Matrix drainage material providing a capillary break and drainage plane between the AWRB and the cement board substrate on vertical surfaces, complying with ASTM E84 for flame spread and smoke development.

(1) Basis of Design: Sto DrainScreen, nominal 6 mm thickness, or nominal 10 mm thickness where required by authorities having jurisdiction.

2.04 CEMENT BOARD SUBSTRATE

A. Cement Board: Non-asbestos, fiber-mat reinforced cement substrate sheets complying with ASTM C1325, minimum 1/2 inch (13 mm) thick, serving as the exterior-rated sheathing/substrate receiving the plaster base coat.

(1) Basis of Design: PermaBase Brand Cement Board, or comparable cement board acceptable to the plaster system manufacturer.

B. Fasteners: Corrosion-resistant screws per manufacturer's requirements: minimum #9 Type S corrosion-resistant screws with 1 inch minimum penetration at wood framing, or minimum #8 Type S-12 screws with 3/8 inch minimum penetration at steel framing; space fasteners maximum 8 inches on center.

2.05 REINFORCING MESH AND DETAIL COMPONENTS

A. Reinforcing Mesh: Alkali-resistant, symmetrical, interlaced open-weave fiberglass mesh, nominal 4.5 oz. per sq. yd. (153 g/sq. m.), embedded in the base coat over cement board joints, corners, accessory flanges, and wall penetrations.

(1) Basis of Design: StoGuard Mesh, or Sto Mesh.

B. Detail/Conformable Membrane: Flexible membrane for dynamic joints and rough openings prior to base coat application.

(1) Basis of Design: StoGuard Conformable Membrane.

C. Starter Track and Trim Accessories: Manufacturer's standard starter track at wall base, casing beads at openings and terminations, and inside/outside corner beads with integral mesh.

2.06 BASE COAT

A. Base Coat: Polymer-modified, portland cement-based (ASTM C150, Type I) trowel-applied base coat providing minimum tensile adhesion of 15 psi per ASTM C297, formulated as the first of two coats over cement board substrate.

(1) Basis of Design: Sto Primer/Adhesive-B; high-build alternates Sto BTS Plus or Sto BTS Xtra where required by manufacturer for the specified finish or exposure.
(2) Applied Thickness: Approximately 1/8 inch (3 mm), uniform, fully embedding reinforcing mesh.

2.07 PRIMER

A. Primer: Acrylic-based, tinted, sanded primer improving substrate absorption, adhesion, and finish color uniformity, where required by the selected finish coat manufacturer's instructions.

(1) Basis of Design: StoPrime Sand.

2.08 FINISH COAT

A. Finish Coat: Factory-blended, integrally colored, textured finish, trowel- or spray-applied over the primed and cured base coat.

(1) Basis of Design: [Stolit (acrylic)] [Stolit Lotusan (hydrophobic, self-cleaning)] [Sto Powerflex or Powerflex Silco (silicone-enhanced elastomeric)] [StoSignature specialty finish]; Architect to select. <Insert selection.>
(2) Texture: [Fine] [Medium] [as indicated on Drawings]; Architect to select from manufacturer's standard textures. <Insert selection.>
(3) Color: [As selected by Architect from manufacturer's full color range] [Integral color, custom match to sample]; coordinate selected color's Light Reflectance Value (LRV) with control joint spacing requirements in Part 3. <Insert selection.>

2.09 MIXING

A. Mix factory-prepared base coat and finish coat materials with clean water in accordance with manufacturer's written instructions and proportions; do not add cement, sand, or other materials not recommended by manufacturer.
B. Mix only the quantity of material that can be applied and tooled within manufacturer's stated working time; do not retemper material that has begun to set.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify exterior wall sheathing is installed, fastened, and inspected in accordance with Section 06 16 00.
B. Verify the AWRB and drainage mat are installed, with laps and flashing integrated at openings and penetrations, and have been inspected and approved prior to covering; verify the drainage mat has not been left exposed longer than the manufacturer's maximum stated exposure period.
C. Verify cement board substrate is dry, structurally sound, straight and true within 1/4 inch in 10 feet, and free of damage that would impair plaster bond.
D. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Install starter track, casing beads at openings and terminations, and flashing prior to cement board installation, coordinated with the drainage plane to direct moisture to the exterior.
B. Lay out control joints and expansion joints per Shop Drawings and the spacing criteria in Part 3.06 prior to cement board and base coat installation.
C. Protect openings, adjacent finishes, and dissimilar materials from contact with wet plaster materials.

3.03 CEMENT BOARD INSTALLATION

A. Install cement board with bottom edge engaged in starter track; fasten to framing at maximum 8 inches on center with fasteners specified in Part 2.04.
B. Stagger vertical joints of cement board; offset cement board joints minimum 6 inches from wall sheathing joints behind the drainage plane.

C. Provide control and expansion joints in the cement board substrate at locations coordinated with the finish plaster control joints.

3.04 REINFORCEMENT AND ACCESSORY INSTALLATION

A. Embed reinforcing mesh over cement board joints, accessory flanges, and at wall penetrations, with minimum 9 by 12 inch diagonal reinforcement at corners of openings.
B. Install inside and outside corner beads with integral mesh at all external and internal corners.
C. Install conformable membrane at dynamic joints and rough openings prior to base coat application.

3.05 BASE COAT APPLICATION

A. Apply base coat uniformly at approximately 1/8 inch thickness over cement board, working in sections not exceeding 40 inches horizontally or vertically to maintain a wet edge and avoid cold joints.
B. Immediately embed reinforcing mesh into wet base coat; overlap mesh seams minimum 2-1/2 inches.
C. Allow base coat to cure for the minimum time recommended by manufacturer before priming or applying finish coat.

3.06 PRIMER AND FINISH COAT APPLICATION

A. Apply primer evenly by brush or roller where required by the selected finish coat manufacturer's instructions.
B. Apply finish coat by spray or trowel over the cured, primed base coat; work continuously toward the unfinished edge to maintain a wet edge and avoid visible lap marks; do not apply in direct sunlight or over high-pH surfaces.
C. Control Joints: Provide finish coat control joints at maximum 25 feet on center for finish colors with Light Reflectance Value (LRV) greater than 70, and at maximum 16 feet on center for colors with LRV between 30 and 70, or at closer spacing as recommended by manufacturer for darker colors.
D. Provide sealant at terminations, penetrations, and accessory butt joints per Section 07 92 00; install weeps at floor lines and window and door heads.

3.07 FIELD QUALITY CONTROL

A. Confirm installed fastening pattern and system components match the tested assembly configuration corresponding to the Project's design wind pressures; notify Architect of discrepancies before proceeding. <Verify wind load compliance with structural engineer.>
B. Inspect completed plaster for cracking, delamination, bond failure, and uniformity of texture and color; repair or replace defective areas in accordance with manufacturer's recommendations at no additional cost to Owner.

3.08 CLEANING AND PROTECTION

A. Remove excess plaster materials, droppings, and overspray from adjacent surfaces, glazing, and dissimilar materials as work progresses.
B. Protect completed system from damage, moisture, and construction traffic until Substantial Completion; do not expose the completed system to weather during the manufacturer's minimum cure period following finish coat application.

END OF SECTION 09 24 00

END OF DIVISION 09

DIVISION 10 – SPECIALTIES

SECTION 10 11 00 – MARKERBOARDS AND TACKBOARDS

SECTION 10 14 00 – SIGNAGE

SECTION 10 21 13 – STAINLESS STEEL TOILET COMPARTMENTS

SECTION 10 26 00 – WALL PROTECTION

SECTION 10 28 00 – TOILET ACCESSORIES

SECTION 10 44 00 – FIRE PROTECTION SPECIALTIES

SECTION 10 11 00 – MARKERBOARDS

PART 1 - GENERAL

1.01 PROVIDE MARKERBOARDS where indicated on the Drawings, in accordance with requirements specified herein, and as required for a complete and proper installation. Types of markerboards include the following:

A. Custom sized glass surfaced magnetic markerboards with concealed mountings
B. Provide units self-edged (trimless) unless indicated otherwise in the Drawings

1.02 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
B. VOC content requirements for wet-applied products: For adhesives and sealants used for installation, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.03 LEED DOCUMENTATION REQUIREMENTS

A. Complete the provided Product Data Reporting Form in spec section 01 81 13 and provide the following:
B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant

1.04 SUBMITTALS

A. SUMMIT PRODUCT DATA for each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. SUBMIT SHOP DRAWINGS for visual display surfaces when product data does not indicate unit size, installation details and attachments to other work.
C. SUBMIT SAMPLES FOR VERIFICATION: For each type of visual display surface indicated.
   (1) Markerboard Surface:
      (a) Not less than 8-1/2 by 11 inches.
      (b) Include three (3) sample panels for each type, color, and finish/texture required.
   (2) Accessories: Full-size Sample of each type of accessory.
D. SUBMIT OPERATION AND MAINTENANCE DATA for visual display surfaces to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. SOURCE LIMITATIONS: Obtain visual display surfaces from single source from single manufacturer.
B. SURFACE-BURNING CHARACTERISTICS: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   (1) Flame-Spread Index: 25 or less.
   (2) Smoke-Developed Index: 50 or less.

1.06 DELIVERY, STORAGE, AND HANDLING

A. DELIVER FACTORY-BUILT MARKERBOARDS completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
B. STORE UNITS vertically with packing materials between each unit.

PART 2 - PRODUCTS

2.01 APPROVED PRODUCT / MANUFACTURER: Refer to Drawings for products, unit size and color(s) required. Other products/manufacturers must be submitted as a substitution request per requirements of Division-01.

A. Basis-of-Design: Clarus (https://www.clarus.com/)

2.02 MAGNETIC GLASS-SURFACED MARKERBOARD: Refer to Drawings for products, unit size and color(s) required. Other products/manufacturers must be submitted as a substitution request per requirements of Division-01.

A. Basis-of-Design: Float Frameless Magnetic

PART 3 - EXECUTION

3.01 EXAMINE SUBSTRATES AND CONDITIONS, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work. Examine walls and partitions for proper preparation and backing for visual display surfaces. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALL UNITS in locations and at mounting heights indicated on Drawings, or if not indicated, at heights directed by the Architect. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

3.03 ANCHOR UNITS by attaching manufacturer’s provided mounts to wall surfaces and to visual display boards with fasteners at spacing or locations as recommended by manufacturer. Secure both top and bottom of panels to walls.

3.04 CLEANING AND PROTECTION: Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room. Touch up factory-applied finishes to restore damaged or soiled areas. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 10 11 16

SECTION 10 14 00 – SIGNAGE

PART 1 - GENERAL

1.01 PROVIDE signage to comply with requirements indicated for manufacturing process, material finishes, style, size and message content, as specified herein, and as required for a complete and proper installation. Types of signage required include to the following:

1.02 Below is a checklist for signage in new buildings as required by the *International Building Code* (IBC) and *International Fire Code* (IFC). The checklist includes the type of sign required, a description of what the sign should say, details about locations of the sign and when it is required, and the code sections that pertain to each sign.

TYPE OF SIGN	DESCRIPTION	DETAILS	CODE SECTIONS
Exits	"EXIT"	Exits are to be marked by an approved exit sign visible from any direction of egress travel. Intervening means of egress doors within exits shall be marked by exit signs. Exit sign placement shall be such that no point in an exit access corridor or exit passageway is more than 100 feet from the nearest visible exit sign.	IBC 1013.1
Emergency Evacuation	Building map of exit routes, pull stations, fire extinguishers, current location	The building is to have an approved fire safety and evacuation plan in compliance with section 404 of the IFC.	IBC 3008.1.3
Emergency Exit Doors	"PUSH UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN ## SECONDS"	Approved delayed egress locks are permitted to be installed in buildings equipped with approved fire protection systems.	IBC 1008.1.9.7
Elevator Emergency Signs	"IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE STAIRS"	Standardized design of approved picture and text is to be posted next to every elevator call station.	IBC 3002.3
Floor Identification	Floor level, story of exit discharge, roof access from exit enclosure	Signs are to be provided on each floor landing where exit enclosures connect more than 3 floors. The sign is to be located 5 feet above the floor landing.	IBC 1023.9
Stairwell Storage	Signage restricting storage of any kind in the stairwell	Provide signs restricting storage of any kind and bike parking in stairwells.	HUD
Areas of Refuge	"AREA OF REFUGE"	Each door providing access to an area of refuge from the adjacent floor is to be identified by a sign. Where exit sign illumination is required, the sign is to be illuminated.	IBC 1008.1 IBC 1009.9
Two-way Comm. System	Directions for summoning assistance and written identification of the location	To be posted next to any two-way communication systems.	IBC 1009.8.2
Fire Protection Equipment	Signs identifying equipment and location for fire department	Rooms containing controls for air-conditioning systems, sprinkler risers and valves, or other fire detection, suppression or control elements shall be identified for the use of the fire department.	IFC 509.1
Fire Department Connections	"AUTOMATIC SPRINKLERS" or "STANDPIPES" or "TEST CONNECTION	A metal sign with raised letters is to be mounted on all building fire department connections.	IFC 912.4
Fire Extinguishers	"FIRE EXTINGUISHER"	A sign extending out from the wall is to be mounted above fire extinguishers in public areas for ease of locating.	
Fire Cabinets	Fire cabinet equipment identified by approved signage	Sign is to be permanently attached with letters not less than 2 inches high in a color that contrasts with the background color.	IBC 905.7.1
Fire Doors	"FIRE DOOR-DO NOT BLOCK" or "FIRE DOOR-KEEP CLOSED"	Sign is to be permanently displayed on or near each fire door in letters not less than 1 inch high.	IFC 703.2.1
Rated Barriers	"FIRE AND/OR SMOKE BARRIER PROTECT ALL OPENINGS"	Any wall required to have protected openings or penetrations is to be permanently identified with signs or stenciling.	IBC 703.6
Locks on Egress Side of Doors	"THIS DOOR TO REMAIN UNLOCKED WHEN BUILDING IS OCCUPIED"	Sign is to be posted on the egress side on or adjacent to the door and have letters at least 1 inch high.	IBC 1010.1.9.4
Electrical Control	"ELECTRICAL ROOM"	Doors into electrical control panel rooms are to be marked with a plainly visible and legible sign.	IFC 605.3.1

Accessibility Directions	Directional signage indicating route to nearest accessible element	These directional signs are also to include the International Symbol of Accessibility. To be provided at the following locations: •Inaccessible building entrances •Inaccessible public toilets and bathing facilities •Elevators not serving an accessible route •Exits serving required accessible spaces that do not have approved accessible means of egress	IBC 1111.1
Hazard Identification	Hazard identification, numbered and color-coded "fire diamond"	Identifies the risk of hazardous materials, as specified in NFPA 704, through four divisions: •Left (blue): health risk •Upper (red): Flammability •Right (yellow): Reactivity •Lower (white): Special notice	IFC 2397.5
Restrooms	Designated sex of the toilet facility	Standardized design or approved picture and/or text is to be posted on each restroom facility.	IBC 2902.4
No Smoking	"NO SMOKING"	Signs are to be posted in conspicuous locations in each structure or location in which smoking is prohibited. The content, lettering, size, color and location of required "No Smoking" signs is to be approved.	IFC 310.3
Occupant Load	Maximum occupant load of the room	In assembly occupancies the occupant load is to be conspicuously posted by the main exit.	IBC 1004.9
Live Loads	Designed live load of each floor or portion thereof	Where designed to exceed 50 psi, live loads are to be conspicuously posted in all locations that they apply, mainly elevators.	IBC 106.1
Unit Numbers	Apartment Unit numbers	Signs for each apartment unit placed next to each apartment entry door.	IFC and ANSI 117.1
Other Public or Tenant accessible rooms	Common Rooms that are accessible to the public or tenants in an Office or MF building.	Signs identifying the room name placed next to each door entering the room.	ANSI 117.1
Accessible Parking	Parking spaces designated as accessible only	Each parking space designated for accessible parking signed as required.	ANSI 117.1
Building Address	Exterior PSV building address numbers	As required by local AHJ	

1.03 INSTALL INTERIOR WAYFINDING SIGNAGE **TBD**.

A. SEPARATE CONTRACT: The Owner will arrange for the following signage to be provided by others:

(1) Monument (or pole type) development / site sign(s)
(2) Exterior Building signage
(3) Development Directory, Tenant Directory, and Market Directory signage
(4) Site traffic signage
(5) Apartment unit identification signs

B. COORDINATE with the Owner's separate Sign Contractor regarding field dimensions, shop drawings, site access, scheduling, power requirements, and other items necessary for timely installation of signs.

1.04 COMPLY WITH applicable requirements of the Americans with Disabilities Act (ADA), requirements of the Building Code, including but not limited to accessibility requirements of ANSI A117.1 (most recent edition), and local regulations or ordinances. Obtain and pay for all exterior signage permits, which may require a separate permit application to the AHJ.

1.05 COORDINATE with Division-26 Electrical Work to provide electrical power to illuminated signage, where indicated on the Drawings.

1.06 SHOP DRAWINGS: Submit shop drawings of all signage items prior to fabrication and erection. Include plans, elevations and large scale details of fabrication, text, and layout, when applicable. Show details of anchorages to other materials, connector housings, and accessory items.

1.07 PERMITS: Obtain approval of governmental AHJ representatives and obtain approval of the Owner before fabrication of signage. Costs for permits and approval is a part of this Section.

1.08 LABELS: With the exception of required UL labels, do not apply fabricator's identification labels to any exposed surface of signs.

PART 2 - PRODUCTS

2.01 SIGN MATERIALS

A. ALUMINUM SHEET: Alloy and temper recommended by aluminum producer or finisher for type of use and finish indicated, and with not less than the strength and durability properties required in ASTM B 209 for 5005 H15.
B. ALUMINUM EXTRUSIONS: Allow and temper recommended by aluminum producer or finisher for type of use and finish indicated, and with not less than the strength and durability properties required in ASTM B 221 for 6063 T5.
C. PRESSURE SENSITIVE VINYL (PSV): "220 Scotchcal" by 3M or equal 2 mil minimum thickness, opaque, non-reflecting, cast PVC film with pressure sensitive adhesive backing sheet, suitable for exterior applications, in colors as selected by Architect from manufacturer's full range of available options, or as indicated on the Drawings.

2.02 FABRICATED ITEMS:

A. ACCESSIBLE PARKING SIGNS (provide one unit at each accessible parking space): 12 x 18 inch white rectangle with longer dimension vertical, with a green message and a blue and white international barrier-free symbol, and including the text: "Disabled Parking – State Permit Required" and "Violators fined up to $200.00" (verify and coordinate final text with local regulations). Provide with standard mounting post set in a concrete post foundation base, and set bottom of sign five (5) feet above grade.
B. ACCESSIBLE DOOR SIGNAGE (per ANSI A117.1 & ADA): 6 x 8 inch minimum radius cornered Pictorial Symbol Signs, with 1/32" raised pictogram symbols, 1/32" x 5/8" high upper case raised letter text, and with 1/32" Grade II Braille text. Text and pictogram to be white on black colored sign panel with matte finish. Provide double sided 1/32" thick Scotchmount tape for attaching at 60" above floor to center of sign on the wall adjacent to the latch side of a door:
   (1) 1 each sign reading "RESTROOM" at each uni-sex Toilet Room: Cal-Royal # NEWUCHS10 in Black or equal
   (2) 1 each sign reading "MEN" at each public Men's Toilet Room: Cal-Royal # MH68 in Black or equal
   (3) 1 each sign reading "WOMEN" at each public Women's Toilet Room: Cal-Royal # WH68 in Black or equal
   (4) 1 each sign reading "EXIT ROUTE" at each exit door: Cal-Royal # CAEXRT4534 in Black or equal
C. WAYFINDING, DIRECTIONAL & ROOM / DOOR SIGNS: Provide tactile accessible sign units with raised letters, raised symbols (when indicated) and with Grade II Braille text meeting requirements of ANSI A117.1 and the 2010 ADA Standard for Accessible Design for fabrication and for installation requirements.
   (1) COMPOSITION: Multi-layer, ultraviolet resistant, moisture-resistant, non-glare interior photosensitive photopolymer sheet with minimum 1/8 inch thick PETG base, with surface burning characteristics that consist of a flame spread of 75 and a smoke development of 120 when tested in accordance to UL 723 (ASTM E 84). Provide in "letter" color as selected by Architect from Manufacturer's full range of available color options.
   (2) SECOND SURFACE or "background" surface to be painted with non-glare acrylic paint as recommended by Manufacturer, in a contrasting color to the remaining character surface, in colors (potentially different on each floor) as selected by the Architect from the manufacturer's full range of available color options.
   (3) TYPICAL FONT: "Helvetica Neue Light" – upper case typical
   (4) BRAILLE CHARACTERS: Fabricate each sign unit with corresponding Grade II Braille text.
   (5) FABRICATION PROCESS: Camera ready artwork is reproduced onto the photosensitive surface and exposed to light – with the background surface removed where not exposed, producing a integrated solid sign panel. Laminated photopolymers, added-on characters, and engraved characters are not acceptable.

2.03 ACCESSIBILITY REQUIREMENTS: Comply with requirements of the ADA (even if not indicated herein):

A. Character Proportions: Letters and numbers on signs must have a width-to-height ratio between 3:5 and 1:1 and a stroke width-to-height ratio between 1:5 and 1:10.
B. Color Contrast: Characters and symbols must contrast with their background - either light characters on a dark background or dark characters on a light background.
C. Raised Characters or Symbols: Letters and numbers on signs must be raised 1/32 in minimum and be sans serif characters. Raised characters or symbols must be at least 5/8 in high but no higher than 2 inches. Symbols or pictograms on signs must be raised 1/32 in minimum.

2.04 NON-ACCESSIBLE TOILET DOOR SIGNAGE 1-3/4 by 6 inch wide minimum radius cornered sign units with double-stick tape for mounting at 60 inches above floor to center of sign on the wall adjacent to the latch side of a door:

A. 1 each sign reading "MEN" – Cal-Royal # M1346 or equal, OR
B. 1 each sign reading "WOMEN" – Cal-Royal # W1346 or equal, OR
C. 1 each sign reading: "RESTROOM" (at uni-sex toilet rooms) - Cal-Royal # RS1346 or equal, AND
D. Custom fabricated "directional signs" with raised text and braille directing users to the nearest accessible toilet facilities.

2.05 PSV LETTERING: Die-cut copy from PSV mounted to paper backing sheet for field application, and as follows:

A. PSV BUILDING NUMBERS: 8" high white reverse-mount to interior side of glass facing main street
B. PSV FIRE-SPRINKLER ROOM DOOR SIGN: 1-1/2" High "RED" colored PSV letters reading: "FIRE-SPRINKLER VALVE" (verify text with AJH)

2.06 FIRE- OR SMOKE- WALL OR PARTITION SIGNS: Within each room or interior space facing a fire- or smoke-rated wall or partition, and at any other walls or partitions required to have fire- or smoke- protected openings or penetrations, provide permanent, adhesive mounted vinyl signs of not less than 11 inch high by 15 inches wide, as follows:

A. Locate within 15 feet of each end on both sides, at each change of direction of the wall or partition, and at intervals not exceeding thirty (30) feet measured horizontally along the length of the wall or partition.
B. Locate approximately 6 inches above suspended ceilings or below access flooring, as applicable. Center units within attic spaces or other concealed areas, as appropriate
C. Locate within all concealed spaces, including ceilings, attics, or concealed areas under finished floors (access flooring).
D. Lettering: 3 inch minimum height, with 3/8 inch thick strokes typical, in a contrasting color to the background,

E. RECOMMENDED TEXT: "FIRE AND / OR SMOKE BARRIER—PROTECT ALL OPENINGS", or similar wording.
F. BASIS-OF-DESIGN: Fire Wall Signs Inc., P: 910-392-4939, website: www.firewallsigns.com or equal.

2.07 PAINTED METAL LETTERS: Fabricate from aluminum plate, producing characters with smooth, flat faces, sharp corners, precisely formed lines and profiles; and free from pits, scale, holes or other defects. Provide lugs into backs of characters and tap to receive threaded mounting studs. Match style and copy as indicated on the Drawings, and as follows:

A. MINIMUM FACE METAL THICKNESS: 0.25 (1/4) inch thick
B. FABRICATED LETTER DEPTH: Two (2) inch deep
C. PROJECTION FROM SUBSTRATE: One (1) inch
D. FINISH: baked enamel finish meeting NAAMM's "Metal Finishes Manual" specification # AA M4xC12C42R1x using thermosetting enamel consisting of prime coat and TWO (2) finish coats.
E. COLOR: As indicated on Drawings, or if not indicated, in custom color to match Architect's sample.

2.08 STAINLESS-STEEL LETTERS: Fabricate from Type 304 stainless steel plate, producing characters with smooth, flat faces, sharp corners, precisely formed lines and profiles; and free from pits, scale, holes or other defects. Provide lugs into backs of characters and tap to receive threaded mounting studs. Match style and copy as indicated on the Drawings, and as follows:

A. MINIMUM FACE METAL THICKNESS: 0.125 (1/8) inch thick
B. PROJECTION FROM SUBSTRATE: One (1) inch
C. FINISH: # 4 "satin" directionally textured finish

2.09 WOOD LETTERS: Fabricate from solid hardwood, producing characters with smooth, flat faces, sharp corners, precisely formed lines and profiles; and free from surface imperfections, depressions, knot holes or other defects. Provide recessed anchorages into backs to receive threaded mounting studs. Match style and copy as indicated on the Drawings, and as follows:

A. MINIMUM WOOD THICKNESS: 3/4 inch thick
B. HARDWOOD SPECIES / CUT: Match "typical" building standard hardwood species / cut per Division-06 Section
C. PROJECTION FROM SUBSTRATE: One (1) inch
D. FINISH: "Natural wood finish" per Division-09 "Painting" Section – in stain / color as indicated on the Drawings or if not indicated, in custom color to match Architect's sample.

2.10 ILLUMINATED LETTERS:

A. LETTER EDGE MATERIAL: .063" aluminum sheet 5" depth, acrylic paint finish outside color as indicated on Materials / Color schedule listed in the Drawings, white finish inside, unless otherwise noted.
B. LETTER BACKING: .090" thick aluminum sheet
C. LETTER FACES: 1/8" thick acrylic, color as noted in material color schedule included in the Drawings, with 3/4" plastic trim caps gold color unless noted otherwise.
D. LED LIGHTING: Provide LED lighting inside each letter that fully and evenly lights each letter.
E. REMOTE DRIVER: Provide remote driver at power source.
F. FABRICATION: Cut backing and faces to comply with letter style and text copy indicated, and in compliance with approved shop drawings. Locate letter edge joints at bottom of letters for exterior applications. Spot weld letter edge to backing to eliminate all light leak. Drill weep holes at all low points of letters at exterior locations. Adhere letter faces to plastic insert in trim cap molding with acrylic cement. Form neon tubing to be centered within letter enclosure. Attach letter edge and trim cap to letter backing with sheet metal screws, painted to match trim cap.

2.11 MISCELLANEOUS MATERIALS:

A. FASTENERS: Use concealed fasteners, unless otherwise indicated, which are fabricated from metals which are non-corrosive to either sign materials or mounting surface.
B. ANCHORS AND INSERTS: Use nonferrous metal or hot dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

PART 3 - EXECUTION

3.01 INSTALL signage in accordance with the approved shop drawings, to be level, plumb, and at height indicated, free from distortion or other defects of appearance. Remove and reinstall signage materials that do not comply with these requirements.

3.02 MOUNT accessible room signs directly onto wall surface centered nine (9) inches from the strke-side edge of the door, at 5'-0" AFF to center of sign. Use double sided foam tape to mount to smooth non porous surfaces.

3.03 MOUNT PSV signs on inside of glass, or directly to surface face of solid doors, as applicable.

3.04 CLEAN soiled sign surfaces and protect units from damage until Substantial Completion.

END OF SECTION 10 14 00

SECTION 10 21 13 – STAINLESS STEEL TOILET COMPARTMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

(1) Floor-mounted, overhead-braced, stainless steel toilet compartments with Permaseal edge panel-to-pilaster and panel-to-door connections.
(2) Hardware and accessories required for a complete installation, including headrail bracing, pilaster shoes, hinges, latches, brackets, coat hooks, and bumpers.

B. Related Sections:

(1) Section 06 10 00 – Rough Carpentry.
(2) Section 10 28 00 – Toilet, Bath, and Laundry Accessories.
(3) Division 22 – Plumbing Fixtures.

1.02 REFERENCES

A. ICC A117.1 – Accessible and Usable Buildings and Facilities.
B. ADA Standards for Accessible Design (Federal).
C. Applicable state and local building and accessibility codes. Conformity and compliance with local and national codes is the responsibility of the Installer, per manufacturer's requirements.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's data sheets indicating material composition, gauge, core construction, hardware options, and finish.
B. Shop Drawings: Indicate compartment layout, dimensions, door swings, accessible stall configuration, and mounting/bracing details, coordinated with partition and blocking locations; verify all rough-in dimensions per manufacturer's requirements prior to installation.
C. Samples: Submit manufacturer's satin brushed stainless steel finish sample for Architect's approval.
D. Selections: Submit manufacturer's standard and optional selections for hinges, door hardware, brackets, and corners for Architect's approval.
E. Warranty: Submit manufacturer's warranty documentation.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Provide toilet compartments, hardware, and accessories from a single manufacturer.
B. Sustainable Design: Provide compartments certified GREENGUARD Gold for low chemical emissions.
C. Accessible Compartments: Provide accessible toilet compartments complying with ICC A117.1 and the applicable governing accessibility code. Provide 69-inch-high doors and panels at 9 inches above finished floor (AFF) at ADA-compliant accessible stalls, and 72-inch-high doors and panels at 6 inches AFF at all other stalls, at locations and in quantities indicated on the drawings.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver components in manufacturer's original, unopened packaging, labeled with manufacturer's name and product identification.
B. Store in a clean, dry, indoor location, protected from damage, until installation.

1.06 WARRANTY

A. Manufacturer's Warranty: Provide manufacturer's standard warranty against defects in materials and workmanship. [Confirm current warranty term with manufacturer; not stated in referenced product literature.]

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Series 400, Sentinel, floor-mounted, overhead-braced, stainless steel toilet compartments, as manufactured by Bradley Corporation (a Watts Brand). [Confirm acceptable substitution/equal provisions with Architect prior to bidding.]

2.02 MATERIALS

A. Panel, Door, and Pilaster Construction: Two sheet metal faces insulated with a moisture-resistant honeycomb core, adhered to the inner surface of each face and set under pressure to cure.
B. Face Sheet Material: 300 Series stainless steel with a #4 satin brushed finish.
C. Panels: 1 inch thick, 22-gauge stainless steel; corners welded underneath a clip affixed to all corners, standard. [Optional: welded corners, ground smooth — confirm selection with Architect.]
D. Doors: 1 inch thick, 22-gauge stainless steel; corners welded underneath a clip affixed to all corners. Provide internal 16-gauge and 14-gauge welded reinforcement at top and bottom hinge locations, with a factory-installed concealed true gravity cam; hinge closing position shall be fully adjustable. Provide a pre-punched hole for field installation of the ADA-compliant concealed slide latch.
E. Pilasters: 1-1/4 inches thick, 20-gauge stainless steel. Provide an internally welded 18-gauge bracket at the floor end to accept a 5/16 inch stainless steel hex bolt, connecting to a stainless steel L-bracket secured to the floor with stainless steel fasteners; hex bolts provided in the shoe kit for leveling.
F. Panel-to-Pilaster and Panel-to-Door Edge Condition: Provide manufacturer's Permaseal edge system, with edges formed to interlock and provide a tight, gap-free fit without crown molding.

2.03 COMPARTMENT CONFIGURATION

A. Configuration: Floor-mounted, overhead-braced style, with anti-grip headrail providing lateral bracing between pilasters; suitable for new or existing construction without special floor or ceiling reinforcement.
B. Stall Heights: Provide 72-inch-high doors and panels at 6 inches AFF at standard stalls, and 69-inch-high doors and panels at 9 inches AFF at ADA-compliant accessible stalls, to allow maximum privacy while meeting accessibility clearance requirements. [Extra-height option is available from manufacturer; confirm with Architect if required.]
C. Doors: Width as indicated on the drawings, self-closing. Doors 32 inches wide or less are provided with a combination coat hook/bumper; doors 34 or 36 inches wide are provided with an individual coat hook, door bumper, and door pulls.

2.04 HARDWARE AND ACCESSORIES

A. General: Provide manufacturer's standard heavy-duty grade chromed Zamac hardware, complete with all fasteners required for a complete installation on concrete floors and masonry block walls, unless a stainless steel or continuous hardware upgrade is selected below.
B. Hinges: Chromed Zamac wraparound gravity hinge, thru-bolted to pilasters, standard. [Optional: stainless steel wraparound gravity hinge; continuous aluminum spring-loaded hinge; continuous stainless steel spring-loaded hinge — select in coordination with Architect.]
C. Door Latch: Chromed Zamac concealed slide latch and keeper, standard, with emergency egress feature; latch does not require a twisting motion and complies with Federal ADA guidelines; strike/keeper is wraparound and thru-bolted. [Optional: stainless steel concealed slide latch and keeper; Zamac or stainless steel surface-mounted slide latch and keeper.]
D. Brackets: Chromed Zamac stirrup-type single-ear, double-ear, and U-brackets with Torx-head fasteners, standard. [Optional: stainless steel stirrup brackets; continuous stainless steel brackets; continuous aluminum brackets.]
E. Corners: Clipped corners, standard. [Optional: welded corners, ground smooth.]
F. Headrail: Etched and anodized extruded aluminum, anti-grip profile, clamped over the pilaster and secured at the wall with plastic brackets.
G. Shoes: One-piece, 4 inches high, 304 Series stainless steel with #4 satin brushed finish, secured to the inside face of the pilaster with stainless steel Torx-head fasteners.
H. Fasteners: Torx-head fasteners supplied with all hardware; zinc-plated fasteners for concrete floor and masonry block wall installation.

2.05 FINISH

A. Finish: Satin brushed (#4), standard.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify field conditions, floor flatness, and wall backing/blocking locations are ready to receive compartments; verify all rough-in dimensions per manufacturer's requirements prior to installation.
B. Verify dimensions and door swing clearances comply with accessibility requirements at accessible compartments.

3.02 INSTALLATION

A. Install compartments in accordance with manufacturer's written instructions, plumb, level, and rigid.
B. Set pilasters with shoes tight to floor; secure floor brackets and level using the hex bolts provided in the shoe kit.
C. Secure headrail to each pilaster and to the wall with plastic brackets; verify a rigid, non-deflecting frame.
D. Adjust hinges, latches, and door stops for smooth operation and proper alignment; verify tight, gap-free Permaseal edge conditions at all panel-to-pilaster and panel-to-door joints.
E. Install accessories, including coat hooks, bumpers, and door pulls, at heights indicated on the drawings and as required by the applicable accessibility code.
F. Comply with local and national codes; conformity and compliance with local and national codes is the responsibility of the Installer, per manufacturer's requirements.

3.03 ADJUSTING AND CLEANING

A. Adjust doors and hardware for smooth, quiet operation without binding.
B. Clean exposed stainless steel surfaces in accordance with manufacturer's recommendations, using non-abrasive methods that follow the grain of the finish; remove labels and protective coverings.
C. Protect installed compartments from damage, scratching, and fingerprints until Substantial Completion.

END OF SECTION 10 21 13.16

SECTION 10 22 26 – OPERABLE PARTITIONS

PART 1 - GENERAL

1.01 SUMMARY:

A. Section Includes:

(1) Manually operated, individual glass panel partitions.

B. Relate Requirements:

(1) Division 03 Sections for concrete tolerances required.
(2) Division 05 Sections for primary structural support, including pre-punching of support members by structural steel supplier per glass operable partition supplier's template.
(3) Division 06 Sections for wood framing and supports and all blocking at head and jambs as required.
(4) Division 08 Sections for lock cylinders and keying requirements.
(5) Division 09 Sections for wall and ceiling framing at head and jambs.

1.02 QUALITY ASSURANCE:

A. Installer Qualifications: An experienced installer who is certified in writing by the glass operable partition manufacturer, as qualified to install the manufacturer's partition systems for work similar in material, design, and extent to that indicated for this Project.
B. Preparation of the opening shall conform to the criteria set forth per ASTM E557 "Standard Practice for Architectural Application and Installation of Operable Partitions."
C. The movable glass wall must be manufactured by a certified ISO-9001-2015 company or an equivalent quality control system.

1.03 REFERENCE STANDARDS:

A. A. ASTM International.

(1) ASTM E557 Standard Practice for Architectural Application and Installation of Operable Partitions.
(2) ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
(3) ASTM C1036 - Standard Specification for Flat Glass.
(4) ASTM C1048 - Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.

B. Health Product Declaration Collaborative.

(1) Health Product Declaration Open Standard v2.1.

C. International Standards Organization.

(1) ISO 14021 - Environmental Labels and Declarations - Self-Declared Environmental Claims (Type II Environmental Labeling).
(2) ISO 14025:2011-10, Environmental Labels and Declarations - Type III Environmental Declarations - Principles and Procedures.
(3) ISO 14040:2009-11, Environmental Management - Life Cycle Assessment - Principles and Framework.
(4) ISO 14044:2006-10, Environmental Management - Life Cycle Assessment - Requirements and Guidelines.
(5) ISO 21930 – Sustainability in Buildings and Civil Engineering Works — Core Rules for Environmental Product Declarations of Construction Products and Services.

D. Other Standards.

(1) ADA – Americans with Disabilities Act.
(2) ANSI Z97.1 - Safety Glazing Materials Used in Buildings.
(3) CPSC 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

1.04 SUBMITTALS

A. Product Data: Material descriptions, construction details, finishes, installation details, and operating instructions for each type of operable glass panel partition, component, and accessory specified.
B. Shop Drawings: Show location and extent of operable glass panel partitions. Include plans, elevations, sections, details, attachments to other construction, and accessories. Indicate dimensions, weights, conditions at openings and at storage areas, and required installation, storage, and operating clearances. Indicate location and installation requirements for hardware and track including floor tolerances required and direction of travel. Indicate blocking to be provided by others.
C. Setting Drawings: Show imbedded items and cutouts required in other work, including support beam punching template.
D. Samples: Color samples demonstrating full range of finishes available for selection by architect. Verification samples will be available in same thickness and material indicated for the work.
E. Reports: Provide a complete and unedited written sound test report indicating test specimen matches product as submitted.
F. Create spaces that are healthy for occupants.

(1) Furnish products and materials with Health Product Declaration (HPD), Manufacturer Inventory, or other material health disclosure documentation. Products without an HPD or other disclosure documentation are not acceptable.

G. Furnish materials that generate the least amount of pollution.

(1) Furnish products and materials that have third party verified environmental product declarations (EPD's). Consider products and materials that have optimized environmental performance (reduced life cycle impacts). Products without an EPD or other disclosure documentation are not acceptable.

H. Buy American: Glass wall products are to be manufactured in the United States in compliance with applicable U.S. Federal Trade Commission (FTC) and U.S. Customs Service and Border Protections regulations and be labeled "Made in America".

1.05 DELIVERY, STORAGE, AND HANDLING

A. Clearly mark packages and panels with numbering systems used on Shop Drawings. Do not use permanent markings on panels.
B. Protect panel and glazing materials during delivery, storage, and handling to comply with manufacturer's direction and as required to prevent damage to the glass and hardware.

1.06 WARRANTY

A. Manufacturer's Special Project Warranty on Glass Panels: Provide written warranty signed by the manufacturer of glass operable partitions agreeing to replace those panels with manufacturing defects.
(1) Manufacturing defects are defined as any defect materially obstructing vision through the glass, and mechanical failure of hardware which prevents the proper operation of the panels after appropriate installation.
(2) Warranty period: Five (5) years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS, PRODUCTS, AND OPERATION:

A. A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
(1) Modernfold, Inc.
B. Panels to be manufactured in the U.S.A.
C. Products: Subject to compliance with the requirements, provide one of the following products:
(1) Modernfold Glass Wall Model PureView "Frameless" – Paired Panel with 4-1/8-inch (105 mm) square top and bottom rails.

2.02 OPERATION:

A. A. Modernfold Glass Wall Model PureView "Frameless" – Paired Panel: Series of paired glass panels hinged together in pairs, manually operated and top-supported. Panels use two-piece, clamp-on top and bottom rails that fasten together from alternating sides.
B. B. Final closure:
(1) Pivot panel.

2.03 CONSTRUCTION:

A. Provide top reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with concealed fasteners. Finished in-place partition shall be rigid, level, plumb, aligned with uniform joints and appearance, free of bow, warp, twist, deformation, and surface and finish irregularities.
B. Dimensions: Fabricate operable glass panel partitions with manufacturer's standard panel sizes to form an assembled system of dimensions indicated on Drawings and verified by field measurements.
(1) Maximum panel width: 48 inches (1219 mm).
(2) Standard rail thickness: 1-9/16 inches (40 mm).
C. Top and Bottom Rails: Continuous two-piece assemblies with removable end caps. Rails fasten together from alternate sides of partition allowing for field adjustment to job site conditions. Snap-on covers are furnished to facilitate installation.
D. Horizontal Top and Bottom Seals: Continuous contact vinyl seals without the need for mechanically operated parts.
E. Bottom Rail Locking System: Engage adjacent panels by use of interlocking floor bolts to stabilize panels from movement in all directions.
(1) Equip a minimum of one end panel with a brass, mortised lock allowing for cylinder and/or thumb turn interior operation. Round bolts engage eccentric bushing floor strikes for security.
(2) Pivot panels to have SFIC mortised cylinder keyed exterior, thumb turn interior.
(3) Intermediate panels to have interconnecting floor bolts.
(4) Lead panels to have mortised cylinder with thumb turn interior.
F. Hinges for panels shall be:
(1) Butt hinges attached to top and bottom rail.
G. Acoustical ratings of panels with this construction achieve Sound Transmission Class of minimum STC when tested in accordance with ASTM E90 and classified in accordance with ASTM E413:
(1) 15 STC.

2.04 MATERIALS:

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; ASTM B221 (ASTM B221M) for extrusions; manufacturer's standard strengths and thicknesses for type of use.

B. Glass Type: Tempered, ½ inch (13 mm) complying with safety standards specified in ANSI Z97.1 CPSC16, CFR1201, ASTM C1036 and ASTM C1048.
C. Glass Finish:
(1) Clear tempered
D. Panel weight: 7.5 lbs./square foot.

2.05 PANEL FINISHES:

A. Provide top and bottom rails with one of the following finishes:
(1) Dark Bronze anodized aluminum.

2.06 SUSPENSION SYSTEM:

A. G-330 Suspension System “Smart Track”
(1) Suspension Tracks: Extruded aluminum with a minimum wall thickness of 0.235 inches (6 mm). Incorporate cast aluminum or mitered intersections, switches, and curves in stacking area. Provide alignment pins for track, intersections, switches and curves insuring both fit and roller surface integrity.
(a) Exposed track soffit: Factory-finished aluminum with white powder coat.
(2) Carriers: Two stainless steel trolleys with vinyl roller surfaces. Trolley design incorporates eight (8) wheels of varying dimensions. Automatic indexing of panels into stack area is provided by pre-programmed switches and trolleys without electrical, pneumatic, or mechanical activation.
(3) Warranty period: Five (5) years.

2.07 OPTIONS:

A. Door pulls back-to-back – Pivot Panel
(1) Location of pivot panel as indicated on Drawings.
(2) 12-inch (305 mm) tubular pull.
(a) Dark bronze anodized.
(3) TG-138 49-inch (1245 mm) locking “Ladder Pull”.
(a) SFIC Mortise Cylinder Floor Locks.
B. Automatic door closer – Pivot Panel
(1) BTS80 floor closer.
C. Bottom rail cover
(1) 4-1/8-inch (105 mm) cover (matches top rail cover).

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General: Comply with ASTM E557, operable glass partition manufacturer’s written installation instructions, Drawings, and approved Shop Drawings.
B. Install operable glass partitions and accessories after other finishing operations, including painting, have been completed.
C. Match operable glass partitions by installing panels from marked packages in numbered sequence indicated on Shop Drawings.
D. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

3.02 CLEANING:

A. Clean metal and glass surfaces upon completing installation of operable glass partitions to remove dust, loose fibers, fingerprints, adhesives, and other foreign materials according to manufacturer’s written instructions.

3.03 PROTECTION:

A. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensure operable glass partitions are without damage or deterioration at time of Substantial Completion.

3.04 ADJUSTING:

A. Adjust operable glass partition to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Lubricate hardware and other moving parts.

3.05 EXAMINATION:

A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable glass partitions. Proceed with installation only after unsatisfactory conditions have been corrected.
(1) Ensure finished floor under operable glass partition is level ± 0.13-inch (3 mm) in ten (10) feet (3048 mm) non-cumulative.

3.06 DEMONSTRATION:

A. Demonstrate proper operation and maintenance procedures to Owner’s representative.
B. Provide Operation and Maintenance Manual to Owner’s representative.

END OF SECTION 10 22 26

SECTION 10 26 00 – WALL PROTECTION

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide wall protection systems, where indicated on the drawings, as specified herein and as needed for a complete and proper installation. Install stainless steel wall paneling, furnished by others.

1.02 RELATED SECTIONS

A. Section 01 81 13 Certification Requirements.

1.03 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants..

1.04 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form and provide the following:

B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant

1.05 SUBMITTALS: Submit samples of each product as follows:

A. Corner Guard: 8 inch sample

B. Paneling: 8x8 inch sample

1. Panel Trim, Joint Dividers, Edge Trim, Inside Corners, Outside Corners: 8 inch sample

C. Data Sheets on all adhesives as applicable.

PART 2 - PRODUCTS

2.01 CORNER GUARDS: Provide pre-formed standard powder coated steel units, of 0.059-inch (16 gage) minimum, full-height (unless otherwise indicated on the Drawings):

A. Provide 90 degree turn, unless otherwise indicated, and with formed edges:

B. WGC Types: Refer to Drawings

1. Type 1 (CG-1)

a. Wing Size: As indicated in Drawings
b. Finish: Refer to Drawings

2. Type 2 (EWG-2)

a. Wing Size: As indicated in Drawings
b. Finish: Refer to Drawings

C. Mounting Method: Countersunk screws with holes 8 inches OC

D. Straight Eddge

2.02 STAINLESS STEEL WALL PANELING: Stainless-Steel Plate: Type 304, minimum 0.0625 inch thick, with bright, directional polished No. 4 finish. Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary covering before shipping.

A. PANEL HEIGHT: Provide full-height stainless steel wall paneling extending from top of base to ceiling, except as otherwise indicated on the Drawings

B. PANEL TRIM: Formed stainless steel trims as manufactured by “Flame Gard”: P: 800-536-3694, www.flamegard.com, or Stainless Supply, P: 877-484-0088, www.stainlesssupply.com, or equal.
C. JOINT DIVIDER TRIM: All stainless steel unit, with 7/16 inch deep pockets each side, and minimum 7/8 inch wide stainless steel face.
D. EDGE TRIM: “J-profiled” stainless steel with minimum 5/16 inch exposed edge.
E. INSIDE CORNERS: Field bend wall panel as required.
F. INSIDE CORNER TRIM: 1-3/4 x 1-3/4 inch 90 degree inside corner unit with one 3/4 inch wide pockets both sides and a 1 x 1 inch inside coved finished corner.
G. OUTSIDE CORNER TRIM: use surface mounted, stainless steel corner guards over panel edges.

2.03 FASTENERS: Provide aluminum, nonmagnetic stainless steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with components, hardware, anchors, and other items being fastened. Use theft-proof fasteners where exposed to view. Provide inserts and other anchorage devices for connecting components to concrete or masonry. Fabricate anchoring devices to be capable of withstanding imposed loads. Coordinate anchoring devices with the supporting structure.

2.04 ADHESIVE: Low VOC type as recommended by the manufacturer for use with material on the substrate indicated. Verify compatibility of adhesive material with fire-retardant treated (FRT) plywood substrate, when applicable.

2.05 FABRICATE wall and door protection systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thicknesses of components. Preassemble components in the shop to the greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling. Fabricate components with tight seams and joints with exposed edges rolled.

2.06 PROVIDE SURFACES free of evidence of wrinkling, chipping, uneven coloration, dents, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

PART 3 - EXECUTION

3.01 EXAMINE AREAS and conditions in which wall surface protection components and wall protection systems will be installed. Complete all finishing operations, including painting, before beginning installation of wall surface protection system materials.

3.02 PREPARATION: Before installation, acclimate wall protection, trim, and adhesives not less than 24 hours before installation. Store panels and trim on a level surface while acclimating. Verify that building temperature will be maintained between 70 to 80 degrees F from 24 hours before, and 48 hours, after installation with relative humidity below 80%. Do not proceed with installation if such conditions will not be maintained.

3.03 SUBSTRATE material must be dry, well-sealed, and free of dirt, loose paint, wax and grease. Sand or otherwise roughen glossy surfaces to promote adhesion. Remove substrate coatings designed to improve clean-up as these coatings may affect adhesion. Prior to installation, clean substrate to remove dust, debris, and loose particles.

3.04 INSTALL WALL SURFACE PROTECTION UNITS plumb, level, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished work. Install retainers, mounting brackets, and other accessories in strict accordance with the manufacturer's instructions.

3.05 INSTALLATION OF STAINLESS STEEL WALL PANELING:

A. Acclimate stainless steel panels, trim and adhesive to room temperature not less than twenty-four (24) hours before installation.
B. Store panels and trim on a level surface while acclimating.
C. Maintain temperature between 70 to 80 degrees F with relative humidity (RH) no greater than 80% for not less than twenty-four (24) hours before installation, and forty-eight (48) hours after installation of wall paneling.
D. If field cutting is required at electrical receptacles or switch boxes, use a sheet-metal nibbler for cuts, wearing a face shield and other appropriate PPE. Finish cut edges with a metal file, so that cut edges will be free of burs or other projections.
E. Attach panels with full-spread of adhesive applied to back of panels for 100% coverage, with a notched trowel. Before adhesive skins over, set panels in position and press against wall. Pull entire panel back away from wall to flash off solvents, if applicable. Press back in place, and apply adequate pressure to make full contact between panel and substrate.
F. INSTALL MECHANICAL ANCHORS by drilling through the installed panel into partition substrate framing, unless otherwise indicated in the Drawings. Space anchors at not less than twenty-four (24) inches OC vertically at each framing member (not to exceed 24 inch centers), or as otherwise required for not less than one anchor per four (4) square feet.
G. SEAL PANEL JOINTS with FSE type clear, silicone sealant struck flush to the panel face.

3.06 CLEANING: Immediately upon completion of installation, clean surface protection units and accessories using a standard ammonia based household cleaning agent. Clean metal components in accordance with the manufacturer's recommendations. Remove excess adhesive and sealant while it is still wet.

3.07 REMOVE SURPLUS materials, rubbish, and debris resulting from installation upon completion of work and leave areas of installation in neat, clean condition. Replace removed plates and fixtures.

END OF SECTION 10 26 00

SECTION 10 28 00 – TOILET ACCESSORIES

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide toilet, bath and laundry room accessories throughout the project, as specified herein, and as required for a complete and proper installation. Provide units as indicated on the Drawings.

1.02 RELATED SECTIONS

A. Section 018113 Sustainable Construction Requirements.

1.03 SUBMIT PRODUCT DATA for each accessory item specified, including construction details relative to materials, dimensions, gages, profiles, mounting method, specified options, and finishes.

1.04 PROVIDE SETTING DRAWINGS where cutouts are required in other work, including templates, substrate preparation instructions, and directions for preparing cutouts and installing anchorage devices.

1.05 SUBMIT MAINTENANCE INSTRUCTIONS including replaceable parts and service recommendations.

1.06 SINGLE-SOURCE RESPONSIBILITY: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise acceptable to Architect.

1.07 COORDINATION: Coordinate accessory locations, installation, and sequencing with other work to avoid interference with and ensure proper installation, operation, adjustment, cleaning, and servicing of toilet accessory items.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. STAINLESS STEEL: AISI Type 302/304, with polished No. 4 finish, 0.034-inch (22-gage) minimum thickness.
B. BAKED ENAMEL FINISH: Factory-applied, gloss white, baked acrylic enamel coating.
C. MIRROR GLASS: Nominal 6.0-mm (0.25-inch) thick, conforming to ASTM C 1036, Type I, Class 1, Quality q2, and with silvering, electro-plated copper coating, and protective organic coating.
D. FASTENERS: Screws, bolts, and other devices of same material as accessory unit, or of galvanized steel where concealed.
E. KEYS & CYLINDERS: Provide universal keys, with all cylinders keyed alike, for access to toilet accessory units requiring internal access for servicing, re-supply, etc. Provide minimum of six keys to Owner's representative.

2.02 ACCEPTABLE MANUFACTURERS OF TOILET ACCESSORIES: Provide toilet accessories by the University standards listing in the finish schedule. No substitutions unless noted “or equal”.

2.03 TOILET ACCESSORIES: Refer to Drawings for toilet accessory units required, and as follows:

A. MOP & BROOM UNIT (at each service sink): American Specialties 1308-3 or equal shelf / mop & broom holders, w/ hooks.

PART 3 - EXECUTION

3.01 INSTALL TOILET ACCESSORY units according to manufacturers' instructions, using fasteners appropriate to substrate as recommended by unit manufacturer. Install units plumb and level, firmly anchored in locations and at heights indicated.

3.02 SECURE MIRRORS TO WALLS in concealed, tamperproof manner with special hangers, toggle bolts, or screws. Set units plumb, level, and square at locations indicated, according to manufacturer's instructions for type of substrate involved.

3.03 INSTALL GRAB BARS to withstand a downward load of at least 250 lbf, complying with ASTM F 446.

3.04 ADJUST TOILET ACCESSORIES for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.

3.05 CLEAN AND POLISH all exposed surfaces strictly according to manufacturer's recommendations after removing temporary labels and protective coatings

PART 4 - BASIS-OF-DESIGN SCHEDULE OF ACCESSORIES (UNIVERSITY STANDARDS):

TISSUE DISPENSERS (ADA Stalls) **OFCI**	Georgia Pacific 56784A compact side-by-side tissue dispenser. Mounting: Surface mounted. No substitution will be permitted. Refer to attached drawing for mounting detail.	one (1) per water closet
TISSUE DISPENSERS (Non-ADA Stalls) **OFCI**	Georgia Pacific 56744B compact quad vertical 4-roll tissue dispenser. Mounting: Surface mounted. No substitutions will be permitted. Refer to UofA standard drawing for mounting detail.	one (1) per water closet
GRAB BARS:	As indicated in Drawings	One (1) 18 inch high vertical unit at side and One (1) 42" wide horizontal unit at side and One (1) 36" wide horizontal unit at back of each handicapped water closet

SANITARY NAPKIN DISPENSER UNITS **OFCI**	Frost 618-3-FREE Push Button w/ Frost 618-RF recessed Frame for ADA Compliance. Stainless Steel finish. No substitutions will be permitted.	one (1) per Women's Restroom
SANITARY NAPKIN DISPOSAL UNITS	Bobrick Contura Series B-270 surface mounted container. No substitutions will be permitted.	one (1) per water closet in Women's Toilets
SOAP DISPENSERS **OFCI**	Soap dispensers will be supplied by Facilities Management Building Services and installed by the contractor. Do not install on mirrors, but leave a 6 inch wide by 12 inch high space over or next to the sink for the soap dispenser. Install one dispenser for every two (2) sinks.	one (1) at each 2 lavatory or sink basins
WASTE RECEPTACLE:	American Specialties 0469-ND recessed open cabinet and waste receptacle. Paper towel dispenser to be mounted in upper portion of cabinet. Provide adequate wall blocking.	1 minimum per RR: Refer to drawings for exact quantity.
PAPER TOWEL DISPENSER **OFCI**	Georgia Pacific SofPull 59489 mechanical hardwound roll towel dispenser. Color: Translucent Smoke. Mounting: Surface mounted. No substitutions will be permitted.	1 minimum per RR: Refer to drawings for exact quantity.
SUPPLEMENTAL WASTE RECEPTACLE:	Peter Pepper 1092 fiberglass receptacle – Architect to select color from manufacturer's standard offering.	1 per restroom.
KEYS	Provide universal keys for internal access to accessories for servicing and resupplying.	Provide minimum of six keys to Owner's representative.
FRAMED MIRROR	Refer to drawings – same as unit mirrors	one (1) unit at each lavatory Hang at code compliant height
COAT / ROBE HOOK	Refer to drawings – same as robe hook at showers.	one (1) per toilet room on back of door Mount at 48 inch max AFF per ADA
BABY CHANGE STATION:	American Specialties, Inc. 9013-9 Roval Baby Changing Station – SS Surface Mounted	One (1) per toilet room where indicated or as directed by Architect on site. Locate prior to gypsum install to ensure correct blocking locations

END OF SECTION 10 28 00

SECTION 10 44 00 – FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide fire –protection specialties throughout the project, as specified herein, and as required for a complete and proper installation.

A. Provide recessed “Knox-Box” for each building, per requirements of local fire-department
B. Provide Fire-extinguishers, and fire-extinguisher cabinets, where indicated on the Drawings

1.02 SUBMIT PRODUCT DATA for each type of product specified. For fire extinguisher cabinets include rough in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type and materials, trim style, door construction, panel style, and materials.

1.03 SUBMIT MAINTENANCE INSTRUCTIONS including service recommendations.

1.04 SINGLE-SOURCE RESPONSIBILITY: Obtain fire extinguishers and cabinets from one source from a single manufacturer.

1.05 COORDINATION: Coordinate accessory locations, installation, and sequencing with other work to avoid interference with and ensure proper installation, operation, adjustment, cleaning, and servicing.

1.06 UL-LISTED PRODUCTS: For fire extinguishers, provide UL-listed units bearing the UL "Listing Mark" for type, rating, and classification of extinguisher.

PART 2 - PRODUCTS

2.01 EMERGENCY KEY-ACCESS BOX: “Knox-Box” 3200 Series with hinged door, with optional recessed mounting kit (#3270) as manufactured by the Knox Company (www.knoxbox.com) Mount at 48 inch above grade or as otherwise required by AHJ representatives, in location indicated on the Drawings. Coordinate keying of key-access box cylinder with local Fire Department officials.

2.02 FIRE EXTINGUISHERS

A. TYPICAL FIRE EXTINGUISHERS (FE): Manufacturer's standard multipurpose dry chemical type unit, 10 lb capacity, UL rated: 4A-80BC equal to JL “Cosmic 10E” # MB846.
B. KITCHEN CLASS-K FIRE EXTINGUISHERS (KFE) at cooking area(s): Manufacturer's standard wet-chemical type, 15 lb, UL rated: for “Class K” (liquid cooking or wet-chemical media fires) equal to JL “Saturn 15” # MB810.

2.03 FIRE EXTINGUISHER CABINETS

A. PREFINISHED STEEL FIRE EXTINGUISHER CABINET (FEC): Provide assembly of formed steel cabinet/tub unit complete with extinguisher and mounting bracket, in tub size as required to fit extinguisher unit.
   (1) BASIS OF DESIGN MANUFACTURE: LARSEN MANUFACTURING: Occult Series – Model 0-2409
   (2) CABINET, TRIM & DOOR MATERIAL:
      (a) Cold-rolled steel with white powder-coat finish for 10 lb extinguisher, typ.
   (3) DOOR STYLE: Flush, solid panel door with surface mounted ADA pull, safety locking “pull to open” hardware.
   (4) FULLY RECESSED WALL CABINET (typical unless otherwise indicated or required for installation indicated; requires 6” deep framed wall): One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge, 1/4 TO 1/2 inch backbend depth and overall not exceeding 5/8 inch projection from wall.
      (a) Larsen Occult Series – Model 0-2409
      (b) Door Style: Solid
      (c) Provide optional Type A Die-cut lettering. Color: Black
   (5) SEMI-RECESSED WALL CABINET (if needed): One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge,4 inch maximum rolled edge for ADA compliance.
      (a) Similar model as fully recessed in appearance and configuration.
   (6) FIRE-RATED CABINET: Similar model as fully recessed but Larsen “FS” steel constructed cabinet with double walls of 0.043 inch thick cold-rolled steel sheet lined with minimum 5/8 inch thick fire-barrier material, with factory-drilled mounting holes.
      (a) Similar model as fully recessed in appearance and configuration but fire-rated.
   (7) SEMI-RECESSED WALL CABINET (typical unless otherwise indicated or required for installation indicated in 3-5/8 inch framed walls): One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge,4 inch maximum rolled edge for ADA compliance.
      (a) Similar model as fully recessed in appearance and configuration.
   (8) SURFACE-MOUNTED CABINET (when indicated or required): Fully exposed cabinet box without additional trim to be fully exposed and mounted directly onto wall.
      (a) Similar model as fully recessed in appearance and configuration.

2.04 ACCEPTABLE MANUFACTURERS: Subject to compliance with requirements, equivalent products of the following manufactures are also acceptable:

A. American Specialties, Inc.; ASI Group.
B. Fire-End & Croker Corporation.
C. Kidde Residential and Commercial Division.
D. Larsens Manufacturing Company.

2.05 MOUNTING BRACKETS: Manufacturer's standard steel unit of plated or baked-enamel finish, provided at each fire-extinguisher unit. Design brackets to secure fire extinguisher of sizes, types and capacities required, to prevent accidental dislodgement of extinguisher unit.

2.06 IDENTIFICATION: Provide wall signage decals and lettering as required by AHJ representatives for letter style, size, spacing, and location. Locate as directed by Architect.

PART 3 - INSTALLATION

3.01 INSTALL UNITS in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of AHJ. Where exact location of surface-mounted cabinets and bracket-mounted fire extinguishers is not indicated, locate as directed by Architect, and per approval of the AHJ.

3.02 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 00

END OF DIVISION 10

DIVISION 11 – EQUIPMENT

SECTION 11 13 19 – HYDRAULIC SCISSOR LIFTS

SECTION 11 13 19 – HYDRAULIC SCISSOR LIFTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

(1) Hydraulic scissor lift, including platform, tubular steel scissor leg assembly, power unit, controls, and safety devices, complete for manned platform operation and material/pallet handling between the levels indicated.

B. Related Sections:

(1) Section 03 30 00 – Cast-in-Place Concrete (pit/foundation).
(2) Division 26 – Electrical.

1.02 REFERENCES

A. ANSI MH29.1 – Safety Requirements for Industrial Scissors Lifts.
B. NFPA 70 – National Electrical Code.
C. Applicable state and local building and lift/elevator code requirements having jurisdiction.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's data sheets indicating capacity, platform dimensions, travel height, power requirements, and controls.
B. Shop Drawings: Indicate pit or foundation requirements, anchor bolt locations, platform layout, clearances, and coordination with structure and electrical rough-in.
C. Structural Data: Submit manufacturer's pit and foundation loading requirements for review by the Structural Engineer of Record.
D. Operation and Maintenance Manuals: Submit prior to Substantial Completion.
E. Warranty: Submit manufacturer's warranty documentation.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be ISO 9001:2015 certified, with equipment manufactured in the USA.
B. Regulatory Requirements: Comply with ANSI MH29.1 and applicable state and local codes governing manned lifting platforms. [Confirm with Authority Having Jurisdiction whether this manned platform lift requires classification and permitting under the adopted elevator/lift code.]
C. Electrical Component Listing: Provide Underwriters Laboratories (UL) listed controller assemblies.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle components in accordance with manufacturer's instructions; protect from damage and weather.
B. Coordinate rigging and crane requirements with the manufacturer's shipping weight of approximately 3,085 lb.

1.06 WARRANTY

A. Manufacturer's Warranty: Provide manufacturer's standard warranty of one (1) year parts and labor, and ten (10) years structural. [Confirm warranty commencement date (shipment vs. Substantial Completion) with manufacturer.]

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Model BFL2-4144 hydraulic scissor lift, "Big Friggin' Lift" (BFL) series, as manufactured by Advance Lifts, Inc. [Confirm acceptable substitution/equal provisions with Architect prior to bidding.]

2.02 PERFORMANCE AND CAPACITY

A. Quantity: 2 or as otherwise indicated in the Drawings.
B. Installation: Pit
C. Rated Capacity: 4,000 lb (1,814 kg) uniform load capacity, with a maximum end load capacity of 2,550 lb and a maximum side load capacity of 1,325 lb.
D. Platform Size: 72 inches by 108 inches (6 feet by 9 feet), nominal. [Model BFL2-4144 accommodates platform sizes from 72" x 108" minimum up to 96" x 132" maximum; confirm final platform size with manufacturer.]
E. Lowered Height: 17-1/2 inches.
F. Raised Height: 161-1/2 inches.
G. Travel: 144 inches (12 feet). [Per manufacturer's published data for this model; confirm required travel against the project's mezzanine or floor elevation and coordinate pit or shaftway depth accordingly.]
H. Speed: 48 seconds for full travel.
I. Operation: Manned platform operation via platform-mounted controls, with remote operation via ground-level controls.

2.03 LIFT MECHANISM AND STRUCTURE

A. Scissor Assembly: Tubular steel leg construction to maximize rigidity while minimizing overall unit weight.
B. Platform Centering Device: Provide manufacturer's patented platform centering device to reduce wear and extend lift life.
C. Platform: Structural steel platform, sized as indicated above.
D. Safety Bar: Provide manufacturer's standard BFL swing arm safety bar at the platform access point.

2.04 POWER UNIT AND HYDRAULIC SYSTEM

A. Motor: 5 HP external electric motor. [Confirm voltage and phase with Division 26.]
B. Cylinders: Machine-grade hydraulic cylinders with clear plastic return lines.
C. Oil Reservoir: Mild steel oil reservoir.
D. Hoses: Double wire braid pressure hoses with JIC fittings.
E. Controller: Power unit with UL-listed controller assembly.

2.05 CONTROLS AND SAFETY DEVICES

A. Platform Controls: Constant-pressure up/down controls mounted at the platform for manned operation.
B. Ground-Level Controls: Constant-pressure up/down controls at ground level to allow remote operation.
C. Safety Devices: Platform centering device and swing arm safety bar as specified above, together with manufacturer's standard safety devices conforming to applicable ANSI codes.
D. Electrical: UL-listed control assemblies; final electrical connection under Division 26.

2.06 FINISH

A. Finish: Manufacturer's standard, fully primed unit with baked enamel finish. [Confirm color selection with Architect.]

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify pit or foundation dimensions, reinforcement, and embedded items comply with manufacturer's requirements prior to installation.
B. Verify structural support and electrical rough-in are complete and coordinated with equipment requirements.

3.02 INSTALLATION

A. Install lift in accordance with manufacturer's written instructions and approved shop drawings.
B. Level and anchor lift base and scissor assembly per manufacturer's requirements.
C. Connect power supply in accordance with Division 26 and the National Electrical Code.
D. Field test lift through full range of travel; verify smooth operation, proper limit switch function, and operation of the platform centering device, swing arm safety bar, and all controls at both platform and ground-level stations.

3.03 ADJUSTING AND CLEANING

A. Adjust controls and safety devices for proper operation per manufacturer's requirements.
B. Clean exposed surfaces; remove protective coverings and labels not required to remain.
C. Provide manufacturer's factory-authorized start-up and demonstrate operation to Owner's representative.

END OF SECTION 11 13 19

END OF DIVISION 11

DIVISION 12 – FURNISHINGS

SECTION 12 24 00 – ROLLER WINDOW SHADES

SECTION 12 36 61 – SIMULATED STONE COUNTERTOPS

SECTION 12 48 13 – ENTRANCE FLOOR MATS AND FRAMES

SECTION 12 52 19 – UPHOLSTERED SEATING

SECTION 12 70 00 – MULTIPLE SEATING SYSTEMS

SECTION 12 24 00 – ROLLER WINDOW SHADES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Motorized and manually operated, roll-up fabric interior window shades, including mounting and operating hardware.

1.02 RELATED SECTIONS

A. Section 06 10 00 – Rough Carpentry: Blocking for support of window shade hardware.
B. Section 07 90 00 – Joint Sealers: Sealants for perimeter of shade system.
C. Section 09 21 23 – Gypsum Board Assemblies: Suspended gypsum board ceilings to contain recessed window shade pockets.
D. Section 09 51 23 – Acoustical Tile Ceilings: Suspended acoustical panel ceilings to contain recessed window shade pockets.
E. Division 26 – Electrical: Power supply and low-voltage control wiring for motorized shade operators and controls.

1.03 REFERENCES

A. NFPA 701 – Fire Tests for Flame-Resistant Textiles and Films.
B. GREENGUARD Gold – Environmental Institute certification for low chemical emissions.
C. ANSI/WCMA A100.1-2022 – Safety standard for manual window shades with closed-loop bead chains, per Consumer Product Safety Commission requirements.

1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 26 – Submittal Procedures.
B. Product Data: Manufacturer's data sheets on each product specified, including preparation, installation, and maintenance instructions; styles, material descriptions, dimensions, profiles, features, finishes, and operating instructions; storage and handling requirements; and mounting details.
C. Window Treatment Schedule: For all roller shades, using the same room designations indicated on the Drawings, with field-verified window dimensions, quantities, type of shade and operation (manual or motorized), controls, fabric, and color, opening sizes, and key to typical mounting details.
D. Selection Samples: For each finish product specified, one complete set of shade cloth options and aluminum finish color samples representing the manufacturer's full range of available colors and patterns.
E. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements; shade fabric sample and aluminum finish sample as selected, representing actual product, color, and pattern, with the interior face marked.
F. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, and instructions for operating hardware and controls.
G. Warranty: Manufacturer's standard defect warranty documentation.
H. Manufacturer's Certificates: Certify that products meet or exceed the specified requirements.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of twenty years' experience manufacturing products comparable to those specified in this section.
B. NFPA Flame Test: Shade fabric shall pass NFPA 701. Materials tested shall be identical to the products proposed for use. Provide manufacturer's certification that the fabric sourced for this project complies with the test data provided.
C. Electrical Component Listing: Motor and control components for motorized shades shall be listed by Underwriters Laboratories (UL).

1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver window shades until the building is enclosed and construction within spaces where shades will be installed is substantially complete.
B. Deliver products in manufacturer's original, unopened, undamaged containers with labels intact.
C. Label containers and shades according to the Window Shade Schedule.
D. Store products in manufacturer's unopened packaging until ready for installation.

1.07 PROJECT CONDITIONS

A. Install roller shades after finish work, with ambient temperature, humidity, and ventilation conditions maintained at levels recommended by the manufacturer.

1.08 WARRANTY

A. Hardware and Shade Fabric: Manufacturer's standard twenty-five-year limited warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: FlexShade®, as manufactured by Draper, Inc., 411 S. Pearl Street, P.O. Box 425, Spiceland, IN 47385-0425; (800) 238-7999; www.draperinc.com.
B. Substitutions: Confirm substitution provisions with Architect prior to bidding.

2.02 MANUALLY OPERATED WINDOW SHADES: **RWS-1**

A. General: Manually operated, vertical roll-up, fabric window shade with components necessary for complete installation; Clutch-operated FlexShade®.
B. Operation: Bead chain and clutch operating mechanism allowing the shade to stop when the chain is released; designed to never require adjustment or lubrication. Provide limit stops to prevent the shade from being raised or lowered too far.
C. Clutch Mechanism: Fabricated from high carbon steel and molded fiberglass-reinforced polyester or injection-molded nylon. color as selected by Architect.]
D. Spring-Assist Clutch Mechanism: Adjustment-free system incorporating spring-assist components to reduce the lifting force required to raise the shade. [Recommended where estimated non-spring-assist torque exceeds 6 lb.-in.; required where estimated torque exceeds 15 lb.-in. — confirm requirement with manufacturer based on shade size and weight.]
E. Bead Chain Loop: Stainless steel.
F. Idler Assembly: Molded nylon roller idler assembly with adjustable or spring-loaded idler pin, to facilitate installation and removal of the shade for service.
G. Bead Chain Hold-Down: Spring-loaded tensioner complying with ANSI/WCMA A100.1-2022; when properly installed, the tensioning device shall have 1-1/2 inches of tolerance to minimize adjustments due to chain stretching.

2.03 MOTORIZED WINDOW SHADES: **RWS-2**

A. Type: UL listed, motorized, vertical roll-up, fabric window shade with motor, controls, mounting brackets, and other components necessary for complete installation; Motorized FlexShade® AC.
B. Mounting: [Mounting brackets / endcaps with pocket headbox — select and coordinate location(s) with the Window Treatment Schedule.]
C. Motor: [Standard Motor — 120V AC, single phase, 60 Hz, instantly reversible, lifetime lubricated, equipped with internal thermal overload protector, electric brake, and pre-set accessible limit switches, tubular motor concealed inside the shade roller tube; or Quiet Motor — 120V AC, operating at 38 dB measured 3 feet from the motor, makes no audible clicks when starting or stopping, tubular motor concealed inside the shade roller tube — confirm motor selection with Architect based on application and noise requirements.]
D. Controls: [Individual Control — toggle three-position wall switch, or key-operated three-position wall switch; or Group Control — single motor controller for motorized roller shades, usable standalone or networked via RS-485 with on-board contact closure interface, configurable to respond to wall switches, RF remotes, and third-party system signals, input power 110-230VAC at 50/60Hz, maximum output 6A at input power, ABS plastic construction, 4"x4"x4" enclosure; or Individual and Group Control — Model IGC4N1, individual and group control of up to four motors with up to three intermediate positions per motor — select control system with Architect and coordinate with Division 26.]

2.04 MOUNTING AND HARDWARE

A. Configuration: Single roller.
B. Mounting: [Universal mounting brackets / endcaps, where not recessed / recessed pocket headbox, where indicated on the Drawings — select and coordinate location(s) with the Window Treatment Schedule.]
C. Brackets: Plated, stamped steel; size compatible with roller size. Mounted to [ceiling / window head / jamb] as indicated on the Drawings. Finish: [TBD].
D. Endcaps: Stamped steel, universal design, suitable for mounting to ceiling, wall, or jamb; size compatible with roller size. Idler endcap to have optional leveling adjustment.
E. Roller Tube: Fabricated from extruded aluminum, galvanized steel, or enameled steel; diameter, wall thickness, and material as selected by manufacturer to accommodate shade type and size. Minimum roller diameter 1-1/2 inches; tube diameters less than 1-1/2 inches are not acceptable unless the manufacturer provides a deflection analysis showing deflection limited to width (inches)/700 or less at 1.5 times the design load.
F. Fabric-to-Tube Attachment: Low surface energy (LSE) double-sided adhesive developed to attach coated textiles to metal, eliminating horizontal impressions in the fabric.
G. Shade Slat: [Open pocket elliptical slat — 1 inch aluminum elliptical slat with plastic ends, inside a 1-5/8 inch pocket — confirm selection with manufacturer and Architect.]
H. Recessed Shade Pocket (Type D): [Where indicated on the Drawings, provide manufacturer's Type D rectangular pocket and endcaps, designed for recessed ceiling installation with ceiling tile lip.]
    (1) Material: Extruded aluminum with white finish.
    (2) Size: 5 inches wide by 5-3/8 inches high.
    (3) Closure Panel: 1-1/2 inch closure dimension, recommended for bead chain operation.
    (4) Pocket End Cap Kit: Metal endcaps with 7/8 inch lip for support of acoustical ceiling panel, where applicable.
    (5) Corners: Welded, one-piece aluminum sections connecting to and matching the pockets, to allow a continuous shade recess at ceiling corners, where applicable.

2.05 FABRIC

A. Light-Filtering Fabric, PVC-Coated Fiberglass, Basketweave: Provide the following, as assigned by location in the Window Treatment Schedule.
    (1) SheerWeave Series SW2000 by Phifer: 500 denier fiberglass, vinyl-coated, woven into a 2-by-2 basket weave, 5 percent open, 14.26 oz/sq yd, 0.019 inches thick. Fire rating: NFPA 701 (small and large scale), NFPA 101 Class A, IBC Section 803.1.1 Class A. Bacterial and fungal resistance: ASTM E2180, ASTM G21, ASTM G22, AATCC 30 Part 3, ASTM D3273; includes Microban antimicrobial additive. Environmental certification: UL GREENGUARD and GREENGUARD Gold for low chemical emissions. Complies with US Consumer Product Safety Commission Section 101 and ANSI/WCMA A100.1 for lead content.

(2) SheerWeave Series SW7500 by Phifer: PVC-free polyester with an acrylic coating, opaque, 12.14 oz/sq yd, 0.016 inches thick. Fire rating: NFPA 701 (small scale), NFPA 101 Class A, IBC Section 803.1.1 Class A. Bacterial and fungal resistance: ASTM E2180, ASTM G21. Environmental certification: UL GREENGUARD and GREENGUARD Gold for low chemical emissions. Complies with US Consumer Product Safety Commission Section 101 and ANSI/WCMA A100.1 for lead content.

B. Color and Pattern: Color Schedule in Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.
B. If substrate preparation is the responsibility of another installer, notify the Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Coordinate requirements for blocking, construction of shade pockets, and structural supports to ensure adequate means for installation of window shades.
B. Coordinate installation of recessed shade pockets with construction of suspended acoustical panel or gypsum board ceilings, where applicable.
C. Coordinate requirements for power supply conduit and wiring required for window shade motors and controls.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install roller shades level, plumb, square, and true; allow proper clearances for window operating hardware.
C. Shade Pockets: Install prior to or in conjunction with installation of the suspended ceiling system; attach to supporting structure with screws through the top of the pocket at 24 inches minimum on center. Install corner pieces and pocket ends securely and in alignment with the pockets. After interior construction is essentially complete, install the shade and operating mechanism in the pocket.
D. Install fascias, closure panels, and/or endcaps as required to conceal the roller and operating mechanism, using no exposed fasteners.
E. Install headbox, side channels, and sill channel with sealant specified in Section 07 90 00 – Joint Sealers, to eliminate light leaks at the perimeter of the shade system.
F. Connect motorized shade operators and controls in accordance with Division 26 and manufacturer's instructions.
G. Position shades level, plumb, and at the proper height relative to adjacent construction; secure with fasteners recommended by the manufacturer.

3.04 TESTING AND DEMONSTRATION

A. Test window shades to verify that the operating mechanism and other operating components are functional; correct deficiencies.
B. Test motorized window shades to verify that controls, limit switches, interface to other building systems, and other operating components are functional; correct deficiencies.
C. Demonstrate operation of shades to the Owner's designated representative.

3.05 PROTECTION

A. Protect installed products until completion of the project.
B. Touch-up, repair, or replace damaged products before Substantial Completion.

3.06 SCHEDULES

A. Refer to Drawings and Window Treatment Schedule for shade types, operation, and locations.

END OF SECTION 12 24 00

SECTION 12 36 61 – SIMULATED STONE COUNTERTOPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

(1) Solid surface material countertops.
(2) Solid surface material backsplashes.
(3) Solid surface material end splashes.
(4) Solid surface material apron fronts.
(5) Solid surface material sinks.

B. Related Requirements:

(1) Section 224100 "Plumbing Fixtures"

1.03 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants. .

1.04 LEED SUBMITTAL REQUIREMENTS

A. Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant

1.05 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Sustainable Design Submittals:

(1) <Double click to insert sustainable design text for certified wood.>
(2) <Double click to insert sustainable design text for adhesives.>
(3) <Double click to insert sustainable design text for composite wood.>

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

(1) Show locations and details of joints.
(2) Show direction of directional pattern, if any.

D. Samples for Initial Selection: For each type of material exposed to view.

E. Samples for Verification: For the following products:

(1) Countertop material, 6 inches (150 mm) square.
(2) Wood trim, 8 inches (200 mm) long.
(3) One full-size solid surface material countertop, with front edge[**and backsplash**], 8 by 10 inches (200 by 250 mm), of construction and in configuration specified.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.08 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
B. Installer Qualifications: Fabricator of countertops.
C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
   (1) Build mockup of typical countertop as shown on Drawings.
   (2) Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements[**after base cabinets are installed but**] before countertop fabrication is complete.

1.10 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.01 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
   (1) Approved Manufacturers:
      (a) CT-1: Caesarstone (https://www.caesarstone.com/)
      (b) CT-2: Corian (https://www.corian.com/)
      (c) CT-3: Corian (https://www.corian.com/)
   (2) Type: Provide Standard type unless Special Purpose type is indicated.
   (3) Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
   (4) Colors and Patterns: As selected by Architect from manufacturer's full range.
B. Particleboard: ANSI A208.1, **Grade M-2**.
C. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.02 COUNTERTOP FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
   (1) Grade: Economy
B. Configuration:
   (1) Front: [Straight, slightly eased at top] [Beveled] [**3/4-inch (19-mm)** bullnose] [Radius edge with apron, **2 inches (50 mm)** high with **3/8-inch (9.5-mm)** radius] [**1-1/2-inch (38-mm)** laminated bullnose] [**1-inch (25-mm)** laminated bullnose] [Straight, slightly eased at top with separate apron, **6 inches (150 mm)** high, recessed **1/4-inch (6.4-mm)** behind front edge] [Wood-trimmed edge as indicated].
   (2) Backsplash: [Straight, slightly eased at corner] [Beveled] [Radius edge with **3/8-inch (9.5-mm)** radius].
   (3) End Splash: [Matching backsplash] [None].
C. Countertops: [**1/2-inch- (12.7-mm-)**] [**3/4-inch- (19-mm-)**] thick, solid surface material[with wood-trimmed edges] [with front edge built up with same material].
D. Countertops: 1/4-inch- (6.4-mm-) thick, solid surface material laminated to 3/4-inch- (19-mm-) thick particleboard with [wood-trimmed exposed edges] [exposed edges built up with **3/4-inch- (19-mm-)** thick, solid surface material] [exposed edges faced with **1/4-inch- (6.4-mm-)** thick, solid surface material].
E. Backsplashes: [**1/2-inch- (12.7-mm-)**] [**3/4-inch- (19-mm-)**] thick, solid surface material[with wood-trimmed edges].
F. Fabricate tops with shop-applied edges[**and backsplashes**] unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
   (1) Fabricate with loose backsplashes for field assembly.
   (2) Install integral sink bowls in countertops in the shop.
G. Joints: Fabricate countertops without joints.
H. Joints: Fabricate countertops in sections for joining in field[**, with joints at locations indicated**].
   (1) Joint Locations: Not within 18 inches (450 mm) of a sink or cooktop and not where a countertop section less than 36 inches (900 mm) long would result, unless unavoidable.
   (2) Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints[**where indicated**]. Make width of cuts slightly more than thickness of splines to provide snug fit.[**Provide at least three splines in each joint.**]
I. Cutouts and Holes:
   (1) Undercounter Plumbing Fixtures: Make cutouts for fixtures[**in shop**] using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

(a) Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch (5 mm) into fixture opening.
(b) Provide vertical edges, rounded to 3/8-inch (10-mm) radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch (5 mm) into fixture opening.
(c) Provide 3/4-inch (20-mm) full bullnose edges projecting 3/8 inch (10 mm) into fixture opening.

(2) Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
(3) Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
(4) Counter-Mounted Cooktops: Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

2.03 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.
B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m), 1/4 inch (6 mm) maximum. Do not exceed 1/64-inch (0.4-mm) difference between planes of adjacent units.
B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

(1) Install metal splines in kerfs in countertop edges at joints[**where indicated**]. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
(2) Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

(1) Seal edges of cutouts in particleboard subtops by saturating with varnish.

I. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 12 36 61

SECTION 12 48 13 – ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide entrance floor mats and recessed frames where indicated on the Drawings, as specified herein, and as necessary for complete installation.

1.02 RELATED SECTIONS: DIVISION-03 sections for concrete Work, including forming, placing, and finishing concrete floor slabs and grouting frames into recess.

1.03 SUBMITTALS

A. SUBMIT PRODUCT DATA for each type of floor mat and frame specified, including manufacturer's specifications and installation instructions, details of construction relative to materials, dimensions of individual components, profiles, and finishes.
B. SUBMIT SHOP DRAWINGS showing layout and types of floor mat and frames, full-scale sections of typical installations, details of patterns or designs, anchors, and accessories.
C. SUBMIT MAINTENANCE DATA in form of manufacturer's printed instructions for cleaning and maintaining floor mats.

1.04 FIELD MEASUREMENTS: Check actual blocked-out openings in floors by accurate field measurements before fabrication of frames and mats; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

PART 2 - PRODUCTS

2.01 FLUSH-RECESSED FLOOR MATS & FRAME: Bolt-thru type construction with individual aluminum spacers – note that swedge, welded and key lock fastening of rails is not acceptable.

A. BASIS-OF-DESIGN PRODUCT / MANUFACTURER: “Ultra Track” foot grille by Mats Inc., P: 800-628-7462 - web: www.matsinc.com.

2.02 COMPONENT MATERIALS:

A. Aluminum Alloy type 6061-T6. (soft aluminum alloy such as 6063-T52 is not acceptable)
B. Recycled Content: Aluminum to be 64% pre-consumer and 16% post-consumer recycled content
C. Blades: T-Shaped blades, 3/16” x 1/8” x 1” Size, spacing between blades not to exceed 3/16 inch.
D. Dimension: Grille depth to be 1”, with frame 1-1/8”
E. Panels: Foot Grille to be supplied in panels not to exceed 48” x 42” (one-piece design not acceptable). Provide all grille panels with individual, pre-fabricated, factory-assembled frames
F. Rolling Load Capacity: 3,831 lbs per 2 foot span

2.03 SHALLOW-RECESSED MAT FRAMES: Provide manufacturer's standard extruded aluminum frame, of design, size and style to fit floor mat type and match approved sample for permanent recessed installation in floor, complete with corner pins or reinforcing and installation anchorages. Provide unit height as required by floor mat. Coat surface of frame that will contact cementitious material with zinc chromate paint or manufacturer's standard protective coating. Pre-assemble and weld all joints at factory.

2.04 FLOOR MAT / GRILLE UNIT: Provide invisible section divider integrated and welded within the frame. For sections larger than 6'-0 by 8'-0, provide a mechanical joint.

2.05 UNIT ACCESSORIES: Provide flush stainless steel hinges and keyed-lock downs attached to each grid section.

2.06 EPOXY UNDERLAYMENT: Provide “Ardex” cement underlayment as required to ensure a level base for mat.

2.07 PROVIDE colors, patterns, and profiles of materials, including metals and metal finishes, as indicated on drawings or by this specification or, where not indicated, as selected by Architect from manufacturer's standard colors, patterns, and profiles.

2.08 SHOP FABRICATE units of floor mat work to greatest extent possible in sizes as indicated. Where not otherwise indicated, provide single unit for each mat installation, but do not exceed manufacturer's maximum size recommendation for units intended for removal and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints. Where possible, verify sizes by field measurement before shop fabrication.

PART 3 - EXECUTION

3.01 INSTALL RECESSED FRAMES and mats to comply with manufacturer's instructions, at locations indicated and with top of frames and mats in proper relationship to one another and to adjoining finished flooring. Set mat tops at height recommended by manufacturer for most effective cleaning action; coordinate top of mat surfaces with doors that swing across mats to provide underdoor clearance.

3.02 UPON COMPLETION OF FRAME INSTALLATIONS and concrete work, provide temporary filler of plywood or fiberboard in recesses, and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and project is near time of Substantial Completion.

3.03 DEFER INSTALLATION of floor mats until near time of Substantial Completion for project.

END OF SECTION 12 48 13

SECTION 12 52 19 – UPHOLSTERED SEATING

PART 1 - GENERAL

1.01 WORK INCLUDED: Provide custom fabricated upholstered seating, as indicated on the Drawings, as specified herein, and as necessary for a complete installation at the Project Site. The Work of this Section includes:

A. Upholstered “banquette” wall seating units with upholstered backs and seats – without exposed ends.

1.02 RELATED SECTIONS: Division-06 “Finish Carpentry”, “Interior Architectural Woodwork” or “Casework” Sections, as applicable.

1.03 DEFINITIONS – ILD: Indent Load Deflection

1.04 QUALITY ASSURANCE: Except as otherwise indicated by the Drawings or these Specifications, comply with applicable requirements of Architectural Woodwork Institute (AWI)’s "Quality Standards" Section 400 – Custom Grade.

1.05 SUBMITTALS

A. SUBMIT PRODUCT DATA for each type unit of standard manufacturer, or components of custom fabrication, Including data for fire-retardant treatment from manufacturers.

B. SUBMIT SHOP DRAWINGS showing location of units at the site, dimensioned plans and elevations, large-scale details, attachment devices, and other components, and unit fabrication details for custom-designed units. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement required to be installed as Work of other Sections.

C. SUBMIT SAMPLES FOR INITIAL SELECTION, to include Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.

(1) Shop-applied transparent or opaque finishes.
(2) Plastic laminates or melamine finished surfaces, if applicable.
(3) Upholstery fabric(s)

D. SUBMIT MAINTENANCE DATA to include upholstery manufacturer’s recommended methods for maintaining fabric, including precautions for cleaning materials and methods that could be detrimental to seating and performance.

1.06 QUALITY ASSURANCE

A. FIRE-TEST RESPONSE CHARACTERISTICS:

(1) Fabric: Class 1 per DOC CS 191 and 16 CFR 1610.61, tested per California Technical Bulletin # 117.
(2) Padding: Comply with California Technical Bulletin # 117
(3) Full-scale Fire Test: Comply with California Technical Bulletin # 122.

1.07 DO NOT DELIVER WORK until painting and similar operations that could damage units have been completed in installation areas. If units must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in the following “Project Conditions" paragraph.

1.08 PROJECT CONDITIONS

A. ENVIRONMENTAL LIMITATIONS: Do not deliver or install units until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. FIELD MEASUREMENTS: Where units are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work. Locate concealed framing, blocking, and reinforcements that support units by field measurements before being enclosed and indicate measurements on Shop Drawings.

(1) Where field measurements cannot be made without delaying the Work, establish and set dimensions and proceed with fabricating units without field measurements, and provide allowance for trimming and fitting at the site. Coordinate construction to ensure that actual dimensions correspond to established dimensions required.

PART 2 - PRODUCTS

2.01 PROVIDE MATERIALS THAT COMPLY with requirements of the referenced AWI quality standard as applicable, and as follows:

2.02 UPHOLSTERY FABRIC: As indicated on the Drawings, and in compliance with requirements herein.

2.03 UPHOLSTERY BACKING / PADDING: Non-woven polyester fiber material equivalent to “Lantuck” by Johnston Industries

2.04 UPHOLSTERY PADDING: Flexible, cellular, molded or slab polyurethane foam, and as follows (if not otherwise indicated on the Drawings):

A. Seat Bases: Minimum four (4) inch thick - 2.7 pound density foam, ILD: 43 minimum
B. Seat Backs: Minimum two (2) inch thick - 2.0 pound density foam, ILD: 24 to 28.

2.05 SEAT SPRINGS: Sinuous type, paper wrapped oil-tempered 9 gage steel wire springs at 3.5 inch centers typically, secured with non-squeak “E” clips, and with fiber-coated wire stabilizer bars running length of seat.

2.06 TYPICAL SUBSTRATE MATERIAL: Minimum 5/4 inch thick solid yellow pine framework (at spring seats typically), or solid panels of 3/4 inch thick softwood plywood meeting DOC PS 1 without urea formaldehyde – manufacturer’s option - except as otherwise indicated.

2.07 HIGH-PRESSURE DECORATIVE LAMINATE: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard. Provide plastic laminate by Manufacturer and color as indicated in the Drawings, or if not indicated, provide materials by one of the following, subject to approval by the Architect:

A. Chemetal
B. Formica Corporation.
C. Laminart
D. Pioneer Plastics Corp.
E. Wilsonart International; Div. of Premark International, Inc.

2.08 HARDWOOD VENEERED PLYWOOD: Provide wood veneer material in species and cut as indicated in the Drawings, in compliance with the Hardwood Plywood and Veneer Association (HPVA)'s grade: HP-1.

2.09 NATURAL-WOOD VENEER LAMINATE: Provide material by manufacturer in color/series as indicated in the Drawings, or if not indicated, use "natural-finished wood" composite veneered laminate material manufactured with real wood, as manufactured by Treefrog Veneer (www.treefrogveneer.com) or equal as approved by the Architect.

2.10 THERMOSET DECORATIVE OVERLAY: Particleboard complying with ANSI A208.1, Grade M-2, or medium-density fiberboard complying with ANSI A208.2, Grade MD, with surface of thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1. Provide material with no added urea formaldehyde (NAUF).

2.11 ADHESIVE

A. for Bonding Plastic Laminate: contact cement.
B. for Bonding Edges: Hot-melt adhesive.

2.12 MISCELLANEOUS WOOD PRODUCTS:

A. Hardboard: AHA A135.4.
B. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade MD.
C. Particleboard (PBD): ANSI A208.1, Grade M-2
D. Softwood Plywood: DOC PS 1, Medium Density Overlay.

2.13 INSTALLATION MATERIALS

A. FURRING, BLOCKING, SHIMS, AND HANGING STRIPS: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
B. ANCHORS: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.14 FABRICATION, GENERAL

A. SHOP FABRICATE units to dimensions, profiles, and details indicated on shop drawings. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting. Complete fabrication, finishing, hardware application and other Work before shipment to project site to maximum extent possible. Mark individual items in sequence with removable materials to facilitate field assembly. Ease edges of exposed solid wood (lumber) members to 1/16 inch radius.
B. WOOD MOISTURE CONTENT: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

2.15 FABRICATION:

A. UPHOLSTERED SEATING UNIT FABRICATION / COMPONENTS:
   (1) Configuration: recessed, wall seating units without exposed ends or outside back (OSB) units.
   (2) Typical Unit size:
      (a) 25 inch unit deep overall (to front edge of padded seat) with a 19 inch deep, recessed base
      (b) 36 inch high overall (without headrail)
      (c) 18.5 inch high padded seat height at front edge
   (3) Removable, foam padded upholstered top cap
   (4) Back pad: three (3) equal height horizontal foam filled continuous channels or as otherwise indicated on the Drawings
   (5) Crumb Rail: laminated finished
   (6) Seat Units: removable single-depth upholstered pad unit
   (7) Seat Skirt: foam padded and upholstered to match removable seat unit above (except as indicated otherwise)
   (8) Seat support: springs mounted to framework so users will not "bottom out"
      (a) Seat support: solid plywood
   (9) Base: Six (6) inch high (or as otherwise indicated on Drawings) closed unit - plastic laminate finished (black color UNO)
B. Fabricate fabric-covered cushions fitted tightly and evenly, with molded padding beneath fabric and with fabric covering free of welts, creases, stretch lines or wrinkles. For each upholstered component, install pile and pattern run of fabric in a consistent direction.
   (1) Reinforce framework by providing glued corner blocks typically,
C. Wrap foam seats and back cushions fully in 1/2 ounce Dacron meeting fire regulations
D. Glue attach fabric to foam, with clips and screws for removable attachment
   (1) Sew cushions with bullnose finish, unless indicated otherwise.

(2) Fabricate for tight fit between cushions, and adjacent construction, unless otherwise indicated.
(3) Sew loop portions of woven nylon hook and loop (“Velcro”) fasteners to align with hook section mounted to substrate

PART 3 - INSTALLATION:

3.01 DELIVER inserts and other anchoring devices to be built into substrates, well in advance of time substrates are to be built. Condition wood materials to average prevailing humidity conditions in installation areas prior to installation.

3.02 DISCARD units of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned or too small to fabricate work with minimum of joints or optimum jointing arrangements, or which are of defective manufacturer with respect to surfaces, sizes or patterns.

3.03 INSTALL the Work plumb, level, true and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8 inch in 8'-0" for plumb and level, and with 1/16" maximum offset in flush adjoining surfaces and 1/8" maximum offsets in revealed adjoining surfaces.

3.04 SCRIBE AND CUT to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.

3.05 ANCHOR to anchors or blocking built-in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation without distortion. Except where prefinished matching fastener heads are required, use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork, and matching final finish where transparent finish is indicated.

3.06 REPAIR DAMAGED and defective units to eliminate defects functionally and visually, or where not possible, replace units. Adjust joinery for uniform appearance. Clean units on exposed and semi-exposed surfaces. Touch-up shop applied finishes to restore damaged or soiled areas.

3.07 TOUCH-UP FINISHING as required by installation. Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing of concealed surfaces and similar items.

3.08 PROTECTION: Provide final protection and maintain conditions, in a manner acceptable to Fabricator and Installer, which ensures that the seating units will be without damage or deterioration at time of substantial completion.

END OF SECTION 12 52 19

SECTION 12 70 00 – MULTIPLE SEATING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY:

A. Section Includes:

(1) Table systems.
(2) Fixed Table: Symmetra System.
(3) Extent: Systems to be as indicated on Drawings and as specified.

1.02 PRODUCT DESCRIPTION:

A. Seat/Table Requirements:

(1) Pedestal: Provide table and supports providing fixed work surface with open access, supported by pedestals.
(2) Power and Data Distribution System: Modular data and electrical system housed in flexible conduit. All power system components shall be UL approved, including the steel pedestal table leg used for power entry, which shall be certified as a “UL Recognized Component,” and will have appropriate labeling documenting that approval.

1.03 ACTION SUBMITTALS:

A. General: Submit listed submittals in accordance with Contract and standard Submittals Procedures.
B. Product Data: Submit manufacturers’ product data, including product specification sheets, for each product specified.
C. Shop Drawings: For unit assembly and installation.

(1) Submit shop drawings showing seating layout, seat-numbering scheme, chair sizes and aisle widths.

D. Samples for Verification: Submit verification samples of finishes, colors and textures specified for each exposed material.

1.04 INFORMATION SUBMITTALS:

A. Quality Assurance Submittals: Submit the following:

(1) Certificates: Product certificates signed by manufacturer certifying materials comply with specify performance characteristics and criteria and physical requirements.
(2) Installer Qualifications: Submit certification indicating installer is qualified to install manufacturer's seating.

B. Bidder Qualifications: Submit certification, prior to drawing completion, indicating site has been inspected for any conditions that may affect the assembly or installation of products required.

1.05 WARRANTY:

A. Project Warranty: Refer to “Conditions of the Contract” to project warranty provisions.
B. Manufacturer's Warranty: Submit, for Owners acceptance:
C. Manufacturer’s standard warranty documents executed by authorized company official. Manufacturer’s warranty is in addition to, and not a limitation of, other rights Owners may have under Contract Documents.
D. Warranty period; Ten (10) year warranty on understructure and seating shells (when utilized) from defects of manufacture and workmanship, commencing on Date of Substantial Completion.
E. Warranty will be null and void if products are installed on flooring not meeting minimum structural requirements as specified by manufacturer.

PART 2 - PRODUCTS

2.01 TABLE SYSTEM:

A. Manufacturer: Navetta division of Shuttlesystem LLC.
B. Product: Symmetra Fixed Table System.
C. Product Specifications:

(1) Pedestal Support Construction: Pedestals shall be constructed of 11 gauge steel tubing of oval cross-section measuring 3.15 inches x 1.57 inches.
(2) Floor Mount: Pedestal shall be computer-controlled welded to a .25 inch thick steel base plate measuring 8 inches x 4 inches with four slotted holes for mounting pedestal to floor with anchor bolts.
(3) Base Cover: Base plate to be fully covered after mounting with two-piece cover constructed of injection molded toughened nylon, attached with two machine screws.
(4) Table Mount: Top mount bracket shall be constructed of 11 gauge steel with four attaching bolts allowing attachment to pedestal and adjustment for variations in floor surface to provide alignment of adjacent tabletops without shimming tops. Bracket shall provide six mounting holes for attaching table top and designed to accept optional power and/or data electrical system.
(5) Top Shroud: Top mount bracket will be covered by shroud with rounded edges constructed of injection molded ABS, attached with machine screws.
(6) Metal Finish: Metal components shall have powder-coat finish in indicated on Drawings.
(7) Table Configuration: Table tops shall be designed to be assembled into continuous surface in straight, radius, or segmented configuration. Adjacent tops to be joined with two mechanical clamping fasteners. Tops shall have cutouts for tabletop power modules when specified. Manufacturer shall be FSC (Forest Stewardship Council) chain-of-custody Certified.

(8) Table Top Construction: Table tops shall be nominal 1.25 inch thick warp-resistant construction with 1.125 inch particleboard center core sandwiched between .040 inch high pressure laminate top surface and phenolic backing surface. Assembly to be permanently bonded under continuous pressure in hot press.
(9) Table Top Edge Treatment: Edges shall be finished to match table top finish as indicated on Drawings, using 3mm PVC, “T” cross-section vinyl continuous molding, wood surface, or bonded resin edging.
(10) Table Top Attachment: Table tops to attach to pedestal brackets with six #12 lag bolts.
(11) Modesty Panel Construction: Modesty panels shall be constructed of .8 inch thick nominal particle board sandwiched with bonded high-pressure laminate as indicated on Drawings and phenolic backing sheet, pattern and finish as indicated on Drawings.
(12) Modesty Panel Attachment: Modesty panels shall interlock into machined recess in underside of table top surface and attach with supplied rigid metal brackets and hardware. Standard configuration provides .5 inch clearance between adjacent modesty panels, continuous configuration optional.
(13) End Panel Construction: End panels shall be constructed of .8 inch thick nominal particle board sandwiched with bonded high-pressure laminate as indicated on Drawings and phenolic backing sheet, pattern and finish as indicated on Drawings.
(14) End Panel Attachment: End panels shall attach with supplied rigid metal brackets and hardware.

PART 3 - EXECUTION

3.01 MANUFACTURER’S INSTRUCTIONS:

A. Comply with manufacturer's installation instructions, including bulletins, product catalog, installation instructions and product carton instructions for installation.

3.02 EXAMINATION:

A. Site Verification: Prior to installation verify, with installer present, that substrates and conditions comply with the requirements for construction tolerances and materials properties as they affect anchors and fasteners and location of junction boxes.
B. Repair: Do not proceed until unsatisfactory components or facility conditions have been corrected.

3.03 INSTALLATION:

A. Installation: Install following manufacturers printed instructions for installation and using manufacturer recommended hardware and fasteners. Tables in curbed rows shall be installed at smooth radius.
B. Repair: Repair minor abrasions and imperfections in painted surfaces with a coating that matches the factory-applied finish.

3.04 CLEANING:

A. Clean Product in accordance with manufacturer instruction prior to Owner’s acceptance. Remove construction debris, including cartons from project site and legally dispose of debris.

3.05 PROTECTION:

A. Protect installed product and finished surfaces from damage during construction.

END OF SECTION 12 70 00

END OF DIVISION 12

DIVISION 13 – SPECIAL CONSTRUCTION

NOT USED

END OF DIVISION 13

DIVISION 14 – CONVEYING SYSTEMS

SECTION 14 21 00 – ELECTRIC STRACTION ELEVATORS

SECTION 14 21 00 – ELECTRIC TRACTION ELEVATORS

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies electric traction elevators.
B. Work Required
   (1) The work required under this section consists of all labor, materials and services required for the complete installation (including operational verification) of all the equipment required for the elevator(s) as herein specified.
   (2) All work shall be performed in a first class, safe and workmanlike manner.
   (3) In all cases where a device or part of the equipment is herein referred to in the singular, it is intended that such reference shall apply to as many of such devices or parts as required to make complete installation.

1.02 RELATED SECTIONS

A. The following sections contain requirements that relate to this section and are performed by trades other than the elevator manufacturer/installer.
   (1) Section 01 50 00 – Temporary Facilities and Controls: protection of floor openings and personnel barriers; temporary power and lighting.
   (2) Section 03 30 00 – Cast-In-Place Concrete: elevator pit and elevator machine foundation.
   (3) Section 04 20 00 – Unit Masonry: masonry hoistway enclosure, building-in and grouting hoistway doorframes, and grouting of sills.
   (4) Section 05 50 00 – Metal Fabrications: pit ladder, divider beams, supports for entrances and rails, and hoisting beam at top of elevator hoistway.
   (5) Section 07 16 00 – Cementitious Waterproofing: waterproofing of elevator pit.
   (6) Section 23 50 00 – Heat Generation Equipment: ventilation and temperature control of elevator equipment areas.
   (7) Section 26 05 00 – Common Work Results for Electrical:
      (a) Main disconnects for each elevator.
      (b) Electrical power for elevator installation and testing.
      (c) Disconnecting device to elevator equipment prior to activation of sprinkler system.
      (d) The installation of dedicated GFCI receptacles in the pit and overhead.
      (e) Lighting in controller area, machine area and pit.
   (8) Wiring for telephone service to controller.
   (9) Section 26 30 00 – Emergency (Standby) Power Supply Systems: emergency generator for elevator operation.
   (10) Section 27 30 00 – Voice Communications: ADAAG-required emergency communications equipment.
   (11) Section 28 31 00 – Fire Alarm Systems: fire and smoke detectors at required locations and interconnecting devices; fire alarm signal lines to contacts in the machine area.
   (12) Section 31 10 00 – Site Clearing: excavation for elevator pit.

1.03 REFERENCES

A. Comply with applicable building and elevator codes at the project site, including but not limited to the following:
   (1) ASME A17.1/CSA B44, Safety Code for Elevators and Escalators.
   (2) ASME A17.7/CSA B44, Performance-Based Safety Code for Elevators and Escalators.
   (3) ADAAG, American Disabilities Act Accessibility Guidelines.
   (4) ANSI A117.1, Building and Facilities, Providing Accessibility and Usability for Physically Handicapped People.
   (5) ANSI/NFPA 70, (NEC) National Electrical Code.
   (6) CAN/CSA C22.1, (CEC) Canadian Electrical Code.
   (7) ANSI/UL 10B, Standard for Fire Test of Door Assemblies.
   (8) CAN/ULC-S104-10, Standard Method for Fire Test of Door Assemblies.
   (9) ANSI/NFPA 80, Standard for Fire Doors and Other Opening Protectives.
   (10) Building Codes IBC or NBCC.
   (11) All Local Jurisdictional applicable codes.

1.04 SYSTEM DESCRIPTION

A. Equipment Description: Gen3 Edge™ gearless machine-room less elevator where all components fit inside the hoistway with the controller in the top landing entrance frame.
B. Equipment Control: Otis GCS Controller.
C. Drive: Regenerative
D. Quantity of Elevators: 2
E. Elevator Stop Designations: 1, 2, 3, 4
F. Stops: [4]
G. Openings: Front and Rear
   (1) Refer to Drawings for rear opening indicated.
H. Travel: 52'-0"
I. Rated Capacity: 3500 lb
J. Rated Speed: 200 fpm

K. Platform Size: 6'-6 3/4" W x 6'-8 3/16" D
L. Clear Inside Dimensions: 6'-6 3/4" x 5'-6 1/8"
M. Cab Height: [93"]
N. Clear Cab Height: 7'-4 5/16" (2243 mm)
O. Entrance Type and Width: Single Slide - 3'-6"
P. Entrance Height: [84"]
Q. Main Power Supply: 480 volts ± 5% of normal, three-phase, with a separate equipment grounding conductor.
R. Car Lighting Power Supply: 120 volts, single-phase, 15 amps, 60 Hz.
S. Machine Location: Inside the hoistway at the top of the hoistway.
T. Signal Fixtures: Manufacturer's standard with metal button targets (excluding CA).
U. Controller Location: [indicate location]
V. Performance:

(1) Car Speed: ± 3% of contract speed under any loading condition or direction of travel.
(2) Car Capacity: Safely lower, stop and hold up to 120% of rated load (code required).
(3) Ride Quality:

(a) Vertical Vibration (maximum): 20 milli-g
(b) Horizontal Vibration (maximum): 12 milli-g
(c) Vertical Jerk (maximum): 4.59 ± 1.0 ft./sec³ (1.4 ± 0.3 m/sec³)
(d) Acceleration/Deceleration (maximum): 2.62 ft./sec² (0.8 m/sec²)
(e) In Car Noise: 55 – 60 dB(A)
(f) Stopping Accuracy: ± 0.375 in. (± 10 mm) max, ± 0.25 in. (± 6 mm) Typical
(g) Re-leveling Distance: ± 0.5 in. (± 12 mm)

W. Operation: Duplex Collective Operation: Using a microprocessor-based controller, the operation shall be automatic by means of the car and hall buttons. In the absence of system activity, one car can be made to park at the pre-selected main landing. The other (free) car shall remain at the last landing served. Only one car shall respond to a hall call. If either car is removed from service, the other car shall immediately answer all hall calls, as well as its own car calls.
X. Operation Features – Standard

(1) Full Collective Operation
(2) Anti-nuisance.
(3) Fan and Light Protection.
(4) Load Weighing Bypass.
(5) Independent Service.
(6) Firefighters' Service Phase I and Phase II (USA only); or Special Emergency Service Phase I and II – Emergency Recall and In-Car Emergency Operation (Canada only).
(7) Top of Car Inspection.
(8) Zoned Car Parking.
(9) Relative System Response Dispatching.

Y. Operation Features – Optional

(1) Zoned Access at Bottom Landing.
(2) Zoned Access at Upper Landing.
(3) Express Priority Service with key-switch(es)
(4) Emergency Hospital Service.
(5) Automatic Rescue Operation
(6) Automatic Standby Power Operation with Manual Override.

Z. Door Control Features:

(1) Door control to open doors automatically when car arrives at a landing in response to a normal hall or car call.
(2) Elevator doors shall be provided with a reopening device that will stop and reopen the car door(s) and hoistway door(s) automatically should the door(s) become obstructed by an object or person.
(3) Door protection shall consist of a two-dimensional, multi-beam array projecting across the car door opening.
(4) Door nudging operation to occur if doors are prevented from closing for an adjustable period of time.

AA. Provide equipment for seismic conditions: No

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's product data for each system proposed for use. Include the following:

(1) Signal and operating fixtures, operating panels and indicators.
(2) Cab design, dimensions and layout.
(3) Hoistway-door and frame details.
(4) Electrical characteristics and connection requirements.
(5) Expected heat dissipation of elevator equipment in hoistway (BTU).
(6) Color selection chart for Cab and Entrances.

B. Shop Drawings: Submit approval layout drawings. Include the following:

(1) Car, guide rails, buffers, and other components in hoistway.
(2) Maximum rail bracket spacing.
(3) Maximum loads imposed on guide rails requiring load transfer to building structure.
(4) Clearances and travel of car.

(5) Clear inside hoistway and pit dimensions.
(6) Location and sizes of access doors, hoistway entrances and frames.

C. Operations and Maintenance Manuals: Provide manufacturer's standard operations and maintenance manual.

1.06 QUALITY ASSURANCE

A. Manufacturer: Elevator manufacturer shall be ISO 9001 certified.
B. Manufacturer shall have a minimum of fifteen years of experience in the fabrication, installation and service of elevators.
C. Installer: Elevators shall be installed by the manufacturer.
D. Permits, Inspections and Certificates: The Elevator Contractor shall obtain and pay for necessary Municipal or State Inspection and permit as required by the elevator inspection authority, and make such tests as are called for by the regulations of such authorities. These tests shall be made in the presence of such authorities or their authorized representatives.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Should the building or the site not be prepared to receive the elevator equipment at the agreed upon date, the General Contractor will be responsible to provide a proper and suitable storage area on or off the premises.
B. Should the storage area be off-site, and the equipment not yet delivered, then the elevator contractor, upon notification from the General Contractor, will divert the elevator equipment to the storage area. If the equipment has already been delivered to the site, then the General Contractor shall transport the elevator equipment to the storage area. The cost of elevator equipment taken to storage by either party, storage, and redeliver to the job site shall not be at the expense of the elevator contractor.

1.08 WARRANTY

A. The elevator contractor's acceptance is conditional on the understanding that their warranty covers defective material and workmanship. The warranty period shall not extend longer than one (1) year from the date of completion or acceptance thereof by beneficial use, whichever is earlier, of each elevator. The warranty excludes: ordinary wear and tear, improper use, vandalism, abuse, misuse, or neglect or any other causes beyond the control of the elevator contractor and this express warranty is in lieu of all other warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose.

1.09 MAINTENANCE AND SERVICE

A. Maintenance service consisting of regular examinations and adjustments of the elevator equipment shall be provided by the elevator contractor for a period of 12 Months after the elevator has been turned over for the customer's use. This service shall not be subcontracted but shall be performed by the elevator contractor. All work shall be performed by competent employees during regular working hours of regular working days. This service shall not cover adjustments, repairs, or replacement of parts due to negligence, misuse, abuse or accidents caused by persons other than the elevator contractor. Only genuine parts and supplies as used in the manufacture and installation of the original equipment shall be provided.
B. The periodic lubrication of elevator components shall not be required, including Sheaves, Rails, Belts, Ropes, Car and CWT guides, etc.
C. The elevator control system must:
(1) Provide in the controller the necessary devices to run the elevator on inspection operation.
(2) Provide on top of the car the necessary devices to run the elevator in inspection operation.
(3) Provide in the controller an emergency stop switch. This emergency stop switch when opened disconnects power from the brake and prevents the motor from running.
(4) Provide in the event of a power outage, means from the controller to electrically lift and control the elevator brake to safely bring the elevator to the nearest available landing.
(5) Provide the means from the controller to reset the governor over speed switch and also trip the governor.
(6) Provide the means from the controller to reset the emergency brake when set because of an unintended car movement or ascending car overspeed.
(7) (Optional) Provide the means from the controller to reset elevator earthquake operation.
D. Provide system capabilities to enable a remote expert to create a live, interactive connection with the elevator system to enable the following functions:
(1) Remotely diagnose elevator issues with a remote team of experts
(2) Remotely return an elevator to service
(3) Provide real-time status updates via email
(4) Remotely make changes to selected elevator functions including:
(a) Control building traffic: Restrict floor access, remove car from group operation, shut down elevator, select up peak/down peak mode and activate independent service.
(b) Conserve energy: Activate cab light energy save mode, activate fan energy save mode, shut down car(s).
(c) Improve passenger experience: Extend door open times, change parking floor, activate auto car full, activate anti-nuisance, advance door opening, door nudging, extend specific floor extended opening time, release trapped passengers.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Manufacturer: Design based upon Otis Elevator's Gen3™ machine room-less elevator system.

2.02 DESIGN AND SPECIFICATIONS

A. Provide machine-roomless Gen3™ traction passenger elevators from Otis Elevator Company. The control system and car design based on materials and systems manufactured by Otis Elevator Company. Specifically, the system shall consist of the following components:

(1) Controller located entirely inside the hoistway.
(2) An AC gearless machine using embedded permanent magnets mounted at the top of the hoistway.
(3) Polyurethane Coated-Steel Belts for elevator hoisting purposes.
(4) Regenerative drive that captures normally wasted energy and feeds clean power back into the building's power grid.
(5) LED lighting standard in ceiling lights and elevator fixtures.
(6) Sleep mode operation for LED ceiling lights and car fan.

B. Approved Installer: Otis Elevator Company

2.03 EQUIPMENT: CONTROLLER COMPONENTS

A. Controller: A microcomputer-based control system shall be provided to perform all of the functions of safe elevator operation. The system shall also perform car and group operational control.

(1) All high voltage (110V or above) contact points inside the controller shall be protected from accidental contact when the controller doors are open.
(2) Controller shall be separated into two distinct halves: Motor Drive side and Control side. High voltage motor power conductors shall be routed so as to be physically segregated from the rest of the controller.
(3) Field conductor terminations points shall be segregated; high voltage (>30 volts DC and 110 VAC,) and low voltage (< 30 volts DC)
(4) Controllers shall be designed and tested for Electromagnetic Interference (EMI) immunity according to the EN 12016 (May 1998): “EMC Product Family Standards for lifts, escalators, and passenger conveyors Part 2 – immunity”
(5) Controller shall be located inside the wall next to the top landing entrance frame. Emergency access shall be provided through an access panel in the entrance frame secured by a key lock.
(6) A separate control room, space or closet is an option.

B. Drive: A Variable Voltage Variable Frequency AC drive system shall be provided. The drive shall be set up for regeneration of AC power back to the building grid.

2.04 EQUIPMENT: HOISTWAY COMPONENTS

A. Machine: AC gearless machine, with a synchronous permanent-magnet motor, dual solenoid service and emergency disc brakes, mounted at the top of the hoistway.
B. Governor: The governor shall be a tension type car-mounted governor.
C. Buffers, Car, and Counterweight: Polyurethane type buffers shall be used for speeds of 150 and 200 feet per minute. Oil buffers shall be used for a speed of 350 feet per minute.
D. Hoistway Operating Devices:

(1) Emergency stop switch in the pit.
(2) Terminal stopping switches.

E. Positioning System: Consists of an encoder, reader box, and door zone vanes.
F. Guide Rails and Attachments: Guide rails shall be Tee-section steel rails with brackets and fasteners. Side counterweight arrangements shall have a dual-purpose bracket that combines both counterweight guide rails, and one of the car guide rails to building fastening.
G. Coated-Steel Belts: Polyurethane coated belts with high-tensile-grade, zinc-plated steel cords and a flat profile on the running surface and the backside of the belt. The belts shall have an FT-1 rating as referenced by NFPA 13. All driving sheaves and deflector sheaves should have a crowned profile to ensure center tracking of the belts. A continuous 24/7 monitoring system using resistance-based technology has to be installed to continuously monitor the integrity of the coated steel belts and provide advanced notice of belt wear.
H. Governor Rope: Shall be steel and shall consist of at least eight strands wound about a sisal core center.
I. Fascia: Galvanized sheet steel shall be provided at the front of the hoistway.
J. Hoistway Entrances:

(1) Frames: Entrance frames shall be of bolted construction for complete one-piece unit assembly. All frames shall be securely fastened to fixing angles mounted in the hoistway and shall be of UL fire rated steel.
(2) Sills shall be extruded: Aluminum
(3) Doors: Entrance doors shall be of metal construction with vertical channel reinforcements.
(4) Fire Rating: Entrance and doors shall be UL fire rated for 1-1/2 hour
(5) Entrance Finish: [Satin Stainless Steel]
(6) Entrance Marking Plates: Entrance jambs shall be marked with 4” x 4” (102 mm x 102 mm) plates having raised floor markings with Braille located adjacent to the floor marking. Marking plates shall be provided on both sides of the entrance.
(7) Sight Guards: Sight guards will be furnished with all doors painted to match with painted doors, painted black for stainless steel doors.

2.05 EQUIPMENT: CAR COMPONENTS

A. Car Frame and Safety: A car frame fabricated from formed or structural steel members shall be provided with adequate bracing to support the platform and car enclosures. The car safety shall be integral to the car frame and shall be Type "B", flexible guide clamp type.
B. Cab: Steel Shell Cab with stainless steel wall panels

C. Car Front Finish: Satin Stainless Steel
D. Car Door Finish: Satin Stainless Steel
E. Ceiling Type: Dropped ceiling with LED lights
F. Ceiling Finish: Brushed Steel Finish
G. Floor Finish: Unless otherwise indicated, refer to Finish Legend and coordinate cab assembly with other trades for installation of:
   (1) Terrazzo Tile as indicated in the Drawings
H. Emergency Car Lighting: An emergency power unit employing a 6-volt sealed rechargeable battery and totally static circuits shall be provided to illuminate the elevator car in the event of building power failure.
I. Fan: A one-speed 120 VAC fan will be mounted to the ceiling to facilitate in-car air circulation, meeting A17.1 code requirements. The fan shall be rubber mounted to prevent the transmission of structural vibration and will include a baffle to diffuse audible noise. A switch shall be provided in the car-operating panel to control the fan.
J. Handrails: Brushed steel finish, 3/8" x 2" flat tubular bar handrails shall be provided on the side walls.
K. Threshold: Aluminum
L. Emergency Exit Contact: An electrical contact shall be provided on the car-top exit.
M. Guides: The car shall have 3" diameter roller guides at top and bottom and the counterweight shall have slide type guides at the top and the bottom. Optional counterweight guides available.
N. Platform: The car platform shall be constructed of metal. Load weighing device shall be mounted on the belts at the top of the hoistway.
O. The LED ceiling lights, and the fan should automatically shut off when the system is not in use and be powered back up after a passenger calls the elevator and pushes a hall button.
P. Certificate frame: Provide a Certificate frame with a satin stainless steel finish.
Q. Otis cab air purifier

2.06 EQUIPMENT: SIGNAL DEVICES AND FIXTURES

A. Car Operating Panel: A luxury swing car operating panel shall be provided which contains all push buttons, key switches, and message indicators for elevator operation. The car operating panel shall have a satin stainless steel finish. (An optional Luxury Swing COP is available. A second COP is available)
   (1) The car operating panel shall contain a bank of round stainless steel, mechanical LED illuminated buttons, flush mounted to the panel and marked to correspond to the landings served. All buttons to have raised numerals and Braille markings with:
   (2) The car operating panel shall be equipped with the following features:
      (a) Raised markings and Braille to the left-hand side of each push-button.
      (b) Car Position Indicator at the top of and integral to the car operating panel.
      (c) Door open and door close buttons.
      (d) Inspection key-switch.
      (e) Elevator Data Plate marked with elevator capacity and car number.
      (f) Help Button: The help button shall initiate two-way communication between the car and a location inside the building, switching over to another location if the call is unanswered, where personnel are available who can take the appropriate action. Visual indicators are provided for call initiation and call acknowledgement.
      (g) Landing Passing Signal: A chime bell shall sound in the car to signal that the car is either stopping at or passing a floor served by the elevator.
      (h) In car stop switch (toggle or key unless local code prohibits use)
      (i) Firefighter's hat (standard USA)
      (j) Firefighter's Phase II Key-switch (standard USA)
      (k) Call Cancel Button (standard USA)

Below are optional.

      (l) Firefighter's Phase II Emergency In-Car Operating Instructions: worded according to A17.1 2000, Article 2.27.7.2.
      (m) Please Exit Symbol: provided with emergency hospital service, or express priority in the hall.
B. Car Position Indicator: A digital, LED car position indicator shall be integral to the car operating panel.
C. Hall Fixtures: Hall fixtures shall be provided with necessary push buttons and key switches for elevator operation.
   (1) Integral Hall fixtures shall feature round stainless steel, mechanical buttons marked to correspond to the landings. Hall fixtures to be located in the wall. Buttons shall be in vertically mounted fixture. Fixture shall be satin stainless steel finish.
   (2) Button: Flat flush mounted, satin stainless steel button with blue or white LED illuminating halo
   (3) Car Lantern and Chime: A directional lantern visible from the corridor shall be provided in the car entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel, and a chime will sound.
D. Access key-switch at top floor in entrance jamb.
E. Access key-switch at lowest floor in entrance jamb.
F. Card Reader Provision is Optional
G. Emergency (standby) Power key-switch: Manual selection of each elevator in normal operation after automatic return in standby power operation has been initiated.

PART 3 - EXECUTION

3.01 PREPARATION

A. Take field dimensions and examine conditions of substrates, supports, and other conditions under which this work is to be performed. Do not proceed with work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Installation of all elevator components except as specifically provided for elsewhere by others.

3.03 DEMONSTRATION

A. The elevator contractor shall make a final check of each elevator operation with the Owner or Owner's representative present prior to turning each elevator over for use. The elevator contractor shall determine that control systems and operating devices are functioning properly.

END OF SECTION 14 21 00

END OF DIVISION 14

DIVISION 21 - FIRE SUPPRESSION

SECTION 21 00 00 GENERAL FIRE SUPPRESSION REQUIREMENTS

SECTION 21 13 14 AUTOMATIC FIRE SPRINKLER SYSTEM

SECTION 21 00 00 - GENERAL FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Specification requirements defined below in this specification apply to and are in addition to the work associated with equipment, systems, materials, and installation requirements specified in Division 21. Contractor shall provide the requirements specified in those Divisions to obtain complete systems, tested, adjusted, and ready for operation.

1.02 RELATED WORK

A. Section 07 84 00 - Firestopping

B. Section 22 00 00 - General Plumbing Requirements

C. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment

D. Section 22 05 20 - Plumbing Excavation and Backfill

E. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment

F. Section 22 05 53 - Identification for Plumbing Piping and Equipment

PART 2 - PRODUCTS

2.01 NOT APPLICABLE TO THIS SECTION.

PART 3 - EXECUTION

3.01 NOT APPLICABLE TO THIS SECTION.

END OF SECTION 21 00 00

SECTION 21 13 14 - AUTOMATIC FIRE SPRINKLER SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies materials, methods, and equipment to be used for automatic sprinkler systems, standpipe systems, and fire pump and related fire protection piping to 5 ft (1.52 m) outside building.

B. Research indicates there is no documentation or indication that microbiologically influenced corrosion (MIC) exists in the area of the project.

C. As shown on drawings, fire protection system(s) shall consist of:

(1) 4 total automatic fire protection system(s) to include:

(a) 4 Wet-Pipe Sprinkler System (s)

D. Engineer of Record:

(1) Contractor shall be Engineer of Record. Contractor shall produce stamped and sealed installation drawings, which are also referred to as shop drawings in this Section, based on design criteria listed in this Section and drawings furnished by Engineer. Contract drawings show zone and main piping layouts of fire protection systems as it relates to architecture, structure, and mechanical/electrical systems.

E. All work shall be installed in conformance with the governing codes, regulations, local ordinances, and requirements of Authorities Having Jurisdiction. It shall be the responsibility of the Fire Protection Contractor to familiarize themselves with all governing codes and requirements and report any noncompliance of the plans or specifications to the Construction Manager/Engineer, prior to entering into the contract. These requirements are minimum criteria and no reductions permitted by Code shall be allowed without written permission of the Engineer.

F. Fire Protection Contractor shall confirm any local requirements for Fire Department Connection type and location with local Authority Having Jurisdiction prior to submittal.

G. Fire Protection Contractor shall confirm any local requirements for Fire Hose Valve type and location with local Authority Having Jurisdiction prior to submittal.

H. No additional compensation shall be granted for work which must be changed as a result of the work not originally complying with codes and standards or not in accordance with the multiple trade coordination design criteria set forth in the contract documents.

I. If code or other requirements exceed provisions indicated in the Contract Documents, the Construction Manager/Engineer shall be notified in writing. Where the work indicated on the Contract Documents exceeds code requirements, the installation shall be done in accordance with the Contract Documents. Any work done contrary to these requirements shall be removed and replaced at the expense of the responsible Contractor.

J. Fire Protection Contractor shall become familiar with all details of the work, verify dimensions in the field, and advise the Construction Manager/Engineer of any discrepancy prior to entering into the contract.

K. Fire Protection Contractor shall file all drawings, pay all fees, and obtain all permits and certificates of inspection related to this work. Fire Protection Contractor shall arrange inspection with proper Authorities Having Jurisdiction and include all costs associated with said inspections in their bid.

1.02 RELATED WORK

A. Section 07 84 00 - Firestopping

B. Section 21 00 00 - General Fire Suppression Requirements

C. Section 22 00 00 - General Plumbing Requirements

D. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment

E. Section 22 05 20 - Plumbing Excavation and Backfill

F. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment

G. Section 22 05 53 - Identification for Plumbing Piping and Equipment

H. Section 28 46 10 - Addressable Fire Detection And Alarm Systems

1.03 QUALITY ASSURANCE

A. Codes and Standards:

(1) This installation shall conform to the following:

(a) Underwriters Laboratories UL (DIR) Fire Protection Equipment Directory

(b) International Building Code (IBC), 2021 Edition

(c) International Fire Code ICC (IFC), 2021 Edition

(d) NFPA 13, Installation of Sprinkler Systems, 2019 Edition

(e) NFPA 14, Installation of Standpipe and Hose Systems, 2019 Edition
(f) NFPA 20, Installation of Stationary Pumps for Fire Protection, 2019 Edition
(g) NFPA 72, National Fire Alarm and Signaling Code, 2019 Edition
(h) Factory Mutual Research Corporation (FMRC) Approval Guide]
(i) Factory Mutual Global (FMG) Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers
(j) Factory Mutual Global (FMG) Data Sheet 3-0, Hydraulics of Fire Protection Systems
(k) Factory Mutual Global (FMG) Data Sheet 3-7, Fire Protection Pumps
(l) Factory Mutual Global (FMG) Data Sheet 3-26, Fire Protection for Non-storage Occupancies
(m) Factory Mutual Global (FMG) Data Sheet 3-7, Fire Protection Pumps
(n) Factory Mutual Global (FMG) Data Sheet 4-4n, Standpipes and Hose Systems
(o) Factory Mutual Global (FMG) Data Sheet 8-1, Commodity Classification
(p) Factory Mutual Global (FMG) Data Sheet 8-9, Storage of Class 1, 2, 3, 4, and Plastic Commodities

B. Contractor Installation Program:

(1) Provide licensed persons employed by sprinkler Contractor to perform planning, calculations, layout, installation, and testing of fire protection systems. The following are acceptable:
(a) Licensed Professional Engineer
(b) National Institute for Certification of Engineering Technologies (NICET) Level IV
(c) Certified sprinkler designer
(2) Provide journeyman sprinkler fitter(s) for installation and supervision.
(3) Contractor shall be licensed in the State of Arkansas for installation of fire protection systems.
(4) Contractor shall submit pre-qualification evidence of at least 3 projects of comparable size successfully completed with their Bid.
(5) Distortion or misrepresentation of qualification evidence may result in contract cessation.
(6) On-site training for fire protection products:
(a) The grooved coupling manufacturer’s factory trained field representative shall provide on-site training for contractor’s field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products.
(b) The flexible sprinkler hose fittings manufacturer’s factory trained field representative shall provide on-site training for contractor’s field personnel in the proper install and selection of the flexible fittings in terms of bend radius, connection types, and brackets.
(c) The factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed.
(d) Contractor shall remove and replace any improperly installed products.

C. Electrical Coordination:

(1) All relays, wire, conduit, pushbuttons, pilot lights, and other devices required for power side or the control of electrical equipment shall be furnished by Division 26 and Division 28 Contractor, except as specifically noted elsewhere in this Specification.
(2) Should any change in electrical equipment size, horsepower rating, or means of control be made to any motor or other electrical equipment after contracts are awarded, Division 21 Contractor is to immediately notify Division 26 and Division 28 Contractors of this change and pay any costs due to this change.
(3) Division 26 Contractor shall provide all power wiring and Division 21 Contractor shall be responsible for providing all control wiring and its conduit. Control wiring shall conform to Division 26 and 28 requirements for control wiring.
(4) Furnish wiring diagrams to Division 26 and Division 28 Contractors for equipment and devices furnished by Division 21 Contractor which have been indicated to be wired by Division 26 and Division 28 Contractors.
(5) Division 21 Contractor shall provide exterior waterflow alarm and coordinate installation with Division 26 and Division 28 Contractor.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 01.
B. Store and protect products under provisions of Division 01.
C. All materials shall be stored in a clean, dry space.
D. Promptly inspect shipments to ensure material is undamaged and complies with Specifications. Storage and protection methods must allow inspection to verify products.

E. Furnish pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling, and installation to prevent pipe-end damage and to eliminate dirt and construction debris from accumulating inside of pipe. Protect fittings and unions by storage inside or by durable, waterproof, aboveground packaging.

F. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade.

G. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

1.05 SUBMITTALS

A. Submittals shall include:

(1) Drawings
(2) Hydraulic Calculations
(3) Product data sheets for the following:
(a) Pipe
(b) Fittings
(c) Hanger Assemblies
(d) Seismic Restraint Components
(e) Valves
(f) Double Check Detector Backflow Preventer
(g) Tamper Switches
(h) Flow Switches
(i) Fire Department Connection (FDC)
(j) Exterior Weatherproof Waterflow Alarm
(k) Sprinklers
(l) Spare Sprinkler Cabinets
(m) Fire Hose Valves (FDV)
(n) Fire Pump and Accessories
(o) Fire Pump Test Connection
(p) Fire Pump Controller with Automatic Transfer Switch
(q) Jockey Pump and Accessories
(r) Jockey Pump Controller
(s) Any additional items required to provide complete installation.

B. Submit fire pump certified shop test curves showing pressure rating and rated horsepower to Engineer.

C. Submit Material Safety Data Sheet (MSDS) for corrosion inhibitive paint.

D. Indicate by red marking or arrow, items that are to be provided, where more than 1 item appears on manufacturer's catalog sheet.

E. Submit stamped and sealed drawings, product datasheets, hydraulic calculations, and a signed copy of the Owner’s certificate to local Fire Department, Engineer, and Owner's insurance representative prior to installation or fabrication of system components.

F. Submit stamped and sealed drawings, product data sheets, and hydraulic calculations to local Fire Department prior to installation or fabrication of system components.

G. Include copy of Fire Department plan review letter in submission to Engineer.

H. Prior to installation or fabrication of system components, submit layout drawings and equipment submittals to Engineer of Record.

I. After review of layout drawings by Engineer of Record, submit drawings and calculations to Local Authority and Owner's Insurance Representative.

J. Review of submittals does not relieve Contractor from coordinating installation of work with other trades, or from compliance with Codes and Standards.

K. At completion of acceptance tests:

(1) Send copy of test log to Engineer
(2) Send copy of Contractor’s Material and Test Certificates and fire pump test results to:
(a) Engineer
(b) Owner
(c) Authority Having Jurisdiction

(3) Provide Owner with following:

(a) Manufacturer's literature and instructions describing operation and maintenance of equipment and devices installed.

(b) Typewritten chart with identification and location of all access panels serving equipment and valves. Incorporate into Operation & Maintenance (O&M) manual.

(c) Typewritten valve schedule indicating valve number, fixture/equipment or areas served by each numbered valve. Incorporate into O&M manual.

(d) For additional O&M manual requirements, refer to Section 23 00 00 - General Mechanical Requirements.

(e) Current copy of NFPA 25 – Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials and Equipment:

(1) Materials and equipment in system shall be new and current products of manufacturer regularly engaged in production of such materials and equipment.

(2) Where 2 or more pieces of equipment are required to perform interrelated functions, they shall be products of same manufacturer.

(3) Clean and cap pipe after fabrication and prior to placing pipe in building.

(4) Pipe shall be marked with removable tags. No permanent markings are to remain on unpainted pipe located in exposed areas

B. Approval Guides:

(1) Unless otherwise shown, products shall be UL Listed in the latest publication of the UL Fire Protection Equipment Directory and approved in the latest Factory Mutual Research Corporation Approval Guide for service intended.

2.02 SPRINKLERS

A. Manufacturers:

(1) Unless otherwise noted below, sprinklers shall be manufactured by Tyco Fire Products, Viking, Victaulic, Reliable, or equal.

B. Temperature class of sprinklers and cover plates shall vary if installed close to heat sources, under skylights, areas of higher ambient temperatures, or in special hazard areas. Refer to NFPA 13 for requirements.

C. Provide high pressure sprinklers where pressures exceed 175 psi (1205 kPa) working water pressure.

D. Light hazard and Ordinary Hazard FM Hazard Class 1 occupancies shall utilize quick-response type sprinklers.

E. Architect will review deviations from specified styles for approval prior to installation.

F. Unless otherwise noted, provide the following type(s) of sprinklers:

(1) In unfinished areas such as mechanical spaces:

(a) Standard coverage, brass upright or pendent; Tyco Fire Products Model TY-FRB, Viking Microfast, or equal.

(b) Extended coverage, brass upright or pendent; Tyco Fire Products Model EC-11 or EC-14, Viking ECOH-ELO, or equal, designed and installed per its listing.

(c) When exposed to corrosive environments, sprinklers shall be polyester coated with bright white finish.

(2) In unfinished areas where conditions do not permit installation of upright or pendent sprinkler:

(a) Standard coverage, brass sidewall; Tyco Fire Products Model TY-FRB, Viking Microfast horizontal (HSW) or vertical (VSW) sidewall or equal.

(b) Where exposed to corrosive environments, sprinklers shall be polyester coated with bright white finish.

(3) In areas with finished ceilings:

(a) Standard coverage, concealed pendent; Tyco Fire Products Model RFII, Viking Mirage, or equal sprinkler with flat cover plate, mounted flush with ceiling. Cover plate shall be factory-finished (i.e., by manufacturer). Finish to be bright white**.**

(4) In areas with finished ceiling conditions that do not permit installation of pendent sprinkler or finished area where sidewall sprinkler provides better coverage of hazard:

(a) Standard coverage, semi-recessed horizontal sidewall (HSW) or vertical sidewall (VSW) sidewall; Tyco Fire Products Model TY-FRB, Viking Microfast or equal with semi-recessed escutcheon; Tyco Fire Products Style 10, Style 20, or equal. Sprinkler and escutcheon shall be factory-finished (i.e., by manufacturer). Finish to be bright white.

(b) Extended coverage, semi-recessed horizontal sidewall (HSW); Tyco Fire Products Model TY-FRB or equal with semi-recessed escutcheon; Style 10, Style 20, Style 30, Style 40, or equal, designed and installed per its listing and FM approval. Sprinkler and escutcheon shall be factory-finished (i.e., by manufacturer). Finish to be bright white.

(5) In exposed areas with ceilings subject to temperatures at or below 40°F (4°C):

(a) Standard coverage, concealed dry pendent, intermediate temperature class sprinkler with intermediate temperature class cover plate, mounted flush with ceiling. Cover plate color shall match ceiling color and shall be factory-painted (i.e., by manufacturer), Tyco Fire Products Model DS-C or equal.

G. Submit samples for examination and approval when appearance is different than sprinkler specified.

H. Provide high pressure sprinklers where pressures exceed 175 psi (1205 kPa) working water pressure.

I. Spare Sprinkler Cabinets:

(1) Shall be complete with required number of spare sprinklers of each type and temperature rating per NFPA 13.

(2) Shall be provided with at least one sprinkler wrench for each type of sprinkler installed.

(3) Provide multiple cabinets to meet this requirement.

(4) Coordinate cabinet locations with Owner's representative.

2.03 FIRE PROTECTION PIPE JOINTS AND FITTINGS

A. Below Ground:

(1) Pipe: Ductile iron, Class 52, American Water Works Association AWWA C151/A21.51, minimum 350 psi (2413 kPa) working pressure, with standard cement mortar lining, AWWA C104/A21.4, American National Standards Institute (ANSI) A21.4

(2) Fittings: Ductile iron or grey iron, mechanical joint, 350 psi (2413 kPa) working pressure, AWWA C153/A21.53, cement mortar lined, AWWA C104/A21.4.

(3) Encasement: Polyethylene encasement, 8 mil (0.2 mm) thick, AWWA C105/A21.5.

(4) Underground Restraint:

(a) Acceptable manufacturers: EBAA Iron, Inc., Smith-Blair, or equal

(b) Mechanical Joints Utilizing Setscrew Retainer Glands

1) Mechanical joint restraint device for nominal pipe sizes 3" (80 mm) through 12" (300 mm) per AWWA C151/A21.51, shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of AWWA C110/A21.10, body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536, minimum working pressure rating of 350 psi (2413 kPa), includes torque limiting breakaway nuts, allows for a minimum of 3° of deflection, and includes fusion-bonded epoxy coating per AWWA C213.

2) Mechanical restraint coupling gasket shall be furnished by same manufacturer.

(c) Pipe Clamps and Tie Rods

1) Clamps, rods, and washers shall be sized per the requirements listed in NFPA 24.

1. Clamps shall be made of steel, used to prevent joint separation through use in combination with rod clamp washers, rod couplings, and heavy hex nuts.

2. Rods shall be carbon steel per ASTM A193/A193M GR B7, using rolled threads for improved physical characteristics, greater thread accuracy, and smooth surface finish.

(5) Underground Penetration Modular Seal:

(a) Acceptable manufacturers: GPT Industries, Roxtec, or equal

(b) Modular sealing device consisting of sealing elements, pressure fittings, and hardware preassembled from manufacturer.

1) Sealing elements: EPDM rubber that adjusts to the outside diameter of the pipe to ensure proper fitment and sealing.

2) Pressure resistant to a minimum of 20 psig (40 ft. of head).

3) Bolts and nuts: 316 stainless steel per ASTM F593

(c) Basis of Design: GPT Industries Link-Seal, Roxtec Model RS, or equal

B. Above Ground:

(1) Steel Pipe: Steel fire protection pipe shall be selected according to nominal pipe diameter. Schedule 30, Schedule 7, or similar thin-walled steel pipes are prohibited. CPVC pipe and fittings are prohibited.

(a) Carbon (Black) Steel Pipe, 2" (50 mm) and smaller:

1) Schedule 10, ASTM A135/A135M

2) Schedule 40, ASTM A795/A795M or ASTM A53/A53M

(b) Carbon (Black) Steel Pipe, larger than 2":

1) Schedule 10, ASTM A135/A135M

2) Schedule 40, ASTM A795/A795M or ASTM A53/A53M

(2) Steel Pipe Finishes: Unless noted otherwise, galvanized (hot dipped zinc coated) pipe and fittings shall be used when sprinkler system is exposed to weather or other corrosive environments.

(3) Steel Pipe Joints:

(a) Black Steel Pipe Joints:

1) Threaded, tapered pipe threads, ANSI B1.20.1

2) Flanged, cast iron,175 psi (1205 kPa) CWP rating, ANSI B16.1, square head machine bolts with semi-finished hexagon nuts, ASTM A183, neoprene gasket

3) Welded, welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.

4) Cut or roll grooved, with mechanical coupling.

5) Factory-welded pipe outlets, threaded or grooved

(b) Galvanized Schedule 10 Steel Pipe Joints:

1) Roll grooved with mechanical coupling.

2) Factory-welded pipe outlets, threaded or grooved

(c) Galvanized Schedule 40 Steel Pipe Joints:

1) Threaded, tapered pipe threads, ANSI B1.20.1

2) Cut grooved with mechanical coupling

3) Factory-welded pipe outlets, threaded or grooved

(4) Steel Pipe Fittings:

(a) Black Steel Fittings:

1) Cast iron threaded fittings, Class 125, 175 psi (1205 kPa) CWP rating, ASME B16.4

2) Ductile iron threaded fittings, Class 150, 175 psi (1205 kPa) CWP rating, ASME B16.3

3) Malleable iron threaded fittings, Class 150 or 300, ASTM A197/A197M /ANSI B16.3

4) Cast iron flanged fittings, Class 125, 175 psi (1205 kPa) CWP rating, ANSI B16.1

5) Carbon steel butt weld fittings, ASTM A234/A234M Grade WPB/American Society of Mechanical Engineers ASME B16.9, standard weight, seamless

6) Mechanical grooved fittings, ASTM A536 ductile iron, ASTM A47/A47M malleable iron or ASTM A53/A53M fabricated steel, 175 psi (1205 kPa) CWP rating, malleable iron conforming to ASTM A47/A47M

1. Acceptable manufacturers: Victaulic, SPF/Anvil, Tyco Grinnell, Viking, or equal.
2. Flexible Couplings: Victaulic Style 75, or equal.
3. Rigid Couplings: Victaulic Style 009N, Victaulic Style 07, Victaulic Style 005H, or equal. Single-bolt or hinged couplings are prohibited.
4. Wet systems gasket: Grade E EPDM gasket per UL 157 and UL 213.
5. Dry systems gasket: Victaulic “FlushSeal” or equal.
6. Rigid or zero flex type couplings shall be provided when operating pressures cause piping to move out of place or sway on hangers. Flexible couplings may be used where pipe is braced or clamped into rigid position.
7. Fitting, gasket, and coupling shall be furnished by same manufacturer.
8. Pre-fabricated, one-piece assemblies that contain the fitting housing, gaskets, and bolts are prohibited.

(b) Flexible Sprinkler Hose Fittings for Fire Protection Service:

1) Listings and Approvals: complete hose and bracket assembly shall be FM approved and UL Listed. FMRC Approved for its intended use pursuant to FM 1637 and UL Listed for its intended use pursuant to UL 2443 – Standard for Flexible Sprinkler Hose with Fittings for Fire Protection Service.

2) For seismic projects, product shall be seismically qualified for use pursuant to ICC-ES AC156 – Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

3) Provide high pressure fittings where pressures exceed 175 psi (1205 kPa) water working pressure. Model numbers on high pressure fittings must include the “H” suffix, or other indication that the product is rated for working pressures over 175psi.

4) Acceptable Manufacturers: FlexHead as manufactured by ASC Engineered Solutions or VicFlex as manufactured by Victaulic.

5) Flexible Hose Assemblies and End Fittings:

1. Application: shall be used in lieu of rigid steel pipe offsets or return bends for sprinkler drops.
2. Composition: 100% Type 304 or 316 corrugated braided stainless steel with true 1" minimum ID.

3. Minimum Bend Radius: 2" minimum bend radius per UL and 7-inch minimum bend radius per FM.
4. Connections shall be threaded.

6) Brackets:
1. Listed Assemblies: shall be of same manufacturer as flexible sprinkler hose fittings. Mixing of manufacturers shall not be allowed.
2. Listings and Approvals: shall be FM approved, UL Listed for use with flexible sprinkler hose fittings.
3. Applications: can be used on ceiling grid, hard lid, and open ceiling applications by attaching to framing, concrete deck or walls.

(5) Copper, 2" and Smaller:
(a) Pipe: Copper tube, Type L, hard drawn, ASTM B88
(b) Fittings:
1) Cast bronze, solder joint, pressure rated, ANSI/ASME B16.18.
2) Wrought copper, solder joint, pressure rated ANSI/ASME B16.22.
(c) Joints:
1) Lead free (<0.2%) solder, Bridgit or Silvabrite, ASTM B32, flux ASTM B813.
2) Brazed, silver solder, BCuP-5, AWS A5.8M/A5.8, 1250°F (676°C) melting point minimum.
(d) Nipples:
1) Red brass pipe, threaded.
(6) Threaded bushings are prohibited.
(7) Plain end couplings such as Roust-A-Bouts, Plainloks or similar fittings are prohibited.
(8) Slip-style fittings such as Wardlox or similar fittings are prohibited.
(9) Adjustable drop nipples are prohibited.
(10) Clamp-on or saddle type fittings (i.e., mechanical tees and tee lox) are prohibited.
(11) Outlet fittings inserted into holes drilled into piping such as Victaulic Style 923 are prohibited.
(12) Outlet couplings such as Victaulic Style 72 are prohibited.
(13) Grooved reducing couplings such as Victaulic Style 750 are prohibited.
(14) Dielectric Fittings:
(a) Acceptable manufacturers: Epco Sales, Lochinvar, Watts Regulator Co., Wilkins, or equal
(b) Insulating nipple, metal casing, inert thermoplastic lining, Clearflow dielectric fitting by Perfection Corporation or equal.
1) Dielectric unions 2" (50 mm) and smaller; dielectric flanges 2" (50 mm) and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets, and pressure rating of not less than 175 psi (1205 kPa) at 180°F (82°C). Provide high pressure type when pressures exceed 175 psi (1205 kPa) water working pressure.

2.04 VALVES

A. Double Check Detector Backflow Prevention Assembly (DCBP):
(1) Acceptable manufacturers: Ames, Apollo, Cla-Val, Febco, Watts, or equal
(2) Weighted clapper double check valve assembly including 2 supervised outside screw and yoke (OS&Y) gate valves.
(3) Assembly shall be double check valve assembly for cross connection devices.
(4) Certified in accordance with ASSE 1015 and AWWA C510.
(5) Double check valve shall be selected based on minimal pressure drop to allow maximum available pressure to sprinkler system.
(6) Provide high pressure DCBP assembly and fittings when pressures exceed 175 psi (1205 kPa).

B. Gate Valve:
(1) Acceptable manufacturers: Kennedy, Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic, or equal
(2) Outside screw and yoke (OS&Y) gate valve, bronze body and trim or cast-iron body bronze mounted and rated for 175 psi (1205 kPa), non-shock water working pressure, Nibco F-607-OTS or equal.
(3) Provide high pressure valves and fittings when pressures exceed 175 psi (1205 kPa) water working pressure.

C. Butterfly Valve with Integrated Tamper Switch - sizes: 2 to 12" (50 to 305 mm)
(1) Acceptable manufacturers: Kennedy, Milwaukee Valve Co., Mueller, Nibco, Tyco Fire Products, Victaulic, or equal
(2) For normally open valves, provide valve equal to Victaulic FireLock Series 705.

(3) For normally closed valves, provide valve equal to Victaulic FireLock Series 705C.

(4) Provide high pressure valves and fittings when pressures exceed 300 psi (2070 kPa) water working pressure.

D. Slow-Close Ball Valve with Integrated Tamper Switch - sizes 1 to 2" (25 to 50 mm):

(1) Acceptable manufacturers: Kennedy, Milwaukee Valve Co., Mueller, Nibco, Tyco Fire Products, Victaulic, or equal

(2) Provide valve equal to Victaulic FireLock Series 728.

E. Vertical Post Indicator Valve (PIV) Assembly:

(1) Acceptable manufacturers: Kennedy, Mueller, Nibco, Stockham, Victaulic, or equal

(2) Non-rising stem (NRS) gate valve, ductile iron body, resilient wedge, epoxy coated interior and exterior, includes indicator post flange and flange screw, rated for 300 psi (2070 kPa) non-shock cold working pressure, Nibco F-609-RWS or equal.

(3) Cast iron post with lockable lever operator for use with non-rising stem gate valve, 1" (25 mm) square valve stem extension rod, UV-stabilized Lexan window containing cast aluminum signage reading “OPEN” and “SHUT”, Kennedy Model 2495A, Nibco NIP-1AJ, Victaulic Series 774, or equal.

F. Wall Post Indicator Valve (PIV) Assembly:

(1) Acceptable manufacturers: Kennedy, Mueller, Nibco, Stockham, Victaulic, or equal

(2) Non-rising stem (NRS) gate valve, ductile iron body, resilient wedge, epoxy coated interior and exterior, includes indicator post flange and flange screw, rated for 300 psi (2070 kPa) non-shock cold working pressure, Nibco F-609-RWS or equal.

(3) Wall post indicator for use with non-rising stem (NRS) gate valve, cast iron body, steel operating rod, Lexan-UV stabilized or polycarbonate window containing cast aluminum signage reading “OPEN” and “SHUT”, Kennedy Model 641, Nibco Model NIP-3AJ, Victaulic Series 773, or equal.

G. Check Valve:

(1) Acceptable manufacturers: Globe Fire Sprinkler, Reliable, Tyco Fire Products, Victaulic, Viking, or equal

(2) Iron body, bronze seat, stainless steel clapper with a replaceable rubber seal, Globe Fire Sprinkler Model RCV, Tyco Fire Products CV-1F, Viking Model G-1, or equal.

(3) Check valve shall be equipped with removable cover for inspection and maintenance.

(4) Provide high pressure valves and fittings when pressures exceed 300 psi (2070 kPa) water working pressure.

H. Check Valve (Anti-Water-Hammer type)

(1) Acceptable manufacturers: Anvil Gruvlok, Reliable, Tyco Fire Products, Victaulic, Viking, or equal

(2) Ductile iron conforming to ASTM A536, Grade 65-45-12, rust inhibiting coating, sizes 2 to 5" (50 to 130 mm) consisting of stainless steel clapper conforming to ASTM A-167 and for sizes 6 to 8" (150 to 200 mm) consisting of ductile iron clapper conforming to ASTM A536, Anvil Gruvlok Series 7800 or equal.

(3) Provide high pressure valves and fittings where pressures exceed 175 psi (1205 kPa) water working pressure.

I. Ball Valve:

(1) Acceptable manufacturers: Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic, or equal

(2) Bronze body and stem, full port design, brass ball with chrome plated finish, conforms to MSS SP-110 standard, Nibco Model KT-585-70-UL or equal.

(3) Provide high pressure valves and fittings when pressures exceed 300 psi (2070 kPa) water working pressure.

J. Angle/Drain Valve:

(1) Acceptable manufacturers: Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic, or equal

(2) Bronze body, stem, bonnet, and packing nut; non-asbestos packing; nitrile seat disc; stainless steel handwheel screw or nut; Nibco Model T-301-W, or equal.

(3) Provide high pressure valves and fittings where pressures exceed 175 psi (1205 kPa) water working pressure.

K. Test and Drain Valves:

(1) Acceptable manufacturers: AGF, Victaulic, or equal

(2) AGF TESTanDRAIN, Victaulic Style 720 TestMaster II, or equal.

(3) Test and drain valve shall include integral pressure relief valve. Pressure relief valve shall be set to operate at 175 psi (1205 kPa) or 10 psi (70 kPa) in excess of the maximum system pressure, whichever is greater.

(4) Provide high pressure valves and fittings where pressures exceed 175 psi (1205 kPa) water working pressure.

L. Air Release Valve:

(1) Acceptable manufacturers: Engineered Corrosion Solutions, Potter Electric Signal Co., or equal

(2) Automatic float type air vent, ball valve with tamper switch, Y-type strainer, and single set of normally closed dry contacts rated 24VAC/DC at 2 Amps, UL 2573 Listed, FM Approved “Automatic Air Release Valve for Sprinkler Systems”, rated to 175 psi (1205 kPa) non-shock water working pressure, Potter Electric Signal Co. Model PAAR-B or equal.

(3) Air release valve shall be installed in an accessible location to permit operation, maintenance, and visual inspection of the status of the valve.

(4) Provide high pressure valves and fittings where pressures exceed 175 psi (1205 kPa) water working pressure.

M. Fire Hose Valve (FHV):

(1) Acceptable manufacturers: Croker, Elkhart Brass, Potter-Roemer, or equal

(2) Fire Hose Valve shall be 2-1/2" (65 mm) angle valve, cast brass body, polished chrome plated finish, equal to Potter-Roemer Model 4065. Valve cap for 2-1/2" (65 mm) 2-1/2 " (65 mm) valve shall be 2-1/2 " (65 mm) cap with chain, Potter-Roemer Model 4625 or equal. Cap and chain finish shall match finish of valve body. Threads shall match Fire Department Standards.

2.05 FIRE DEPARTMENT CONNECTION (FDC)

A. Manufacturers:

(1) Acceptable Manufacturers: Croker Corp.; Dixon Fire; Elkhart Brass; Potter-Roemer; or equal

B. Fire Department Connection:

(1) Provide wall mounted, flush type, cast brass body with drop clappers, faceplate shall be polished chrome plated finish, with lettering reading AUTOSPKR STANDPIPE.

(a) Unit shall include 4 2-1/2" (65 mm) inlets with rigid end threading to match local fire department standards by pin-lug hose thread swivels, pin-lug plugs and chains. Finish of snoots shall match faceplate finish. Provide Potter Roemer Series 5100-5400 or equal.

C. Ball Drip

(1) Acceptable manufacturer: Potter-Roemer, Tyco Fire Products, or equal

(2) Provide bronze ball drip for fire department connection (FDC) inside of building and pipe to nearest floor drain or discharge to exterior.

(3) Exterior discharge location must be coordinated with Architect and Owner.

2.06 ROOF FIRE HOSE MANIFOLD

A. Acceptable Manufacturers: Croker Corp., Elkhart Brass, Potter-Roemer, or equal

B. Basis of Design: Two-way connection, cast brass body with female NPT inlet and (2) 2-1/2" (65 mm) male NPT outlets, Potter-Roemer Model 5886 or equal.

2.07 TAMPER SWITCH

A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, or equal

B. Outside screw and yoke (OS&Y) supervisory switch, NEMA 4 enclosure, provided with 2 sets of SPDT (Form C) contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. For areas identified as hazardous locations, provide “EX” Model. Potter Electric Signal Co. OSY series or equal.

C. Control valve supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide with optional cover tamper kit. For areas identified as hazardous locations, provide “EX” Model. Potter Electric Signal Co. PIBV series or equal.

D. Tamper switch shall be capable of transmitting signal during first 2 revolutions of handwheel or during 1/5 of travel distance of valve control apparatus from its normal position.

E. Unit shall be compatible with building’s fire alarm system.

2.08 FLOW SWITCH

A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, or equal

B. Vane type waterflow switch for use in wet sprinkler systems, minimum 300 psi (2070 kPa) service pressure rating, 10 gpm (0.63 L/s) minimal flow rate to activate alarm, and 2 sets of SPDT (Form C) contacts. Potter Electric Signal Co. VS series or equal.

C. Unit shall be compatible with building’s fire alarm system.

2.09 WATERFLOW ALARM PRESSURE SWITCH

A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, or equal

B. Pressure actuated switch for use in dry sprinkler systems, 300 psi (2070 kPa) service pressure rating, adjustable between 4-15 psi (27-100 kPa), 2 sets of SPDT (Form C) contacts rated at 2 amps at 30 VDC and 10.1 amps at 125/250 VAC. Potter Electric Signal Co. PS10 series or equal.

C. Unit shall be compatible with building’s fire alarm system.

2.10 WATERFLOW ALARM (EXTERIOR OF BUILDING)

A. Acceptable manufacturers: Cooper Wheelock, Potter Electric Signal Co., or equal

B. Basis of Design:

(1) Cooper Wheelock ASWP series, red finish with compatible weatherproof backbox. Audible strobe shall comply with UL 1638 – Standard for Visual Signaling Appliances, and UL 464 – Audible Signal Appliances.

C. Device shall be compatible with building's fire alarm system.

D. If required by code official, provide approved signage per NFPA 13.

2.11 PRESSURE GAUGES

A. Acceptable manufacturers: Ashcroft, Potter-Roemer, Viking, or equal

B. Pressure gauges shall be 3-1/2" (90 mm), corrosion resistant moving parts, polycarbonate window, and provided with connection not smaller than 1/4" (6 mm) NPT.

C. Include ball valve with provisions for draining on each pressure gauge.

2.12 WET PIPE SYSTEM COMPONENTS

A. Each wet pipe system shall include:

(1) Indicating-type control valve with tamper switch

(2) Indicating-type, pressure regulating control valve with tamper switch

(3) Check valve

(4) Pressure gauge

(5) Waterflow switch

(6) Inspector's test and drain assembly with integral pressure relief valve.

(7) Means of testing pressure reducing valve

B. Riser Manifold

(1) Acceptable manufacturers: Tyco Fire Products, Victaulic, Viking, or equal

(2) Ductile iron or fabricated steel pipe body; threaded or grooved connections; rated to 175 psi (1205 kPa) non-shock water working pressure; includes test and drain valve with integral pressure relief valve, flow switch, and pressure gauge; Tyco Fire Products Model RM-1, Victaulic UM, Viking EasyPac, or equal.

(3) Provide high pressure valves and fittings when pressures exceed 175 psi (1205 kPa) water working pressure.

C. Alarm Check Valve Assembly

(1) Acceptable manufacturers: Reliable, Tyco Fire Products, Victaulic, Viking, or equal

(2) Alarm check valve shall be check valve assembly with retard chamber.

(3) Include gauges, waterflow alarm pressure switch, drain valve, bypass piping and valves.

(4) Alarm check valve shall be capable of transmitting signal when water flow equals or exceeds discharge of single sprinkler.

2.13 HANGERS

A. Acceptable manufacturers: Afcon, Anvil, Eaton, Pentair, Tolco, or equal

B. Concrete expansion hangers, when provided, are to be Hilti, Illinois Tool Works (ITW), Powers Fasteners, or equal.

C. Screw anchors for concrete, when provided, are to be Hilti, Illinois Tool Works (ITW), Powers Fasteners, or equal.

D. Screw anchors for steel structure, when provided, are to be Illinois Tool Works (ITW), Powers Fasteners, or equal.

E. Screw anchors for wood structure, when provided, are to be Illinois Tool Works (ITW), Powers Fasteners, or equal.

F. Hanger rods shall comply with Manufacturer Standardization Society (MSS) standards and manufacturer's published load rating.

G. Provide hanger rod, hanger rod attachments, pipe stands, bolts, U-bolts, nuts, studs and washers with electroplated zinc coating or with hot-dipped galvanized finish.

H. Riser clamps shall be electroplated zinc coated or have a hot-dipped galvanized finish and shall not protrude more than 2" (50 mm) beyond edge of hole, Anvil Fig. 261 or equal.

I. Hangers for stainless steel pipe shall be of stainless steel construction.

J. Hangers for copper tube shall be of copper construction.

2.14 FIRE PUMP (FP)

A. Acceptable Manufacturers: A-C Fire Pump, Fairbanks Nijhuis, Patterson Pump, Peerless Pump, Pentair Aurora or equal

B. Fire pump shall meet following criteria:

(1) Deliver rated flow at rated pressure

(2) Deliver not less than 65% of rated pressure at 150% rated capacity

(3) Not exceed 140% of rated pressure at shutoff

C. Pump Type: Electric Driven

D. Pump Configuration: Horizontal Split Case

E. Pump casing shall be pressure rated to handle system pressure.

F. Pump and motor shall be mounted on common steel baseplate.

G. Motor:

(1) Provide open drip proof, high-efficiency, foot-mounted.

(2) Locked rotor current shall not exceed values specified in NFPA 20.

H. Engine

(1) Provide compression ignition type engine.

I. Accessories to be provided with each fire pump are as follows:

(1) Fire Pump Test Connection:

(a) Test connection shall be flush type, cast brass body, polished chrome plated with lettering reading “PUMP TEST CONNECTION”.

(2) Discharge pressure gauge and compound suction gauge shall be liquid-filled type.

(3) Circulation Relief Valve: 3/4" (19 mm) Cla-Val Model 55L pressure relief valve or equal

(4) Automatic Air Release Valve

2.15 CONTROL EQUIPMENT FOR ELECTRIC DRIVE

A. Acceptable Manufacturers: Eaton, Firetrol, Joslyn Clark, Metron, or equal

B. Fire Pump Controller:

(1) Shall be completely assembled, wired and tested by control manufacturer before shipment from factory

(2) Shall be labeled “Fire Pump Controller”

(3) Shall be located as close as practical and within sight of motor

(4) Shall be located and protected such that it will not be damaged by water escaping from pump or connections

(5) Shall be combined manual and automatic

(6) Heavy gauge formed steel, NEMA Type 2 enclosure with top drip hood

(7) Provide complete with following:

(a) Starter: Reduced Voltage Solid State

(b) Isolating Switch: Externally operable, quick-break type

(c) Locked rotor protector for drive motor

(d) Pilot light to show circuit breaker closed and power available

(e) Ammeter and voltmeter displays on front of panel

(f) Alarm relay to energize audible or visible alarm

(g) Pressure recording device

(h) With Automatic Transfer Switch

(i) Voltage surge protection

(j) Contacts for remote alarm of:

1) Pump Running

2) Loss of Line Power in any phase

3) Phase Reversal

4) Controller Connected to Alternate Source

(k) Provide remote fire pump alarm panel in a location of constant attendance.

1) Remote pump alarm panel shall be key lockable enclosure consisting of audible or visible alarms.

2) Alarms shall show: “Pump Running”; “Supervisory Power Failure”; “Phase Reversal” and, when required by NFPA 20, “Controller Connected to Alternate Source”.

2.16 JOCKEY PUMP (JP)

A. Acceptable manufacturers: A-C Fire Pump, Fairbanks Nijhuis, Patterson Pump, Peerless Pump, Pentair Aurora or equal

B. Jockey pump shall be:

(1) Same manufacturer as main fire pump

C. Pump casing shall be pressure rated to handle system pressure.

D. Motor shall be:

(1) Open Drip Proof (ODP)

(2) Pump and motor shall be integrally mounted on common steel baseplate.

2.17 JOCKEY PUMP CONTROLLER

A. Acceptable manufacturers: Eaton, Firetrol, Joslyn Clark, Metron, or equal

B. Jockey pump controller shall be same manufacturer as main fire pump controller.

C. Jockey pump controller:

(1) Wall mounted, NEMA Type 2 control cabinet

(2) Maintain automatic sprinkler system at 5-10 psi (35-70 kPa) above fire pump starting pressure.

(3) Mercury-free pressure switch with independent adjustment

(4) Multiple position control switch

(5) 3-pole disconnect switch

(6) Starter

PART 3 - EXECUTION

3.01 GENERAL

A. Fire Protection System Layout and Installation Drawings:

(1) Contractor shall review Design Drawings and Specifications, and shall provide installation drawings, calculations, and product datasheets.

(2) Conceal sprinkler piping above ceilings where possible.

(3) Contractor shall consult with Architect during development of piping layout to avoid conflicts with general appearance. Pipe routing is a critical issue due to attributes of this building.

(4) Submit stamped and sealed installation drawings, calculations and product data sheets for coordination review to: local Fire Department, Engineer, Architect, Owner's insurance representative, City of _____ and other Authorities Having Jurisdiction prior to installation (see submittals).

(5) Contractor shall be responsible to have examined "Reflected Ceiling" drawings as well as Mechanical, Electrical, Piping, Information Technology, Structural and Architectural building plans prior to system layout.

(6) Contractor shall coordinate routing of piping with other trades and Architect.

(7) Contractor shall participate in coordination process and shall not install piping prior to coordination with other trades.

(8) Provide identification sign (enamel on metal) for valves per NFPA requirements.

3.02 DESIGN CRITERIA

A. Sprinkler Contractor, prior to preparation of installation drawings and hydraulic design calculations, shall conduct a hydrant flow test within the last 12 months.

B. Send current hydrant flow test data to Engineer.

C. Fire pump shall be designed to meet fire protection system demand.

D. Hydraulically calculated system shall be designed to a minimum of 5% below available water flow curve.

E. Basis of Design:

(1) Hazard Category -1 spaces shall be hydraulically designed to provide minimum density of 0.1 gpm (_____ L/s) per sq ft (sq m) over most hydraulically remote 1,500 sq ft (sq m). Maximum spacing shall not exceed 225 sq ft (_____ sq m) per sprinkler.

(2) Hazard Category - 2 , shall be hydraulically designed to provide minimum density of 0.2 gpm (_____ L/s) (mm/min) per sq ft (sq m) over most hydraulically remote 2,500 sq ft (_____ sq m). Maximum spacing shall not exceed 120 sq ft (_____ sq m) per sprinkler.

(3) Hazard Category - 3 shall be hydraulically designed to provide minimum density 0.3 gpm (_____ L/s) per sq ft (sq m) over most hydraulically remote2,500 sq ft (_____ sq m). Maximum spacing shall not exceed 100 sq ft (_____ sq m) per sprinkler.

F. Hose Streams:

(1) Add 250 gpm (_____ L/s) hose stream to sprinkler zone hydraulic calculations, for Hazard Category - 1 Occupancies.

(2) Add 250 gpm (_____ L/s) hose stream to sprinkler zone hydraulic calculations, for Hazard Category - 2 Occupancies.

(3) Add 500 gpm (_____ L/s) hose stream to sprinkler zone hydraulic calculations, for Hazard Category - 3 Occupancies.

3.03 INSPECTION

A. Investigate site conditions; verify utility locations and elevations before start of excavation. Forward discrepancies to Architect/Engineer before proceeding with construction.

3.04 INSTALLATION

A. Install hydraulically designed sprinkler system and associated accessories according to requirements of NFPA 13 and as shown on drawings.

B. Install hydraulically designed standpipe system and associated accessories according to requirements of NFPA 14 and as shown on drawings.

C. Install fire pump pipe, fittings, and associated accessories according to the requirements of NFPA 20.

D. Install underground pipe, fittings, and associated accessories according to the requirements of NFPA 24 and as shown on drawings.

E. Install pipe, fittings, couplings, and valves according to requirements of manufacturer.

F. Keep materials within listed temperature range to assure jointing in accordance with manufacturer's requirements.

G. Pipe and fittings shall be of corresponding materials when assembled.

H. Underground Pipe:

(1) Underground pipe shall be restrained against movement at changes in direction per the requirements of NFPA 24. Restraint shall be provided by using thrust blocks or one of the following methods:

(a) Mechanical joint restraint utilizing setscrew retainer glands

1) Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly.

2) Proper actuation of the gripping wedges shall be ensured by use of torque limiting twist off nuts.

(b) Pipe clamps and tie rods

(c) Locking mechanical or push-on joints

(d) Bolted flange joints

(2) Thrust blocks shall be of concrete, of a mix not leaner than one part cement, two and one-half parts sand, and five parts stone.

(3) Wherever possible, thrust blocks shall be located so that the joints are accessible for repair.

(4) Pipe clamps and tie rods shall not be installed where the pipe penetrates building walls or floors.

(5) Threaded sections of rods shall not be formed or bent.

(6) Except for fittings, valves, glands, and other accessories having an epoxy-coated finish, all rods, nuts, bolts, washers, clamps, and other restraining devices shall be cleaned and thoroughly coated with a bituminous or other acceptable corrosion-retarding material after installation.

(7) Provide metallic bond at each joint of ductile iron and cast-iron pipe. Bond wire shall be type RHW-USE size 1/0 neoprene-jacketed copper conductor shaped to stand clear of joint.

(8) Polyethylene encasement shall be installed for ductile iron pipe. Refer to AWWA C105/A21.5 for material standards and installation procedures.

I. Above Ground Pipe:

(1) Provide pipe identification system with flow directional arrows on fire protection pipe in accordance with manufacturer’s installation instructions. For additional information, refer to Section 22 05 53 - Identification for Plumbing Piping and Equipment.

(2) Make joints of threaded pipe by cutting pipe square and reaming inside.

(3) Exposed pipe threads shall be protected by one of the following methods

(a) Coat bare threads with corrosion inhibitive paint, equal to Rust-Oleum. Apply paint per manufacturer’s instructions.

(b) Cover bare threads with thread tape or joint compound. Use of thread tape and joint compound shall not be excessive.

(4) Joints for mechanically coupled pipe shall be made according to manufacturer's instructions. Use manufacturer’s gasket lubricant sparingly.

(5) Welded joints shall be made in fabrication shop. Welding at project site is prohibited.

(6) Changes in pipe sizes shall utilize one of the following installation methods:

(a) Concentric threaded reducers. Threaded bushings are prohibited.

(b) Concentric grooved reducers. Reducing couplings such as Victaulic Style 750 are prohibited.

(c) Threaded reducing elbows and tees.

(d) Grooved reducing elbows and tees such as Victaulic No. 25 and No. 29T.

(e) Groove x Thread End-Of-Run fitting such as Victaulic No. 67.

(f) Shop-fabricated threaded or grooved weld-o-lets.

(7) Provide readily removable fittings at end of cross-mains. Minimum size of flushing connection shall be 2" (50 mm).

(8) Provide dielectric fittings between dissimilar pipe materials.

(9) Provide nonferrous metal pipe, fittings, and hanger assemblies in MRI area(s).

(10) Provide stainless steel pipe, fittings, sprinklers, and hangers in cooling towers.

(11) All tools used for fabrication and installation of stainless steel pipe and fittings shall be dedicated for use on stainless steel materials only.

J. Sprinkler heads

(1) Install sprinklers as recommended by manufacturer. Sprinklers shall be set level and at locations to avoid interference with spray pattern of sprinkler. When ducts and lights are obstructions to sprinkler distribution, provide additional sprinklers beneath obstruction.

(2) Feed sprinklers, installed in finished ceilings, with flexible sprinkler drop, swing joint, or return bend arrangement for final positioning in ceiling grid pattern during construction phases.

(3) All arm-over and flexible sprinkler fittings shall be taken from the sides or top of the branch line. No arm-overs or flexible sprinkler fittings shall be connected to the bottom of the branch line.

(4) Sprinklers are required to be installed in the center of ceiling tiles

(5) Provide minimum 1" (25 mm) outlets with sprigs for sprinklers located in shelled spaces.

K. Provide test connection for each flow switch.

L. Discharge test connections inside building to receptacles provided as part of plumbing system or to standpipe's drain riser. Outside discharge is preferred.

M. Drain line detailed adjacent to standpipe/sprinkler risers shall be considered as part of Sprinkler System from combination test/auxiliary drain valve for each zone or sub-zone shown on plans to plumbing receptacle.

N. Provide auxiliary drains at low points of systems per requirements of NFPA 13.

O. Identify valve with brass tag denoting which flow switch is being tested, when test valves are located remote from flow switch.

P. Clamp-on or saddle type fittings (i.e., mechanical tees) are not allowed. Outlet fittings inserted into holes drilled into piping or pipe-o-lets are not allowed.

Q. Provide reducing fittings or provide shop fabricated weld-o-lets to change pipe sizes in sprinkler/standpipe systems. No bushings or grooved reducing couplings, such as Victaulic Style 750, are allowed.

R. System Drains, Inspector's Test Connections, and Auxiliary Drains

(1) Provide system drain lines sized in accordance with NFPA 13.

(2) Provide inspector's test connection for each vane-type or pressure actuated flow switch in accordance with NFPA 13. When inspector's test valve is remotely located from associated flow switch, identify valve with brass tag denoting which flow switch is being tested.

(3) Inspector's test connections and system drains shall discharge to one of the following locations:

(a) Outside building at location approved by owner.

(b) Inside building to waste receptacle (hub drain) provided as part of plumbing system.

(c) Combination drain serving multiple standpipe and/or sprinkler systems

1) Combination drain shall discharge to exterior building location approved by owner or inside building to waste receptacle (hub drain) provided as part of plumbing system.

(d) Provide auxiliary drains at low points of systems in accordance with NFPA 13.

S. Valves

(1) Valves and associated accessories shall be installed according to manufacturer's instructions.

(2) Each shutoff valve shall be equipped with a tamper switch.

(3) Install locking device with each shutoff valve to prevent inadvertent closing of valve. Keys shall be indexed to identify valve location.

T. Hangers, Bracing, and Restraint of System Piping:

(1) Provide hangers and associated parts to support piping in perfect alignment without sagging or interference, to permit free expansion and contraction, and meet requirements of NFPA 13 and manufacturer's installation instructions.

(2) Select and size building attachments per Manufacturer Standardization Society (MSS) standards and manufacturer's published load rating.

(3) Coordinate hanger support installation to group piping of all trades.

(4) Hang pipe from building members using either concrete inserts for concrete construction or beam clamps for steel construction. Installation shall comply with manufacturer's installation instructions. Expansion type inserts may be used for branch piping.

(5) Hang pipe from steel purlins via side or bottom screw applications. Install steel screws with restraining nuts. Installation shall comply with manufacturer's installation instructions.

(6) Suspend hangers by means of electroplated zinc or hot-dipped galvanized finish hanger rods. Perforated band iron and flat wire straps (strap iron) are not allowed.

(7) Mains larger than 4” in diameter when installed parallel to open web joists shall not be supported from a single joist. Mains larger than 4” in diameter when installed parallel to joists, shall be supported by trapeze hanger assembly and shall be positioned equally between two joists. Trapeze hangers shall be positioned to load joists at panel points only

(8) Support pipe from top flange of beams.

(9) Where joists are used, locations of pipe supports shall be approved by the structural engineer prior to installation.

(10) Supporting equipment or piping from metal roof deck is prohibited.

U. Install pressure gauges ____, and as required per NFPA standards.

3.05 FIRE PUMP INSTALLATION

A. Install fire pump, jockey pump and their controllers per manufacturer’s installation instructions, as shown on drawings and as required in NFPA 20.

B. Grout base–mounted pumps after securely anchoring to structure.

C. Coordinate installation with Division 26 and Division 28 Contractors.

3.06 CLEANING

A. Ensure underground feed pipe has been flushed per NFPA 24 to clear out construction debris, prior to connecting aboveground fire protection system to it. Provide copy of underground pipe flush test certificate to engineer.

B. Clean systems after installation is complete.

C. Clean piping both internally and externally to remove dirt, plaster dust, or other foreign materials. When external surfaces of piping are rusted, clean and restore surface to original condition. Replacement of heavily soiled and deteriorated materials shall be done at the Contractor’s expense.

D. Clean equipment as recommended by manufacturers. Thoroughly clean equipment of stains, paint spots, dirt, dust, and any other foreign materials. Remove temporary labels not used for instruction or operation.

3.07 TESTING

A. Refer to testing paragraph of Section 22 00 00 - General Plumbing Requirements.

B. Perform all NFPA required acceptance tests.

C. Test sprinkler system as entire system or partial system. System shall be hydrostatically tested at not less than 200 psi (1380 kPa) or 50 psi (350 kPa)above static pressure in excess of 150 psi (1035 kPs) for 2 h. No leakage allowed. Replace defective joints with new materials. No caulking of defective joints allowed. Re-test system after defective joints are replaced, until satisfactory results are obtained.

D. Hydrostatically test piping between the exterior fire department connection (FDC) and the check valve in the fire department inlet pipe in the same manner as the balance of the system.

E. Pipe shall not be concealed until satisfactorily pressure tested.

F. Conduct drain test. Record static pressure and residual pressure per NFPA 13.

G. Owner’s representative or engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.

H. Log of tests shall be kept at job site and shall identify:

(1) Who performed test

(2) Time of test

(3) Date of test

(4) Section of system tested

(5) Results of test

(6) Completed Contractor's Material and Test Certification form(s) from NFPA 13 and NFPA 14.

I. Operate flow switches to test that signals are transmitted to Fire Alarm Control Panel.

J. Include test for tamper switches.

K. Conduct forward flow test of backflow prevention assembly in accordance with NFPA 13 and NFPA 24.

3.08 FIRE PUMP TESTING

A. Test fire pump, jockey pump and their controllers per manufacturer’s installation instructions and as required in NFPA 20.

B. Furnish test certificate indicating suction pipe has been flushed and suction and discharge pipe has been hydrostatically tested in accordance with NFPA 20, prior to fire pump acceptance test.

C. Coordinate fire pump acceptance test so Local Authorities, Owner's representatives, and Insurance Company representatives can witness the test.

D. Coordinate fire pump test with Division 26 and Division 28 contractors.

E. Owner's representative or Engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.

F. Representatives from following shall be present for fire pump field acceptance test:

(1) Pump manufacturer
(2) Controller manufacturer
(3) Transfer switch manufacturer

G. Coordinate fire pump test with local utilities to verify acceptable method for disposal of water.

H. Provide equipment to perform fire pump test, including:

(1) Calibrated test gauges
(2) Calibrated tachometer
(3) Hoses
(4) Nozzles
(5) Valves

I. Diesel engine fire pumps shall be run for a minimum of 30 min no less than once per week.

3.09 WARRANTY

A. Installing contractor shall warranty system installation for a minimum of 1 year from date of substantial completion.

B. Installing contractor in combination with flexible sprinkler head manufacturer shall provide a warranty of 5 years from date of substantial completion related to leak assurance and water damage.

C. Manufacturer shall warranty all pumps and components for 2 years from date of start-up.

END OF SECTION 21 13 14

END OF DIVISION 21

DIVISION 22 - PLUMBING

SECTION 22 00 00 GENERAL PLUMBING REQUIREMENTS

SECTION 22 05 13 COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

SECTION 22 05 20 PLUMBING EXCAVATION AND BACKFILL

SECTION 22 05 29 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

SECTION 22 05 53 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

SECTION 22 05 94 DOMESTIC WATER SYSTEMS BALANCE

SECTION 22 07 00 PLUMBING INSULATION

SECTION 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS

SECTION 22 11 18 WATER DISTRIBUTION SYSTEM

SECTION 22 13 14 SANITARY WASTE AND STORM DRAINAGE SYSTEMS

SECTION 22 14 14 BUILDING SUBSOIL DRAINAGE

SECTION 22 16 00 NATURAL GAS PIPING

SECTION 22 21 14 PLUMBING SPECIALTIES

SECTION 22 33 14 WATER HEATING EQUIPMENT

SECTION 22 40 00 PLUMBING FIXTURES

SECTION 22 40 14 EQUIPMENT BY OTHERS

SECTION 22 00 00 - GENERAL PLUMBING REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. Specification requirements defined in Division 20 of this Specification apply to, and are in addition to the work associated with equipment, systems, materials, and installation requirements specified in Division 22. Contractor shall provide the requirements specified in Division 20 to obtain complete systems, tested, adjusted, and ready for operation.

1.02 RELATED WORK

A. Section 01 81 13 - Certification Requirements

B. Section 20 00 00 - General Mechanical Requirements

C. Section 20 05 13 - Motors

D. Section 20 05 14 - Variable Frequency Drives

E. Section 20 05 29 - Piping and Equipment Supporting Devices

F. Section 20 05 53 - Mechanical Systems Identification

G. Section 20 05 73 - Mechanical Systems Firestopping

H. Section 20 07 00 - Mechanical Systems Insulation

1.03 LEED V4 BD+C NEW CONSTRUCTION CERTIFICATION

A. Project goal is to pursue certification under LEED v4 BD+C New Construction. Provide services, documentation and product data required to meet LEED features involving equipment and components specified in Division 22.

(1) LEED Credits

(a) Water Efficiency – Indoor Water Use Reduction (Prerequisite)

1) Provide product data and shop drawings for plumbing fixtures indicating water consumption in gallons/minute or gallons/cycle.

2) Once through cooling with potable water sources for heat rejection shall not be used for any equipment or appliances.

1.04 LEED PERFORMANCE CRITERIA

A. VOC Emissions Evaluation: For adhesives and sealants used to install Plumbing, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants used to install Plumbing, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.05 LEED SUBMITTALS

A. Submit additional LEED submittals as required for targeted LEED credits and detailed in LEED guidance and applicable specification sections concurrent with standard product submittal packages. All references to specification section and related LEED credit should be clearly identified where specific information is requested.

B. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

C. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant.

PART 2 PRODUCTS

2.01 NOT APPLICABLE TO THIS SECTION.

PART 3 EXECUTION

3.01 NOT APPLICABLE TO THIS SECTION.

END OF SECTION 22 00 00

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 23 05 14 - Variable Frequency Drive (VFD) System

B. Section 26 29 13 - Enclosed Controllers

1.02 SUBMITTALS

A. Product Data including the following:

(1) Manufacturer
(2) hp (kW), voltage, phase, hertz, rpm
(3) Motor type
(4) Enclosure type
(5) Frame type
(6) Insulation class
(7) NEMA design designation
(8) Service factor
(9) Nominal efficiency at full load
(10) Power factor at full load
(11) Full load amperes
(12) Bearings
(13) Mountings
(14) Dimensions
(15) Weight
(16) Shaft grounding brush for motors driven by Variable Frequency Drives (VFD)

1.03 PRODUCT CRITERIA

A. Motors covered by this Specification shall conform to applicable requirements of NEMA, IEEE, ANSI, and NEC Standards and shall be UL Listed where applicable for service specified.

B. Motors shall be designed for conditions in which they will be required to perform, i.e., general purpose, splash proof, explosion proof, standard duty, high torque or other special type as required by equipment manufacturers.

C. Select motors so they do not exceed nameplate rating nor operate into service factor to meet specified duty.

D. Motors located in outdoor or wash down environments shall have totally enclosed fan cooled (TEFC) enclosures.

E. Motors shall be furnished for starting in accordance with utility requirements and be compatible with starters specified hereinafter or under Electrical sections of Specifications.

(1) Refer to Section 26 29 13 - Enclosed Controllers for reduced voltage starting requirements.
(2) Starters for NEMA rated 200 or 230 V motors, 25 hp (18.5 kW) and above shall be reduced voltage starting type.
(3) Starters for NEMA rated 460 V motors, 60 hp (45 kW) and above to be reduced voltage starting type.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials shall be new and guaranteed for service intended.

2.02 ELECTRICALLY COMMUTATED MOTORS (ECM)

A. Motor assembly shall be designed for use on direct drive fans or pumps and shall be electrically commutated, DC, brushless type, specifically designed for use with 120 Volt or 208-230/277 Volt, 60 Hz single-phase electrical input or three-phase, 60 Hz electrical input as scheduled.

B. Motor speed shall be variable via compatible input signal and shall be complete with and operated by single-phase integrated controller/inverter that operates wound stator and senses rotor position to electronically commutate stator. Motor shall maintain minimum of 70% efficiency over entire operating range.

C. Motors shall:

(1) have permanently lubricated ball bearings.
(2) be designed for synchronous rotation.
(3) be permanent magnet type with near-zero rotor losses.
(4) be able to be mounted with shaft in horizontal or vertical orientation.

(5) be controllable from local and remote speed-control adjustments.

(6) be designed to overcome reverse rotation without affecting life expectancy.

D. Provide Power Factor Correction / Harmonic Correction module to limit harmonic distortion to less than 10% THDi at input of the filter.

E. Speed Control (Drive):

(1) Motor manufacturer shall provide factory installed PWM speed control drive for local (manual) and remote speed adjustment. Local PWM drive shall be field adjustable with standard screwdriver. Drive shall also be capable of receiving 0-10 vdc signal from DDC controller to control fan or pump speed.

(2) Drive shall provide soft start and adjustable speed change ramp rate.

(3) Drive shall provide motor protection consisting of locked rotor, over-current, and thermal overload protection at minimum.

2.03 INDUCTION MOTORS

A. Voltage Ratings

(1) Refer to equipment schedules and specification sections for voltages required.

(2) Unless otherwise indicated, motors 1/3 hp (0.25 kW) and smaller shall be rated 115 V for operation on 120 V, 1 Ph, 60 Hz service.

(3) Unless otherwise indicated, motors 1/2 hp (0.37 kW) and larger shall be rated:

(a) 460 V for operation on 480 V, 3 Ph, 60 Hz service.

(b) 200 V for operation on 208 V, 3 Ph, 60 Hz service.

(c) 230 V for operation on 240 V, 3 Ph, 60 Hz service.

B. Motors shall be 4 pole (approximately 1750 rpm) unless otherwise noted.

C. Single-phase motors shall be furnished with built-in thermal overload protection.

D. Use NEMA Design B motors, normal starting torque with greasable ball bearings, and Class B insulation unless specified otherwise or unless manufacturer of equipment on which motor is being used has more stringent requirements.

(1) Bearings shall be rated for minimum AFBMA 9, L-10 life of 26,280 hours (belted) and 200,000 hours (direct-coupled) at full-load.

E. Motors shall be rated continuous duty and have 1.15 service factor unless otherwise noted.

F. Motors Driven by Variable Frequency Drives (VFD)

(1) Motors shall comply with the latest NEMA MG 00001, Section IV, Part 31.

(2) Motors shall have service factor not less than 1.0 at rated load.

(3) Insulation shall be Class F or H.

(4) Furnish each motor with shaft grounding ring utilizing conductive microfiber similar to AEGIS SGR to protect motor bearings from electrical damage.

G. Vibration shall not exceed 0.15" (3.8 mm) per second, unfiltered peak unless otherwise noted.

H. Motors (180 frames and larger) shall have provisions for lifting eyes or lugs capable of safety factor of 5.

I. Full load nominal efficiency of motors 1 hp (0.75 kW) and larger, except special-purpose motors including 2-speed or multi-speed motors, and rewound motors, shall meet or exceed listed values when tested in accordance with IEEE Standard 112 Method B as defined by NEMA MG 00001-12.6C. Efficiency values listed are based on NEMA Premium Efficiency Electric Motors of NEMA MG 00001-2011, Table 12-12.

	Open Drip Proof Motors			Totally Enclosed Fan-Cooled Motors		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
hp (kW)	(6 pole)	(4 pole)	(2 pole)	(6 pole)	(4 pole)	(2 pole)
1 hp (0.75 kW)	82.5	85.5	77.0	82.5	85.5	77.0
1.5 hp (1.1 kW)	86.5	86.5	84.0	87.5	86.5	84.0
2 hp (1.5 kW)	87.5	86.5	85.5	88.5	86.5	85.5
3 hp (2.2 kW))	88.5	89.5	85.5	89.5	89.5	86.5
5 hp (3.7 kW)	89.5	89.5	86.5	89.5	89.5	88.5
7.5 hp (5.5 kW)	90.2	91.0	88.5	91.0	91.7	89.5

	Open Drip Proof Motors			Totally Enclosed Fan-Cooled Motors		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
hp (kW)	(6 pole)	(4 pole)	(2 pole)	(6 pole)	(4 pole)	(2 pole)
10 hp (7.5 kW)	91.7	91.7	89.5	91.0	91.7	90.2
15 hp (11 kW)	91.7	93.0	90.2	91.7	92.4	91.0
20 hp (15 kW)	92.4	93.0	91.0	91.7	93.0	91.0
25 hp (18.5 kW)	93.0	93.6	91.7	93.0	93.6	91.7
30 hp (22 kW)	93.6	94.1	91.7	93.0	93.6	91.0
40 hp (30 kW)	94.1	94.1	92.4	94.1	94.1	92.4
50 hp (37 kW)	94.1	94.5	93.0	94.1	94.5	93.0
60 hp (45 kW)	94.5	95.0	93.6	94.5	95.0	93.6
75 hp (55 kW)	94.5	95.0	93.6	94.5	95.4	93.6
100 hp (75 kW)	95.0	95.4	93.6	95.0	95.4	94.1
125 hp (90 kW)	95.0	95.4	94.1	95.0	95.4	95.0
150 hp (110 kW)	95.4	95.8	94.1	95.8	95.8	95.0
200 hp (150 kW)	95.4	95.8	95.0	95.8	96.2	95.4
250 hp (185 kW)	95.4	95.8	95.0	95.8	96.2	95.8

J. Single-phase motors for hard starting applications including outdoor applications shall be capacitor start type. Motors for fans and pumps located indoors may be split phase or permanent split-capacitor. Motors shall be equipped with permanently lubricated and sealed ball bearings and shall be selected for quiet operation. Motors 1/8 hp (0.09 kW) and below may be shaded pole type.

(1) Refer to individual equipment section for additional requirements or specific type of motors.

K. 3 Ph, 2-speed motors shall be one winding, consequent pole, variable torque type and 1 Ph, 2-speed motors shall be capacitor start capacitor run type.

L. When submersible pumps are specified, each pump shall include in addition to controls specified, all necessary controls, relays, wiring, etc. that may be required for safety features incorporated in motor design. No submersible motor shall be run or activated until all requirements of motor manufacturer's recommendations have been complied with.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install materials in accordance with drawings, approved Shop Drawings, and manufacturer's recommendations.

END OF SECTION 22 05 13

SECTION 22 05 20 - PLUMBING EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section lists methods and materials for trench excavation and backfill for plumbing piping systems inside and outside the building.

1.02 RELATED WORK

A. Division 31 - Earthwork

1.03 SUBMITTALS

A. List of materials to be used for backfill.

PART 2 - PRODUCTS

2.01 FILL MATERIAL

A. Type 1 Fill:

(1) Material from excavation separated from materials, which do not compact by tamping and rolling. No stones larger than 3” (75 mm) and no building, organic, corrosive, or frozen materials.

B. Type 2A Fill:

(1) Sand or gravel materials with none larger than 2” (50 mm) and of that portion passing #4 sieve less 5% to pass #200 sieve.

C. Type 2B Fill:

(1) Sand or gravel materials with none larger than 1/2” (13 mm) and of that portion passing #4 sieve less 5% to pass #200 sieve.

D. Type 3 Fill:

(1) Gravel of rounded to subangular shape, screened, which will pass 0.75” (19 mm) sieve and retained on #4 sieve.

E. Type 4 Fill:

(1) Pit run rock or gravel with maximum stone size of 1” (25 mm).

F. Type 5 Fill:

(1) Pea gravel, screened, which will pass 0.375” (9 mm) sieve and retained on #4 sieve.

G. Type 6 Fill:

(1) Soils Engineer approved fill material, backfilled, and compacted beneath building footprint.

PART 3 - EXECUTION

3.01 PREPARATION

A. Establish grade lines and locations of mains and manholes. Provide necessary stakes and batter boards.

B. Verify invert elevations of existing utilities prior to excavation for new utility piping.

3.02 EXCAVATION

A. Provide excavation for all underground work, including piping, manholes, catch basins, tanks, concrete structures, etc., unless otherwise shown or specified. Lay piping in open trench except when Architect gives written permission for tunneling.

B. Include all necessary clearing; tree removal; grubbing; pavement removal; substructure removal such as walls, footings and piers and all incidental work such as tunneling, sheet piling, shoring, underpinning, pumping, bailing and transportation. Coordinate excavation extending beyond construction limits with Contractor and Owner.

C. Blasting is not allowed on this project without written permission of Architect and Owner.

D. Remove all excess excavation material from site unless directed otherwise.

E. Use mechanical methods to remove rock in trenches for piping systems.

F. Include rock excavation in the Bid unless otherwise indicated.

3.03 PIPE INSTALLATION

A. Keep underground piping to proper line and grade and sealed at all times to prevent entrance of animals or foreign matter.

B. Provide bracing and sheet piling as necessary to support trenches. Comply with Local Regulations, applicable provisions of OSHA Regulations on trenching, or with provisions of “Manual of Accident Prevention in Construction” published by Associated General Contractors of America.

C. Under no circumstances lay pipe or install appurtenances in water. Keep trench free from water until pipe joint material has hardened.

D. Presence of ground water in soil or necessity of sheet piling or bracing trenches shall not constitute condition for which any increase may be made in Contract price, except when sheet piling is left in place on written order of Owner, Contract price will be adjusted.

E. Cut off sheet piling left in place not less than 2” (50 mm) below new finished grade. Do not remove sheet piling until trench is substantially backfilled.

F. Install underground plastic pipe per ASTM D2321.

G. Place underground piping outside and inside building in open excavated trenches. Where trench bottom does not contain stones larger than 1” (25 mm) in size or where bedrock is not encountered, trench may be excavated to final pipe grade. Where bedrock or stones larger than 1” (25 mm) is encountered, excavate entire length of trench to depth 4" (100 mm) below final pipe grade elevation and provide 4" (100 mm) of pipe bedding material compacted to minimum of 90% Standard Proctor Density consisting of Type 2B, 3 or 5 fill to establish final pipe grade. Shape bedding for clearance for all joints and fittings, tamped in place and graded evenly to ensure uniform bearing for full length of pipe. Do not support piping by blocking, planking, or mounding of bedding material.

3.04 BACKFILL

A. Exterior:

(1) Backfill outside building including all piping beyond construction limits only after piping and appurtenances have been inspected, recorded, tested and approved. Backfill around pipe by hand to depth of 12” (300 mm) above top of pipe with Type 2B, 3 or 5 fill in 6" (150 mm) layers. Take care not to disturb pipe or damage pipe coating. Do not use Type 3 fill where it will come in contact with polyethylene encasement specified in Section 21 11 14 - Exterior Fire Suppression Piping Systemsand Section 22 11 14 - Exterior Services. Compact backfill thoroughly with compactor of suitable weight or with approved mechanical tamper. No flooding or jetting with water is allowed.

(2) Place backfill from 12” (300 mm) above pipe in layers not exceeding 8" (200 mm) in depth with Type 1 fill. Compact backfill material to the same density as surrounding area prior to that of excavation.

(3) When excavating through areas which are to become walks, roads, driveways or parking areas of concrete, bituminous or exposed gravel surfacing or such areas are existing to remain; backfilling from 12” (300 mm) above pipe to subgrade shall be with Type 2A, 2B, 3 or 4 fill. Backfill in 12” (300 mm) layers and compact with mechanical means to density 95% modified proctor. Frequency of compaction testing shall be determined by testing consultant, based on site conditions, materials and workmanship.

(4) When excavation occurs on public property or areas beyond property line, all excavation, pipe laying, backfilling, grading, and surfacing shall conform as herein specified, except additional requirements for public utility or other authorities shall be complied with when in order. Check with each utility and incorporate cost of any additional requirements in Base Bid.

B. Interior:

(1) Backfill inside building only after piping and appurtenances have been inspected and approved. Backfill to 12” (300 mm) above pipe with Type 2B, 3 or 5 fill in 6" (150 mm) layers. Remainder of backfill shall be Type 2A, 2B, 3, 4, or 6 fill in 12" (300 mm) layers.

(2) Install lines passing under foundations with minimum of 1-1/2” (40 mm) clearance to concrete and ensure there is no disturbance of bearing soil.

(3) Backfill piping suspended from slab on grade with Type 2B or 5 fill in 6” (150 mm) layers. Same fill materials shall be provided for 12” (300 mm) minimum on each side of pipe.

3.05 ROCK EXCAVATION

A. Consider material over 1 yd³ (0.80 cubic meter) in size encountered during excavation as rock. Rock excavation will be paid as extra if it cannot be removed by 200 net hp (150 net kW) crawler tractor with ripper attachment all in good running condition and operated by an experienced individual.

B. Excavate rock to 4” (100 mm) below intended pipe invert.

3.06 FINISHING

A. On completion of trenching and backfilling operations, restore grades to original elevation or to new subgrade elevation.

B. When trenching is through existing areas or beyond constructions limits, replace surfaces to existing conditions.

C. In landscaped areas use 6” (150 mm) of topsoil and sod to match existing elevations, or as otherwise approved by Landscape Architect.

END OF SECTION 22 05 20

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 22 07 00 - Plumbing Insulation

B. Section 23 05 50 - Vibration Isolation (Spring Hangers and Mounts)

1.02 DESCRIPTION

A. Provide all supporting devices not provided as part of building structure or indicated on structural drawings or structural details, as specified and as required for proper supporting, anchoring, and guiding of piping, equipment, materials, and systems.

B. Support for all conditions of operation, including variations in installed and operating weight of equipment, piping, and ductwork, to prevent excess stress and allow for proper expansion and contraction.

C. Support of fire protection pipe shall comply with NFPA 13 Standard for the Installation of Sprinkler Systems, Current Edition.

1.03 SUBMITTALS

A. Product Data for each piping system for all pipe sizes and all applicable equipment including the following:

(1) Manufacturer's name

(2) Model numbers

(3) Materials of construction and load ratings lbs (kg).

(4) Schedule of hangers and support devices with pipe support spacing

(5) Insulated pipe supports along with application chart or table including pipe support spacing.

(6) Insulation protection saddles and weight bearing insulation table.

(7) Details and calculations for sizing supplementary steel utilized for trapeze or specially designed supports.

(8) Structural attachments, inserts, and concrete anchors. Submit ICC-ES Evaluation Report for each type of anchor.

(9) Calculations and drawings for concrete inserts and anchors for each application.

(10) Drawings showing specific locations of any weld attachments to structure, including weight supported by such attachments.

(11) Drawings showing specific locations of any suspended loads which exceed 100 lbs (45 kg) within joist chord panel to be attached to open web steel joist structural members. Include weight supported by such attachments. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord.)

(12) Equipment mounting devices.

(13) Pipe guides and anchors.

(14) All other appropriate data.

B. Submittals in PDF format shall be organized using PDF bookmarks per detailed instructions on assembling submittal packages identified under Submittal Requirements section of 22 00 00 - General Plumbing Requirements.

1.04 DESIGN CRITERIA

A. Materials and application of pipe hangers and supports shall conform to the latest requirements of ANSI B31/ASME B31.1 Code for Pressure Piping and MSS Standard Practice SP-58-2018 (Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation), except as supplemented or modified herein.

B. Support materials shall be steel or stainless steel unless specifically indicated.

C. Support devices shall be factory fabricated and have published load ratings.

D. Unless otherwise indicated, design supports, anchors, and related components with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.

E. Maximum deflection of support members, including trapeze supports, shall be in accordance with the following equation, but shall not exceed 0.3" (7.5 mm):

D = L/240

Where D = Max deflection in " (millimeters)

L = Support member length in " (millimeters)

F. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard black, primed, galvanized, or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application and corrosive atmospheres. Coat cut edges, welds, or any damaged finish with galvanized paint.

(1) Corrosive atmospheres include the following locations:

(a) Exterior locations
(b) Chemical storage and hazardous waste storage rooms
(c) Food service/kitchen areas
(d) Locker/shower rooms
(e) Meter pits
(f) Utility tunnels
(g) Cage washroom (dirty and clean)
(h) Sterilizer/autoclave room

G. Materials in contact with pipe shall be galvanically compatible with piping material to eliminate conductive path for galvanic corrosion. Provide galvanic separation, such as nonmetallic coating or inserts between piping and metallic supports where piping and support materials have galvanic potential. Pipe insulation is acceptable galvanic separation. Galvanic potential shall be determined by table below:

	Galvanized Steel	**Carbon Steel**	**Stainless Steel (Type 304 or 316)**	**Copper** **Brass** **Bronze**
Copper, Brass, Bronze	Yes	Yes	No	NA
Stainless Steel (Type 304 or 316)	Yes Note (1)	Yes Note (1)	NA	
Carbon Steel	No	NA		
Galvanized Steel	NA			

(1) Required where stainless steel surface area near interface is equal or greater than steel surface area

H. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish. Paint type shall be approved by Architect/Engineer.

I. This Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe. Coordinate with Contractor performing work specified in Section 22 07 00 - Plumbing Insulation.

J. In addition to hangers specified in this Section, piping connected to pumps, compressors, and similar rotating or reciprocating equipment shall have vibration isolation hangers or supports for specified distance from such equipment. Refer to Section 23 05 50 - Vibration Isolation for required distance.

K. Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

L. Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.

M. Unless otherwise indicated, continuous insert channels are not allowed.

N. Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.

O. Refer to Structural Documents and ICC-ES Evaluation Report for application of concrete inserts and concrete anchors.

P. Lateral braces shall be designed and detailed to apply loads as directly as possible to structural floor slabs, roof decks, or other building lateral elements. Braces shall not be applied to bottom flanges of steel beams or bottom chords of open web steel joists.

Q. Coordinate with Contractor for any proposed weld attachments to building structure. This may result in use of welding codes or standards, which may apply to "structural work". and may necessitate repair of fireproofing and/or extension of fireproofing to support members. Execution of this work may be assigned to General Trades responsible for building structural steel. Cost for this work, however, will remain the responsibility of this Contractor.

R. Top or bottom chords of open web steel joists may be used to support loads, provided total load within panel does not exceed 100 lbs (45 kg) and load is placed concentric to joist. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord).

S. Where fire rated fiberglass products are used for channel and support devices, the following properties shall apply:

(1) Flame Spread Properties
(a) Polyester Fiberglass (PF) Class 1 ASTM E84

(b) Vinylester Fiberglass (VF) Class 1 ASTM E84

T. Fasteners including concrete anchors for seismic application shall have ICC Evaluation Service Report (ESR) and meet requirements of local authorities.

PART 2 - PRODUCTS

2.01 STRUCTURAL SUPPORTS

A. Unless specifically indicated on structural drawings, design and provide all supporting devices including miscellaneous steel (angles, channels, beams, etc.), required for proper support of piping, equipment, and materials.

2.02 PIPE HANGERS AND SUPPORTS (METALLIC)

A. Manufacturers: Anvil, Erico, Tolco, PHD, National Pipe Hanger Corporation, or B-Line, equal to Anvil figures listed. Corresponding MSS Type is indicated where applicable.

B. Clevis and Roller Type Hangers:

System	Pipe Size	Clevis	Roller
Hot Pipes with Insulation (105°F (41°C) and above)	and 2" (50 mm) and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2" (65 mm) to 6" (150 mm)	---	171 (MSS Type-41), 181 (MSS Type-43)
	8" (200 mm) and larger	---	171 (MSS Type-41)
Cold Pipes with Insulation (33°F (1°C) to 60°F (15°C))	2" (50 mm) and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2" (65 mm) and larger	260 (MSS Type-1), 295 (MSS Type-1)	---

(1) For pipe size 2-1/2" (65 mm) and larger, where there is transverse movement at support points due to thermal expansion/contraction, clevis type hangers similar to Anvil Figure 260 (MSS Type-1) may be used if vertical angle of hanger rod is less than 4°.

C. Flat Surfaces (Trapeze, Rack Type):

(1) Use structural steel members such as struts, angles, channels, and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Refer to Part 1 for design criteria. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers, or slides indicated below at each support point.

System	Pipe Size	Straps or Clamps	Rollers	Slides
Hot Pipes with Insulation (105°F (41°C) and above)	2" (50 mm) and smaller	Anvil Klo-Shure	---	
	2-1/2" (65 mm) and larger	---	171 or 177(MSS Type-41), 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only. Type 4, 5 or 6 for both longitudinal and transverse movement
Cold Pipes with Insulation (33°F (1°C) to 60°F (15°C))	10" (250 mm) and smaller	137 (MSS Type-24)	---	---
	12" (300 mm) and larger	432	171 or 177 (MSS Type-41), 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement.

D. Vertical Pipe within Wall Cavities

(1) Use clamps, straps, inserts or channels to support pipes concealed in wall cavity. Select members for pipe support types and loading conditions. Refer to Part 1 for design criteria.

(2) Provide clamps, strut channels, insulated supports, or brackets and inserts equal to manufacturer indicated below:

System	Pipe Size	Supports	Clamps, Brackets/Inserts	Pre-insulated Inserts
Hot and Cold Pipes with Insulation	All sizes	Anvil 137	HoldRite 260 series with SBIS bracket, Anvil 262	Anvil Klo-Sure, Pipe Shields A2000

2.03 INSULATION PROTECTION SHIELDS

A. Anvil Fig. 167 (MSS Type-40) constructed of galvanized carbon steel. Per the latest edition of Standard MSS SP-58, select shield to accommodate outer diameter of insulation. Shield length and gauge for insulation compression strength not less than 15 psi (103 kPa), shall be as follows:

Pipe Size	Length	Gauge
1/4" (8 mm) thru 3" (80 mm)	12" (300 mm)	18 (1.316 mm)
4" (100 mm)	12" (300 mm)	16 (1.621 mm)
5" (130 mm) and 6" (150 mm)	18" (450 mm)	16 (1.621 mm)
8" (200 mm) thru 14" (350 mm)	24" (600 mm)	14 (2 mm)
16" (400 mm) thru 24" (600 mm)	24" (600 mm)	12 (2.758 mm)

2.04 INSULATED PIPE SUPPORTS

A. Description:

(1) Products designed specifically for weight-bearing support of insulated pipes. Apply products in accordance with manufacturer’s recommendations and requirements indicated below:

(2) Refer to PART 3 – EXECUTION for application of Type A, Type B, and Type C Insulated Pipe Supports specified below.

B. General:

(1) Supports shall be designed and rated for applied load, including weight of pipe, fluid, insulation, and any other imposed loads, with minimum 1.5 safety factor. Ratings shall be published by manufacturer and included in submittals.

(2) High compressive strength inserts utilized to support loads shall encircle circumference of pipe. Block-style inserts are not allowed.

(3) Supports shall be suitable for hot or cold pipe service as applicable.

(4) Submit chart or table indicating selected model along with pipe sizes, rated loads, support device types and support spacing for each piping system.

(5) Pipe support spacing shall be in accordance with manufacturer's recommendations but shall not exceed maximum spacing indicated under Hanger and Support Spacing in Part 3 of this Section.

(6) Testing of insulation for compressive strength properties shall comply with ASTM D1621.

(7) Insulation thickness shall match adjacent pipe insulation thickness.

(8) Integrity of vapor barrier jacket shall be maintained continuously through support assembly.

(9) Insulated pipe support style shall be specifically selected for the application and shall consider the following criteria at minimum:

(a) Vertical, lateral, and axial support design load limits.

(b) Vertical, lateral, and axial support design travel limits.

(c) Temperature of support, at pipe surface, and ambient conditions.

(d) Test or pre-operational loads that may exceed normal operating conditions.

(e) Material for any items that will be welded directly to the pipe.

(f) Loading and displacements caused by seismic, hydraulic surge, or other forces.

(g) Temperature at support steel.

(10) All steel components shall have corrosion protection coating consisting of hot-dip galvanizing or zinc-rich primer coating.

C. Type A Insulated Pipe Supports (Light Duty)

(1) Description:

(a) Pipe insulation specified in Section 22 07 00 - Plumbing Insulation with insulation protection shields specified in this Section. Weight-bearing inserts are not required.

(b) Type B or Type C supports may be utilized in lieu of Type A supports.

D. Type B Insulated Pipe Supports (Standard Duty):

(1) Manufacturers:

(a) SNAPP ITZ insulation inserts by KB Enterprise, Tru-Balance Insulated Saddles by Buckaroos, Inc., Value Engineered Products or approved equal.

(b) Klo-Shure insulation couplings may be used for cold pipes insulated with elastomeric insulation. Mount shall be 7 Series Strut Mount with metal clamps or Clevis System for clevis hangers.

(c) Type C supports may be utilized in lieu of Type B supports.

(d) Contractor may propose to utilize contractor-fabricated insulated pipe supports in lieu of manufactured Type B Supports. Use of contractor-fabricated assemblies is subject to approval of appropriate submittal data. Submit detail drawings of assemblies and product data showing equivalency to specified manufactured products for approval.

(2) Description:

(a) Load-rated assembly consisting of high compressive strength insulation material completely encompassing circumference of pipe, vapor barrier jacket, and insulation protection shield.

(b) Insulation protection shield shall conform to ANSI/MSS SP-58. Shield shall be G90 galvanized steel and shall span full circumference of pipe insulation. Half-shields spanning lower 180° degrees arc of insulation outer circumference will be acceptable when used with clevis hangers.

(c) Axial length of insulation material shall be not less than 9" (230 mm) or 2" (50 mm) longer than insulation protection shields 1" (25 mm) minimum on each end), whichever is longer.

(3) Insulation Materials:

(a) Hot Pipes 105°F (41°C) to 250°F (120°C):

1) Rigid closed cell, polyisocyanurate or phenolic insulation by ITW, Resolco, or Kingspan. Minimum compressive strength shall be 100 psi (690 kPa).

(b) Hot Pipes 251°F (121°C) to 1200°F (650°C):

1) High-density calcium silicate insulation similar to Johns Manville Thermo-12 Gold. Minimum compressive strength shall be 100 psi (690 kPa).

(c) Cold Pipes 60°F (16°C) and below:

1) Rigid closed cell, polyisocyanurate, phenolic insulation similar to ITW, Resolco, Kingspan, or cellular glass insulation similar to Pittsburgh Corning Foamglas.

E. Type C Insulated Pipe Supports (Heavy Duty):

(1) Manufacturers:

(a) Pipe Shields, Inc., Bergen Pipe Supports, or Rilco equal to Pipe Shields models listed.

(b) Unless otherwise indicated, pre-insulated pipe supports shall be as indicated in the following schedule. Model numbers are based on Pipe Shields, Inc.

1) Pipe supported on hangers: Model “A” Series and Model “D” Series

2) Pipe supported on flat surfaces and pipe rollers: Models “A” Series

3) Pipe supported on slides: Model "B" Series with lateral guide or restraint

4) Pipe anchors: Model “C” Series

5) Riser clamps: Model “E” Series with thrust plates. Select proper model for restraint for downward load or upward load.

(c) Contractor may propose to utilize contractor-fabricated insulated pipe supports in lieu of manufactured Type C Supports. Use of contractor-fabricated assemblies is subject to approval of appropriate submittal data. Submit detail drawings of assemblies and product data showing equivalency to specified manufactured products for approval.

(2) Description:

(a) Load-rated assembly consisting of high compressive strength insulation material completely encircling circumference of pipe, vapor barrier jacket system incorporating structural inserts and insulation protection shield/casing where applicable.

(3) Insulation Material:

(a) Water-resistant high density calcium silicate with minimum density of 13 lb/ft³ (208 kg/m³) and compressive strength not less than 100 psi (690 kPa). Thermal conductivity shall be not more than 0.38 Btu in/hr ft²°F (0.055 W/m°C at 24°C) at 75°F (23.89°C).

(b) Structural Inserts:

1) Structural inserts used by manufacturer to reinforce between pipe and insulation jacket for clamping devices shall be water-resistant high compressive strength inorganic materials selected by manufacturer for desired combination of structural strength and insulating properties. Structural inserts shall have minimum compressive strength of 600 psi (4140 kPa). Thermal conductivity shall be not more than 0.58 Btu in/hr ft²°F (0.084 W/m°C at 24°C) at 75°F (23.89°C).

(c) Jacket:

1) Jacket shall consist of G90 galvanized steel conforming to ASTM A653/A653M and shall provide complete vapor barrier around insulation and bearing surface for protection of insulation.

2) When recommended by manufacturer, use reinforced insulation protection shield at support bearing surface. Insulation shall extend 1" (25 mm) beyond insulation protection shield to maintain vapor barrier integrity.

2.05 HANGER RODS (METALLIC)

A. Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.

B. Rods shall have electroplated zinc or hot dip galvanized finish.

C. Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule. Rod size may be reduced one size for double rod hangers. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated.

Max. Pipe Size with Single Rigid Rod	Rod Diameter inches (millimeters)	Max Load lbs (kg)of Hanger Rod (Not exceeding 650 °F (340 °C) Service Temp.)
2" (50 mm)	3/8 (10)	730 (330)
3" (80 mm)	1/2 (13)	1350 (610)
5" (130 mm)	5/8 (16)	2160 (980)
8" (200 mm)	3/4 (20)	3230 (1460)
12" (300 mm)	7/8 (24)	4480 (2030)
18" (450 mm)	1 (25)	5900 (2670)
30" (750 mm)	1-1/4 (33)	9500 (4310)

D. Threaded rods are not allowed in clean rooms.

2.06 BOLTS, NUTS, STUDS AND WASHERS

A. ASTM A307, electroplated zinc finish

2.07 ROD ATTACHMENTS

A. Anvil Fig. 290 (MSS Type-17), galvanized finish

2.08 U-BOLTS

A. Anvil Fig. 137 (MSS Type-24), galvanized finish

2.09 BEAM CLAMPS

A. Beam Clamps: Anvil Fig. 133/134 (MSS Type-21), 218 (MSS Type-30), 228 (MSS Type-28 or 29) and 292 (MSS Type-28 or 29)

B. Top Beam Clamps: Anvil Fig. 227 (MSS Type-25)

C. C-Clamps: Anvil Fig. 86, 92 or 93 (MSS Type-19 or 23) with set screw and lock nut

2.10 ADJUSTABLE PIPE SADDLE SUPPORTS

A. Anvil Fig. 264 (MSS Type-38), galvanized finish. Provide Anvil Fig. 63 Type T stanchion with base, galvanized finish, where applicable.

2.11 RISER CLAMPS (BARE PIPE)

A. Anvil Fig. 261 (MSS Type-8), galvanized finish

B. B-Line B3373C, PVC coated carbon steel, in area at pipe contact, for bare copper tubing

C. Proset system, proseal plug and fire-fill for sleeved and cored holes.

2.12 RISER CLAMPS (INSULATED PIPE)

A. Unless otherwise indicated, insulated pipe riser clamps shall be Type C insulated pipe supports. Refer to Insulated Pipe Supports in Part 2.

B. Contractor may propose to utilize contractor-fabricated riser supports. Use of contractor-fabricated riser supports is subject to approval of appropriate submittal data. Submit support detail drawings, bearing stamp of Structural Engineer registered in project jurisdiction, for approval. Supports shall be engineered to withstand static and dynamic forces with minimum safety factor of 2.0. Submit insulation details addressing thermal break from building structure and vapor barriers.

2.13 CONCRETE INSERTS (WOODEN FORMED CONCRETE)

A. Anvil Fig. 281 or 282, or Hilti HCI-WF (MSS Type-18), suitable for rod diameter and weight supported.

2.14 CONCRETE INSERTS (METAL DECK FORMED CONCRETE)

A. Anvil Fig. 284, Tolco No. 109DD, B-Line Fig. B3019, DeWalt/Powers "Bang-It+", Hilti HCI-MD, or MSCO No. MX34.

2.15 CONCRETE ANCHORS

A. Manufacturers: Hilti, DeWalt/Powers, or Red Head

B. Anchors shall be selected, sized, and detailed by Contractor's structural engineer registered in project's jurisdiction, based on project conditions and in accordance with project building code. Calculations and drawings shall be submitted.

C. Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.

D. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.

E. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.

F. Anchors for seismic load application shall be approved by ICC-ES Evaluation Reports to resist seismic loads and selected to meet project seismic design requirements. Refer to Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment and Structural drawings.

G. Anchors shall be zinc plated in accordance with ASTM B633.

H. Select anchors with load ratings based on cracked concrete conditions.

2.16 METAL FRAMING SUPPORT SYSTEM (STRUT SYSTEM)

A. Manufacturers: Unistrut, B-Line Strut Systems, Anvil-Strut, Power-Strut, Erico, Superstrut, Kindorf, Hilti, and Hydra-Zorb.

B. Channels shall have epoxy paint or electroplated zinc finish.

C. Channels shall not be lighter than 12 ga (2.5 mm).

2.17 PIPE MOUNTING PEDESTALS

A. Equal to Roof Products & System Corporation consisting of equipment rail, "U" shaped mounting brackets, galvanized threaded rod and cast-iron pipe rollers. Rail shall have built-in raised cant to match roof deck insulation.

2.18 EQUIPMENT RAILS

A. Manufacturers: Roof Products & Systems, ThyCurb, Custom Curb, Inc. or Vent Products equal to Roof Products & Systems Model ER-4 with raised cant style for built-up roofing system. Mounting rails shall be galvanized steel with integral base plate, continuous welded corner seams, factory installed 2" (50 mm) x 4" (100 mm) wood nailer and 18 ga (1.2 mm) galvanized steel counter flashing.

B. Manufacturers: Roof Products & Systems, ThyCurb, Custom Curb, Inc. or Vent Products equal to Roof Products & Systems Model ER-2 for elastic sheet roofing system. Mounting rails shall be galvanized steel with integral base plate, continuous welded corner seams, factory installed 2" (50 mm) x 4" (100 mm) wood nailer and 18 ga (1.2 mm) galvanized steel counter flashing.

C. Mounting rail gauge shall be selected to support equipment adequately but shall be not less than 18 ga (1.2 mm).

D. Height shall be as detailed, but not less than 8" (200 mm) above finished roof.

E. Equipment rails shall span minimum of 2 joists and not cantilever more than 6" (150 mm) where joists are used. Rails shall be level at top with pitch built in when deck slopes 1/4" per foot (21 mm per meter) or greater.

2.19 PIPE ROOF PENETRATION PROTECTIONS

A. Manufacturers: Roof Products & Systems, ThyCurb or Vent Products equal to Roof Products & Systems "RPS-Pipe Portals" consisting of 12" (300 mm) OD prefabricated roof curb, laminated acrylic coated ABS plastic curb cover with EPDM protective rubber cap and stainless steel clamp.

2.20 PIPE GUIDES

A. Unless otherwise indicated, guides shall be equal to Pipe Shields "B" Series, selected by load and movement. Refer to Insulated Pipe Supports in Part 2.

2.21 PIPE ANCHORS

A. Unless otherwise indicated, anchors shall be Type C Insulated Pipe Supports. Refer to Insulated Pipe Supports in Part 2.

B. Contractor may propose to utilize contractor-fabricated anchors. Use of contractor-fabricated anchors is subject to approval of appropriate submittal data. Submit anchor system detail drawings, bearing stamp of Structural Engineer registered in project jurisdiction, for approval. Anchors shall be engineered to withstand static and dynamic forces with minimum safety factor of 3.0. Submit insulation details addressing thermal break from building structure and vapor barriers.

2.22 CASEWORK PIPE SUPPORTS

A. Hinged pipe clamp and Strutcatcher, nylon 12 Grilamid, Clic by Litchfield International.

B. Vibration isolation pipe clamp, yellow zinc chromate finish, B-Line BVT Series Vibraclamp or Kwik-Clip by B-Line.

2.23 FIXTURE SUPPLY SUPPORT

A. Acceptable manufacturers: Erico, Holdrite, Siou

B. Vertical Pipe Support:

(1) Galvanized steel stud support bracket, pre-drilled tube support mounting holes, adjustable stud width, Erico TSGB or equal.

(2) UV resistant nylon tube support, rated for 0-130°F (32-54°C) through 0-130°F (32-54°C), resealable locking mechanism, Erico TPC or equal.

(3) Support bracket and tube support to be from same manufacturer.

C. Through Stud Support:

(1) Polypropylene stud insert for isolation of water tubing through metal wall studs, rated for maximum water temperature of 130°F (54°C), Erico ESGP or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend piping hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping and ductwork shall be supported independently from other piping or ductwork.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Do not support equipment, or piping from metal roof decking or ceiling grid.

H. Install adequate supports so as not to over stress either piping or equipment to which piping is connected.

I. Refer to Section 22 00 00 - General Plumbing Requirements for requirements of personnel injury protection guards for supporting devices.

3.02 HANGER AND SUPPORT SPACING

A. Space pipe hangers and supports for horizontal pipe accordance with the following schedule, with exceptions as indicated herein:

B. Copper Tube (Unless Otherwise Noted):

Pipe Size	Max Spacing
3/4" (19 mm) and smaller	5 ft-0" (1.5 m)
1" (25 mm) to 1-1/4" (32 mm)	6 ft-0" (1.8 m)
1-1/2" (40 mm) to 2-1/2" (65 mm)	8 ft-0" (2.4 m)
3" (80 mm) and larger	10 ft-0" (3.0 m)

C. Copper Tube (Domestic Water, Laboratory Water, Non-potable Water):

Pipe Size	Max Spacing
1-1/4" (32 mm) and smaller	6 ft-0" (1.8 m)
1-1/2" (40 mm) and larger	10 ft-0" (3.0 m)

D. Plastic Pipe

(1) PVC Pipe:

Pipe Size	Max Spacing
All sizes	4 ft-0" (1.2 m)

(2) PVDF Pipe (Waste and Vent):

Pipe Size	Max Spacing
2" (50 mm) and smaller	3 ft-0" (0.9 m)
3" (80 mm) and larger	4 ft-0" (1.2 m)

(3) PP Pipe (Waste and Vent):

Pipe Size	Max Spacing
2" (50 mm) and smaller	3 ft-0" (0.9 m)
3" (80 mm)	4 ft-0" (1.2 m)
4" (100 mm)	4 ft-6" (1.4 m)

(4) Support plastic pipe at all changes of direction. Adequate consideration shall be given to piping expansion.

E. Cast Iron Pipe:

(1) Maximum hanger and support spacing shall be 10 ft (3 m) for all pipe sizes. Provide minimum of one hanger per pipe section close to joint on barrel, at each pipe fitting, at change of direction and branch connections.

(2) Support Cast Iron No-Hub pipe as recommended in CISPI Publication "Cast Iron Soil Pipe and Fittings Handbook, Chapter IV - Installation of Cast Iron Soil Pipe and Fittings."

F. Maximum spacing shown above may be restricted by strength of attachment to building structure. Submit data with calculations with published load ratings showing attachment to be utilized and maximum spacing allowable for that type of attachment and pipe size.

G. Spacing less than indicated above may be required to conform to building structure design or loading limitations.

H. Spacing less than indicated may be required depending on compressive strength of pipe insulation and insulated pipe supports.

I. If pipe size changes between support points, maximum spacing shall be based on the smaller pipe size.

J. If trapeze hangers are used to support multiple services, spacing shall be based on the most restrictive pipe size and material on trapeze hanger.

K. For non-metallic pipe, follow manufacturer's installation recommendations in addition to requirements noted herein.

L. Install supports for vertical piping and anchors as recommended by pipe manufacturer.

M. Place hangers and supports to meet requirements of Section 23 21 16 - Pipe and Pipe Fittings or specific pipe system sections, with regard to pitch for drainage and venting and clearance between services.

N. Hangers and supports shall bear on outside of insulation when pipes are to be insulated.

O. Place hangers and supports within 1 ft (0.3 m) of each fitting, such as elbows and tees, and at each valve, strainer, and other piping specialty for piping 4" (100 mm)and larger.

P. Place hanger or support at first elbow upstream of pump inlet and first elbow downstream of pump outlet.

3.03 RISER SUPPORTS

A. Insulated Piping:

(1) Unless otherwise indicated, support vertical piping as indicated below:

(2) Support vertical piping at approximately midpoint of riser, secured and anchored to building structure. Provide guides on vertical piping. Use spring hangers at top and bottom of riser and at take offs from riser at each floor. Use spring hangers for minimum 3 hangers away from top and bottom elbows and from each take off at riser.

(3) Guide vertical piping 2-1/2" (65 mm) and smaller at every floor. Guide 2-1/2" (65 mm) and larger at every other floor. Spring hangers (Type 6) and guides (Type VSG) are specified in Section 23 05 50 - Vibration Isolation.

B. Bare Piping:

(1) Unless otherwise indicated, maximum vertical support spacing for ambient bare steel and cast-iron pipes shall be 15 ft (4.6 m).

(2) Maximum vertical support spacing for other piping including copper tubing and plastic piping shall be 10 ft (3 m).

(3) Install riser clamps and intermediate supports as required.

(4) Rest riser clamps on floor or on pipe sleeve.

(5) Bare piping above 120°F (50°C) such as steam vents shall be supported per insulated piping requirements.

3.04 INSULATED PIPE SUPPORTS APPLICATION

A. Install insulated pipe support at each support point of insulated pipe.

B. Pipe Size 1-1/2" (40 mm) and Smaller:

(1) Use Type A insulated pipe support. Pipe insulation specified in Section 22 07 00 - Plumbing Insulation shall be continuous through support points.

(2) Use one shield (bottom) for clevis hanger.

(3) Use 2 shields (top and bottom) for roller hanger/support or strap/clamp support. Apply 2 metal straps to hold top and bottom shields onto insulation jacket.

(4) Type B or Type C insulated pipe supports may be used in lieu of Type A support.

C. Pipe Size 2" (50 mm) through 5" (125 mm):

(1) Use Type B insulated pipe supports. Refer to Part 2 for acceptable products.

(2) Type C insulated pipe supports may be used in lieu of Type B supports.

D. Pipe Size 6" (150 mm) and Larger:

(1) Use Type C insulated pipe supports. Refer to Part 2 for applicable products.

3.05 PIPE FLOOR SUPPORTS

A. Unless specifically shown otherwise, use adjustable pipe saddle supports with associated stanchion similar to Anvil Fig. 264/63. Select supports properly for weight and height of pipe stand.

3.06 CONCRETE INSERTS

A. Concrete insert application, size, loading, and placement shall be this Contractor’s responsibility.

B. Coordinate placement of inserts before concrete pour. Minimize use of inserts and anchors after concrete pour.

3.07 BEAM CLAMPS

A. Provide locknut for hanging rod at clamp.

B. C-clamps are allowed for rod size 3/8" (9 mm) or smaller and only for static loading such as air piping, cold water piping, fire protection piping and, other similar piping. C-clamps are not allowed for hot water piping and steam and steam condensate piping, except hot water runouts to terminal heating devices.

C. C-clamps are not allowed for open web steel joist application.

D. C-clamps are not allowed for seismic application.

3.08 TRAPEZE SUPPORTS

A. Construct trapeze supports with struts, angles, or channels and hang them by inserts or welded beam attachments and rods.

B. Determine trapeze supports spacing by the smallest pipe on trapeze.

C. If trapeze supports are used to support multiple services, support spacing shall be based on the most restrictive pipe size and material on trapeze supports.

D. Refer to Part 1, Design Criteria for maximum deflection allowed for trapeze supports.

3.09 PIPE MOUNTING PEDESTALS

A. Use for all piping on roof. Install bottom of pedestal flat on roof deck, insulate exterior of pedestal, flash. and counter flash.

3.10 EQUIPMENT RAILS

A. Use for all roof-mounted equipment, which is not curb mounted. Install bottom of equipment rail flat on roof deck. Insulate exterior of equipment rail.

B. Provide equipment rails with sufficient height to provide code required space for servicing roof below supported equipment.

C. Provide supplemental roof/structure framing for required anchoring of rail bases per wind load requirements.

D. Provide supplemental lateral wind bracing between rails when supporting items above roof to meet wind load design requiremetns.

E. Flashing shall be by Division 07. Provide counter flashing as specified and secure to wood nailer with stainless steel truss head screws.

3.11 CONCRETE ANCHORS

A. Anchor application, size, and placement shall be this Contractor's responsibility.

3.12 PIPE ROOF PENETRATION PROTECTIONS

A. Install at points where pipes are penetrating roof. Install as shown and according to manufacturer's installation instructions.

3.13 PIPE GUIDES

A. Install where shown on drawings.

B. For manufactured expansion devices, install minimum of 2 pipe guides at each side of manufactured pipe expansion device. Locate first guide no more than 4 pipe diameters from expansion device and second guide at 14 pipe diameters from first guide. Install intermediate guides in accordance with guide spacing data recommended by manufacturer or the following table, whichever is more stringent.

MAXIMUM DISTANCE BETWEEN INTERMEDIATE GUIDES (ft (m))				
	Pipe Operating Pressure			
Pipe Size (inches (millimeters))	0-50 psig (0-345 kPa)	51-100 psig (350-690 kPa)	101-150 psig (695-1035 kPa)	151-200 psig (1040-1380 kPa)

3 (80)	21 (6.4)	19 (5.8)	17 (5.2)	16 (4.8)
4 (100)	35 (10.6)	29 (8.8)	25 (7.6)	22 (6.7)
6 (150)	57 (17.0)	44 (13.0)	37 (11.0)	32 (9.7)
8 (200)	66 (20.0)	52 (15.0)	45 (13.0)	40 (12.0)
10 (250)	91 (27.0)	69 (21.0)	58 (17.0)	51 (15.0)
12 (300)	107 (32.0)	79 (24.0)	66 (20.0)	58 (17.0)
14 (350)	115 (35.0)	85 (25.0)	71 (21.0)	62 (18.0)
16 (400)	127 (38.0)	94 (28.0)	78 (23.0)	68 (20.0)

C. If anchor is located within 4 pipe diameters from expansion joints, guides need not be installed on anchor side.

3.14 PIPE ANCHORS

A. Install anchors where shown on drawings or in conjunction with expansion joints, loops and swing joints as required to allow proper expansion and contraction of piping without damage to structure, equipment or piping.

B. Do not anchor piping to concrete block walls, wood, or partition walls.

END OF SECTION 22 05 29

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUBMITTALS

A. Product Data: For identification materials and devices.

B. Valve Schedules: For each piping system.

C. Samples: Of color, lettering style, and graphic representation required for each identification material and device.

PART 2 - PRODUCTS

2.01 IDENTIFYING DEVICES

A. Marker System:

(1) Manufacturers: Brady USA, Marking Services Inc. (MSI), Kolbi, or Seton

(2) Manufacturer's standard, preprinted with color coding, lettering size, and length of color field according to ASME A13.1.

(3) Use pressure-sensitive type or “snap-on” type.

(4) “Strap-on” type may be used for piping over 6” (150 mm) size, including insulation.

B. Valve Tags:

(1) Minimum 1-1/2” (40 mm) diameter, 0.032" (0.8 mm) thick, polished brass or 316 stainless steel.

C. Laminated Plastic Nameplates:

(1) Nameplates shall be approximately 1-1/2” x 4”, 1/16” (40 mm x 100 mm, 1.5 mm) thick, and have 1/2" (13 mm) high lettering. Face of plastic nameplates shall be black with white letters.

(2) Fasteners shall be self-tapping, stainless steel screws or contact type with permanent adhesive.

D. Underground Warning Tape:

(1) Manufacturers: Brady USA, Marking Services Inc. (MSI), Kolbi, or Seton

(2) Underground warning tape, 5.0 mil overall thickness, 2” (50 mm) width minimum, aluminum foil core where required to be detectable, bonded polyethylene jacket. Brady “Identoline” or equal.

(3) Following services shall be provided with warning tape with colors and trace wire as indicated:

(a) Natural Gas: Yellow with black letters, detectable

(b) Water Lines: Blue with black letters, (non) detectable

(c) Sanitary Sewer: Green with black letters, (non) detectable

(d) Storm Sewer: Green with black letters, (non) detectable

PART 3 - EXECUTION

3.01 GENERAL

A. After painting and/or covering is completed, identify equipment and piping as indicated. Locate identification as conspicuously as possible except where such would distract from finished area.

B. Where markers are used in high heat applications or exposed to harsh chemical or acid environments, specifically select marker materials for those applications.

C. Coordinate, obtain and confirm mechanical systems identification criteria and requirements from Owner.

3.02 PIPING SYSTEM IDENTIFICATION

A. Install pipe identification on each system.

B. Place flow directional arrows at each pipe identification location.

C. Identify all piping (except medical gas) not less than once every 25 ft (8 m), not less than once in each room, at each branch, adjacent to each access door or panel, at each valve and where exposed piping passes through walls and floors.

D. Identify piping with marker system.

(1) For “strap-on” type, ensure marker is fitted snugly to pipe or pipe insulation surface with sufficient straps.

3.03 VALVE IDENTIFICATION

A. Identify valves with brass tags bearing system identification and valve sequence number in 1/2” (13 mm) black characters. Attach tag to valve body with brass jack chain and “S” hook for brass tag and SS jack chain or SS braided wires with swag sleeves and “S” hook for stainless steel tag. Non-metallic fasteners are not allowed.

B. Valve numbers shall be prefixed with corresponding piping system identification in 1/4” (6 mm) black letters.

C. Furnish typewritten valve schedule indicating valve number, fixtures, equipment, or areas served by each numbered valve and incorporate in O&M Manuals.

3.04 EQUIPMENT IDENTIFICATION

A. Identify major equipment, including heat exchangers, pumps, water heaters, tanks, compressors, etc.

B. Identify equipment with laminated plastic nameplates.

C. Identify control equipment and panels with laminated plastic nameplates.

D. Nameplate Markings:

(1) Identify model number, size, capacity, electrical characteristics, serial number, along with other items scheduled for equipment on drawings.

(2) Indicate motor horsepower, voltage, phase, cycles, RPM, full load amps, locked motor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency, minimum circuit amps, minimum feeder conductor size, disconnect or fuse size, refrigerant, and other pertinent information.

E. Locate motor nameplates for easy reading. Relocate or provide new nameplates on motors if original nameplates are not located for easy reading.

3.05 ACCESS PANEL IDENTIFICATION

A. Identify each service opening or access opening with minimum 1/2" (13 mm) high letters indicating type of damper.

B. Furnish typewritten charts with identification and location of all access panels serving equipment and valves and incorporate in O&M Manuals.

3.06 SPRINKLER ZONE CONTROL VALVE IDENTIFICATION

A. Identify sprinkler zone control valves with laminated plastic nameplates. Nameplate shall include name of sprinkler zone served and description of area served.

B. Identify inspector's test valve with laminated plastic nameplate if valve is located remote from sprinkler control valve. Nameplate shall include name of sprinkler zone served.

3.07 UNDERGROUND WARNING TAPE

A. Install detectable warning tape 4" to 6" (100 mm to 150 mm) below grade to allow for accurate above surface detection.

B. Install non-detectable warning tape 6" to 12" (150 mm to 300 mm) below grade.

C. Repair and replace existing underground warning tape where disturbed by excavation.

END OF SECTION 22 05 53

SECTION 22 05 94 - DOMESTIC WATER SYSTEMS BALANCE

PART 1 GENERAL

1.01 RELATED WORK

A. Section 22 11 18 – Water Distribution System

B. Section 22 21 14 – Plumbing Specialties

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

A. Test and Balance (TAB) Contractor shall be responsible for providing complete testing and balancing work of liquid fluid handling systems, such as domestic hot water return, laboratory hot water return, water mixing valves, and other processes included in this Project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports as specified herein.

C. Scope of work includes new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. Scope of work also includes existing liquid fluid handling systems as defined by drawings and/or schedules.

E. Work is limited to new areas within construction boundaries and does not include central pumping equipment or other areas. Adjust and balance flows to values indicated or scheduled. If flow is abnormal, attempt to proportional balance flows to the same percentage below design and contact Engineer for additional instruction.

F. Procedures shall be in accordance with the latest edition of AABC or NEBB and as per detailed herein.

G. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Contractors who are members of AABC or NEBB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval.

H. Contractors who are members of AABC or NEBB and who have qualified personnel available to perform Work may submit Quality Assurance Submittal for approval. Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor who will submit it for approval.

I. Owner will separately contract with an independent TAB Contractor to perform all testing, adjusting and balancing of HVAC hydronic systems required for this Project. Work related to testing, adjusting, and balancing that must be performed by Mechanical Contractor is specified in other sections of these Specifications.

J. Upon direction of Architect/Engineer or TAB subcontractor, Contractor shall provide (at no additional cost to Owner) any additional work and/or devices necessary to properly balance the system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer wells. Contractor shall be responsible for trimming and balancing pump impellers as necessary to obtain design pump flow rates at minimum pressure differential.

K. TAB work shall not proceed until all assigned personnel have been approved by, Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be complete before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Engineer.

1.04 SUBMITTALS

A. General:

(1) Make submittals in accordance with Section 01 33 00 – Submittals. Submit minimum of 5 copies of all submittals unless otherwise directed.

(2) Reports shall be assembled using a 3-ring hard cover binder with Project Name and location on the cover and the side panel. Information sheets shall be 8-1/2” x 11” white bond paper. Use pre-printed forms of NEBB or AABC wherever possible. Assemble report in the following order.

(a) Transmittal letter

(b) Cover sheet with Project title, location, submittal date, and names and addresses of Owner, Contractor, TAB subcontractor, Architect, and Engineer

(c) Index of numbered tabs listing major systems

(d) Data organized by system in the following order:

1) Equipment data and measurement summary

2) Equipment measurement data

3) Branch main measurement data
4) Terminal device measurement data

(e) Provide numbered tabs for each system.

B. Quality Assurance Submittal:

(1) Within 30 days of signing Contract, Contractor shall submit the following information:

(a) Firm resume

1) AABC or NEBB active membership required
2) Names of 3 recent relevant completed projects along with the project address, Owner's contact person, supervising design professional.

(b) Supervisor resume

(c) Balance technician(s) resume

(2) Architect/Engineer and Owner reserve the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this Project due to lack of relevant experience or problems on previous projects.

C. Planning Report:

(1) Submit Planning Report as detailed in Part 3-EXECUTION of this Section to demonstrate to Engineer and Owner that proper procedures are being followed. Planning Report shall be submitted after Quality Assurance submittal and 30 days before fieldwork starts.

D. Initial Test Report:

(1) Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to A/E and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:

(1) Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.05 REFERENCE STANDARDS

A. Refer to the latest publications of the NEBB, the American Society of Plumbing Engineers (ASPE) and the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) for establishing required procedures.

PART 2 PRODUCTS

2.01 INSTRUMENTATION

A. Provide required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by Architect/Engineer upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB or AABC Standards.

PART 3 EXECUTION

3.01 GENERAL

A. TAB work shall be done in separate phases as outlined herein. Project schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

B. Set point for individual branch balancing valves in domestic hot water return system shall be 0.5 gpm unless otherwise noted on drawings or schedules.

C. Set point for the domestic hot water return circulating pump shall be the flow rate defined in the schedules on the plumbing drawings.

3.02 PLANNING PHASE

A. Procedure:

(1) Obtain latest contract documents including addenda and change orders. Obtain shop drawings and performance curves from Contractor for pumps, flow measuring devices, and terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:

(1) Planning Report shall contain the following minimum requirements.

(a) Narratives:

1) Provide written narratives of procedures used. Provide separate narratives for each pump and liquid fluid handling system.

2) Identify flow-measuring devices to be used at each pump and terminal device. Provide different narratives for constant and variable flow systems.

3) For non-standard water systems, include narratives on how to measure and adjust for different viscosities.

4) Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances. For this Project, minimum acceptable is ± 10% of design flow.

(b) Prebalance Checklist: include, but not limited to:

1) Check for completeness or work
2) System cleaning
3) System fill and air venting
4) Place system into operation
5) Check expansion tanks and fill pressures
6) Pump bearings, alignment, starters, vibration isolators, rotation
7) Setting valves to proper position including shutoff and bypass valves
8) Set up of controls and control devices

(c) Measuring Instrument List: list measuring instruments to be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:

1) Manufacturer name and model number
2) Measurement range
3) Pressure/temperature limits
4) Date put into service
5) Date of last calibration
6) Include certificate from calibration firm

(2) Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within the past year.

(3) Samples: Submit copies of TAB forms to be used.

(4) Branch circuit and terminal measurements: indicate on pre-printed forms of AABC or NEBB measurements to be taken in the field. Include branch circuit or terminal identification, system, space served, location, design flows (include zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate initial setpoint on forms.

3.03 SET-UP PHASE

A. Procedure:

(1) Perform prebalance checkout as per Planning Phase narrative.

B. Initial Test:

(1) Measure pump data and flows in "as found" condition after initial valve settings are made.

C. Initial Test Report:

(1) Submit report to Architect/Engineer and Contractor indicating measurements made and make notes of items, which are not complete or are not within design tolerance.

3.04 FINAL BALANCE PHASE

A. Procedure:

(1) Perform procedures as per Planning Phase narrative. Correct deficiencies and redo procedures as required before submitting Final Report.

B. Final Report:

(1) Submit report to Engineer and to Contractor indicating data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

C. Final Report Adjustments:

(1) Architect/Engineer reserves the right to check any measurement made and to reject any portion of work not within the design tolerance of ± 10% of design flow. Contractor shall resubmit all or portions of Final Report as directed by Engineer.

END OF SECTION 22 05 94

SECTION 22 07 00 - PLUMBING INSULATION

CPART 1 - GENERAL

1.01 RELATED WORK

A. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment

1.02 DESCRIPTION

A. Provide insulating materials and accessories as required for mechanical systems as specified below.

B. Insulating products delivered to construction site shall be labeled with manufacturer's name and description of materials.

1.03 DEFINITIONS

A. Concealed areas, where indicated in this Section, shall apply to shafts, furred spaces and space above finished ceilings, inaccessible tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

B. Unless otherwise indicated, unit of thermal conductivity is Btu in/(h ft² °F) (W/(m K)).

C. Interstitial spaces are considered as concealed areas.

1.04 SUBMITTALS

A. Product Data for each piping system for all pipe sizes and all equipment, including but not limited to, the following:

(1) Manufacturer's name

(2) Schedule of insulating materials

(3) Insulation material and thickness

(4) Jacket

(5) Adhesives

(6) Fastening methods

(7) Fitting materials

(8) Intended use of each material

(9) Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings

(10) Insulation installation details (manufacturer's installation instruction/details, Contractor's installation details, MICA plates where applicable)

(11) Literature data sheet from sealants and adhesive manufacturers stating VOC compliance with USGBC LEED IEQ 4.1.

(12) Literature data sheet from coatings and mastics (including lagging adhesives) manufacturers stating VOC compliance with USGBC LEED IEQ 4.2.

(13) All other appropriate data

1.05 DELIVERY, STORAGE AND HANDLING

A. Insulation material shall be delivered to project site in original, unbroken factory packaging labeled with product designation and thickness. Shipment of materials from manufacturer to installation location shall be in weather-tight transportation. Protect insulation materials from moisture and weather during storage and installation. Protect insulation material against long exposure to UV light from sun.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Insulation:

(1) Owens Corning, Johns Manville, Manson, Knauf or CertainTeed similar to product indicated except where product of manufacturers not listed above is specifically identified for special type of insulation.

B. Coatings, Mastics, Sealants and Adhesives:

(1) Foster, Childers, Design Polymerics, Vimasco, Miracle or Pittsburgh Corning

2.02 MATERIALS

A. Products used for or related to air conditioning and ventilating systems shall conform to NFPA 90A possessing flame spread index of not over 25 and smoke developed index no higher than 50.

B. Unless otherwise indicated, all products, material itself or on composite basis, shall have flame spread index not more than 25 and smoke developed index not more than 50, when tested in accordance with ASTM E84 or UL 723.

C. Pipe insulation installed outdoors may have smoke developed index not exceeding 450.

D. Insulation shall not contain formaldehyde.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in manufacturing process.

F. Insulation applied on stainless steel shall meet requirements of ASTM C795 and NRC 1.36.

2.03 INSULATION

A. Insulation materials shall be fire retardant, moisture, and mildew resistant, vermin proof, and suitable to receive jackets, adhesives and coatings as indicated.

B. Glass fiber insulation shall be of inert inorganic material, non-corrosive to mechanical surfaces.

C. Insulating cement shall be Quick-Cote by PK Insulation MFG Co. or Ryder GP, with dry density of no more than 38 lb/ft³ (603 kg/m³) thermal conductivity of 0.96 at 400°F (0.138 at 204°C) mean temperature, and service temperature to 1200°F (650°C).

D. Filling and finishing cement shall be Super-Stik by PK Insulation MFG Co., or Ryder MW, with dry density of no more than 24 lb/ft³ (384 kg/m³), thermal conductivity of 0.74 at 500°F (0.107 at 260°C) mean temperature, and service temperature to 1900°F (1040°C).

E. Type A Insulation (Flexible Elastomeric):

(1) Flexible, closed-cell, elastomeric cellular insulation.

(a) ASTM Standard: ASTM C534/C534M, Type I (tube form) or Type II (sheet form), Grade I

(b) Thermal Conductivity: Maximum 0.28 at 75°F (0.04 at 24°C) mean temperature

(c) Water Vapor Permeability: Maximum 0.08 perm-" (0.12 ng/s m Pa)

(d) Water Absorption: Maximum 0.2 % by volume

(e) Service Temperature: -297 to 220°F (-183°C to 104°C)

(2) Manufacturers/Products:

(a) Armacell, AP Armaflex FS

(b) Aeroflex, Aerocel

(c) K-Flex, Insul-Tube

F. Type R Insulation (Rigid Mineral Fiber Pipe Insulation):

(1) Mineral fiber (fiberglass) preformed pipe insulation faced with specified jacket.

(a) ASTM Standard: ASTM C547, Type I

(b) Density: Minimum nominal 3 lb/ft³ (48 kg/m³)

1) Thermal Conductivity: Maximum 0.23 at 75°F (0.034 at 24°C) and 0.29 at 200°F (0.040 at 93°C)

2) 0.29 at 200°F (0.040 at 93°C) mean temperature

(c) Service Temperature: To 850°F (454°C)

(2) Manufacturers/Products:

(a) Johns Manville, Micro-Lok HP

(b) Owens Corning, ASJ Max Fiberglas Pipe Insulation

(c) Knauf, Earthwool 1000° Pipe Insulation

2.04 JACKETS

A. Jacket puncture resistances shall be based on ASTM D781 test methods. Vapor barrier permeance ratings shall be based on ASTM E96/E96M Procedure A.

B. Type A-1 Jacket (Aluminum Roll Jacketing):

(1) Factory fabricated 0.016" (0.41 mm) thick, ASTM B209/B209M, Type 3003 or 3105, stucco embossed aluminum jacket with integrally bonded moisture barrier/retarder consisting of 3 layers of polymer films with total thickness of 3 mil (0.075 mm).

(2) Fitting covers shall be factory fabricated from not lighter than 0.016" (0.41 mm) 0.024" (0.61 mm)thick, Type 3003 or 1100 aluminum. For large pipes, where factory fabricated fitting covers are not available, Contractor shall fabricate fitting covers from like sheet materials.

(3) Manufacturers/Products:

(a) Johns Manville, Aluminum Jacketing

(b) RPR Products, Insul-Mate

C. Type P-1 Jackets:

(1) Heavy-duty, fire retardant material with glass fiber reinforcing and self-sealing lap. Jacket shall have neat, white Kraft finish suitable for painting, with burst strength of 1.5 Joules (50 beach units) minimum and tensile strength 45 lbs/in (7.9 N/mm) minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm (1.15 ng/s m² Pa).

(2) Manufacturer/Products:

(a) Owens Corning: ASJ-SSL

(b) Johns Manville, ASJ

(c) Knauf, ASJ+

2.05 ADHESIVES, MASTIC, COATINGS, SEALANTS, AND REINFORCING MATERIALS

A. Adhesives and sealants shall comply with the South Coast Air Quality Management District SCAQMD 1168; VOC limits shall comply with Indoor Environmental Quality Section, Credit IEQ-4.1.

B. Coatings and mastics shall comply with VOC limits set forth by Green Seal BS-11 and comply with the South Coast Air Quality Management District SCAQMD 1113; VOC limits shall comply with Indoor Environmental Quality Section, Credit IEQ-4.2.

C. Products shall be compatible with surfaces and materials on which they are applied and shall be suitable for use at operating temperatures of systems to which they are applied.

D. Products shall be fire retardant, moisture resistant and mildew resistant and vermin proof.

E. Vapor Barrier Mastic: Below ambient insulation. Water vapor permeance shall be less than 0.08 perms at 45 mils dry film thickness per ASTM F1249.

(1) Foster 30-33

(2) Childers CP-33

(3) Vimasco 749

F. Weather Barrier Breather Mastic: Above ambient insulation. Permeance shall be greater than 1.0 perms at 1/16" (1.59 mm) dry film thickness per ASTM E96/E96M.

(1) Foster 46-50 Weatherite

(2) Childers CP-10/CP-11 Vi Cryl

(3) Vimasco WC-5

G. Lagging Adhesive/Coatings: Indoors applications used in conjunction with canvas/glass cloth.

(1) Foster 30-36

(2) Childers CP-50 AMV1

(3) Vimasco 713

H. Metal jacketing sealant for aluminum jacketing:

(1) Foster 95-44 Elastolar

(2) Childers CP-76 Chil Byl

(3) Pittsburgh Corning 727

I. Insulation joint sealant for Type P, Type PP, and Type G insulation:

(1) Foster 95-50 Flextra

(2) Childers CP-76 Chil Byl

(3) Pittsburgh Corning CW Sealant

J. Glass fiber fabric reinforcing shall be 10 x 10 mesh similar to Childers Chil Glas #10 or Foster Mast A Fab.

K. Wire mesh reinforcing shall be 22 ga (0.7 mm), 1" (25 mm) galvanized.

L. Insulation cement shall be ANSI/ASTM C195, hydraulic setting mineral wool.

M. Finishing cement shall be ASTM C449.

N. Butt joint and longitudinal joint adhesive for Type A insulation shall be Armstrong 520, Rubatex 373, Childers CP-82 or Foster 85-75.

O. Weather-resistant protective finish for Type A insulation shall be equal to Armstrong WB Armaflex finish or Foster 30-64 elastomeric coating.

2.06 METAL BANDS AND WIRES

A. Aluminum bands shall be 0.5 x 0.20" (13 mm x 0.51 mm) up to 48" (1220 mm) diameter and 0.75 x 0.020" (19 mm x 0.51 mm) over 48" (1220 mm) diameter.

B. Stainless steel bands shall be 0.5 x 0.015" or 0.75 x 0.015" (13 mm x 0.38 mm or 19 mm x 0.38 mm).

C. Stainless steel wires shall be 16 ga (1.50 mm).

2.07 REMOVABLE INSULATING BLANKETS

A. Custom designed removable, reusable, flexible, blanket thermal insulation system.

B. Acceptable Manufacturers: Thermal Energy Products, Inc., Advanced Thermal Corp., Temptec and Remco Technology, Inc.

C. Removable insulation system shall be custom designed for each individual item to provide close contour fit. Overlapping seams and gaps are not acceptable.

D. Removable insulation shall be designed to overlap adjoining pipe insulation by.

E. Insulation: Minimum 2" (50 mm) thick, 2.4 lb/ft³ (38.4 kg/m³) density, 1000°F (540°C) continuous service temperature thermal insulating wool; Owens Corning Fiberglass or equal.

F. Interior and Exterior Fabric: Minimum weight 0.59 kg/m² (17.5 oz/sq yd) silicone rubber coated fiberglass cloth.

G. Securement: Blanket seams shall be closed with buckle and strap assembly (D ring closure).

H. Identification/Tagging: Label each removable insulation device with plastic or 304 stainless steel tag with raised letters. Tag as directed by Owner.

2.08 ACOUSTICAL BARRIER MATERIALS

A. Acoustical barrier material shall be combination of absorber and barrier, similar to Sound Seal Model B-10 LAG/QFA-3. Absorber/Barrier material shall have acoustic ratings of STC-29,1.0 lb/ft³ (4.88 kg/m³)nominal density, 1" (25 mm) thick, flame spread index of less than 25, smoke developed index less than 50, and minimum continuous operating range from --20 to 350°F (-29 to 176°C).

B. Minimum sound transmission loss at each octave band shall be as follows:

Sound Transmission Loss (dB)					
Octave Band Center Frequency (Hz)					
125	250	500	1000	2000	4000
18	18	23	30	39	46

PART 3 - EXECUTION

3.01 APPLICATION

A. Provide insulation and jackets with minimum insulation thickness as indicated in the following schedule. The schedule applies to both exposed and concealed applications unless noted otherwise:

Piping System							
		Minimum Insulation Thickness According to Pipe Size					
Service	Jacket Type	Insulation Type	3/4" (19 mm) and Smaller	1" - 1-1/4" (25 mm to 32 mm)	1-1/2" - 3" (40 mm to 80 mm)	4" - 6" (100 mm to 150 mm)	8" (200 mm) and Larger
Domestic Cold Water	P-1	R	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)
	---	A	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)
(Type A Insulation is an option)							
Domestic Hot Water and Hot Water Return 105-140°F (40-60°C)	P-1	R	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)
	---	A	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)	NA
(Type A Insulation is an option)							
Stormand overflow piping including roof drain body	P-1	R	NA	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)
	---	A	NA	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)	NA
(Type A insulation is an option.)							
Sanitary waste piping downstream of cooling coil condensate connection	P-1	NA	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)
	P-1	A	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)	NA
(Type A insulation is an option.)							

Equipment & Systems			
Service	Jacket Type	Insulation Type	Insulation Thickness
Heat Exchangers (Shell and Tube Type)	P-1	R	2-1/2" (65 mm)
Heat Exchangers (Plate and Frame Type)	---	A	1" (25 mm)
Water Softener Mineral Tanks		A	1" (25 mm)

3.02 INSTALLATION - GENERAL

A. All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards published by MICA (Midwest Insulation Contractors Association) and manufacturer's installation instructions, except as modified in this Section of specifications.

B. Install products with good workmanship, with smooth and even surfaces. Use full-length factory-furnished material where possible. Do not use scrap pieces.

C. Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed. Do not insulate any section of system that must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects prior to end of guarantee period shall be accomplished at no expense to Owner.

D. Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required, and to allow for expansion.

E. Where possible longitudinal joints in jackets shall face toward wall or ceiling.

F. Apply insulation to each pipe individually. Common insulation applied to adjacent pipes will not be accepted.

G. Unless otherwise indicated, pipe insulation shall be continuous through walls and floors.

H. Where multiple layers of insulation are used, stagger and secure each layer with metal bands.

I. Where penetrations occur through fire-rated walls, partitions, or floors, provide fire seal as specified in Section 22 00 00 - General Plumbing Requirements and Section 07 84 00 - Firestopping.

J. Insulate water piping within casework up to penetration of casework pipe chase at fixture stop. Insulate water piping within walls up to pipe penetration through the wall at fixture stop when serving wall-mounted fixtures. Termination of insulation shall be in neat and workman like manner with insulation jacket cap.

K. Insulate the following systems for complete vapor barrier protection:

   (1) Storm
   (2) Cold Water
   (3) All equipment with surface temperature below 60°F (16°C)

L. Apply Type A insulation for insulation and jackets requiring vapor barrier protection where specified insulations are cut for mounting sensors, control devices, parts of valves, devices or components which extend out from specified insulation to prevent condensation.

3.03 PIPING, VALVE AND FITTING INSULATION

A. Apply insulation to pipe, unions, flanges, fittings, valves and piping specialties with butt joints and longitudinal seams closed tightly. Valve insulation shall cover entire valve body including bonnets and packing nuts.

B. Laps on factory-applied jackets shall be 2" (50 mm) minimum width firmly cemented with lap adhesive or shall be pressure sealing type lap.

C. Cover joints with factory furnished tape 3" (80 mm) minimum width) to match jacket. Cement firmly with lap adhesive. On systems requiring a vapor barrier (ASJ), vaporseal all longitudinal and butt joints ASJ/Saran seams with 4" (100 mm) wide coat of vapor barrier mastic or 3" (80 mm) minimum tape.

D. Where staples are used, they shall be on 6" (150 mm) maximum centers. When used for systems requiring vapor barrier, cover lap and staples with finish coat of vapor barrier mastic or 3" (80 mm) minimum tape.

E. For finishing of insulated pipe fittings and valves where surface temperature of insulation is not higher than 125°F (51°C), use one piece PVC fitting covers, minimum thickness of 20 mil (0.05 mm), Fitting cover shall be Johns Manville Zeston 2000 PVC, PROTO Fitting Covers, or similar by other manufacturers listed. Where fitting and valve insulation requires vapor barrier, seal joints of PVC covers with vapor barrier adhesives. Insulation type, R-value and density of insulation used at fittings shall match insulation of adjacent piping. Install insulation at pipe fittings and valves completely prior to applying PVC covers.

   (1) For Type R (Rigid glass fiber) pipe insulation, PVC fitting covers with flexible mineral fiber blanket insulation inserts are acceptable, except those located in mechanical rooms within 6' (1.8m) above floor. For fitting covers located in mechanical room within 6' (1.8m) above floor, insulation inserts shall be pre-molded rigid fiber glass type wrapped around elbows.

F. Stove pipe style insulation on elbows (Detail A on Plate 2-200 of MICA 8th Edition) is not allowed. It may be used for closed cell elastomeric insulation.

G. Where terminations of pipe insulation are required, insulation shall have tapered ends, built up and finished as specified for fittings.

H. For pipes 1" (25 mm) and smaller, install specified pipe insulation and jacket continuous through hanger or support locations. Install insulation protection shields to protect insulation from compressing.

I. For pipes 1-1/2" (40 mm) and larger, where manufactured pre-insulated pipe supports are used at hanger or support locations, extend insulation to insulated pipe supports. Where vapor barrier is required, this Contractor shall be responsible for continuity of vapor barrier at insulated pipe supports. 3" (80 mm) wide vapor barrier tape on hot and cold systems at pipe supports.

J. For pre-insulated pipe supports and insulation protection shields, refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

K. For Contractor-fabricated anchors, secure insulation directly to pipe surface and extend insulation up anchor for distance of 4 times insulation thickness. For pre-insulated anchors, cover entire surface of anchors with Type A insulation. Where applicable, take special care to assure vapor seal at anchor.

L. Where mechanical grooved pipe connections are used in piping system, insulate couplings as specified for pipe.

M. Piping, fittings, and valves not to be insulated:

(1) Valves furnished with removable insulation/jacket

3.04 EQUIPMENT INSULATION

A. Where multiple layers of insulation are required, stagger and secure each layer with stainless steel bands.

B. Install removable insulation where access is required for cleaning, repair, and inspection. Construct removable insulation with Type A insulation for cold equipment and Type R insulation with V-1 jacket for hot equipment. Do not apply bonding adhesive to equipment surface.

C. Provide removable insulating blankets on expansion joints.

D. Do not insulate over equipment nameplates or ASME stamps. Bevel and seal insulation at these locations.

E. Equipment not to be insulated:

(1) Equipment furnished with factory insulation.

3.05 EQUIPMENT AND COMPONENTS

A. Acoustical Barrier Materials:

(1) Provide 2" (50 mm) thick Type R insulation with Type D-1 jacket as inner layer. Over insulation install acoustical barrier materials as outer layer in accordance with manufacturer’s installation instruction.

(2) Refer to plans for equipment requiring acoustical barrier materials.

3.06 PROTECTIVE INSULATION SHIELD (A-1 JACKET) FOR PIPE JACKETS EXTERIOR TO BUILDING

A. Unless otherwise indicated, install shields (A-1 jacket) around insulated pipe and fittings exterior to building. Seal water and vapor tight at terminations.

B. Longitudinal overlap shall be at least 2" (50 mm) wide with vapor barrier sealant.

C. Secure jacketing with 3/4" (19 mm) wide .015" (.38 mm) stainless steel or 3/4" (19 mm) wide .020" (.51 mm) aluminum bands and wing seals on maximum 18" (450 mm) centers.

END OF SECTION 22 07 00

SECTION 22 08 00 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Commissioning of Plumbing is the process of ensuring that the Plumbing System is installed and performs interactively according to the basis of design criteria and meets the building's operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up, and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Plumbing System from installation to complete dynamic operation and optimization.

B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Agent (CxA). Primary elements of Commissioning during the construction, acceptance, and warranty phases of the project include:

(1) Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.

(2) Demonstrate functional operational performance of equipment and systems in the commissioning program.

(3) Verify O&M documentation submitted is complete. Provide required documentation and information to the ____ to allow compilation of Building Systems Manuals in accordance with Section 01 78 23 - Building System Manuals (O&M).

(4) Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.

(5) Verify systems are interacting and performing optimally in accordance with the system sequence of operations.

(6) Furnish labor and material to accomplish plumbing system commissioning and systems' testing as specified herein and other related sections.

1.02 RELATED SECTIONS

A. Section 01 79 13 - Demonstration and Training

B. Section 01 78 23 - Building System Manuals (O&M)

C. Section 01 91 13 - General Commissioning Requirements.

D. Section 01 91 14 - Functional Testing Requirements.

1.03 SUBMITTALS

A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the Commissioning Agent, in addition to the copies required by the Owner and Design Professional.

1.04 COORDINATION

A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

B. All maintenance points for components installed by the contractor for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 - General Commissioning Requirements for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed, or certificates be readily available.

C. Datalogging equipment or software required to test equipment will be provided by the CxA but shall not become the property of the Owner.

PART 3 - EXECUTION

3.01 COMMISSIONING

A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13 - General Commissioning Requirements.

B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting Contractor Pre-Testing. Both of these documents are required prior to the CxA scheduling the Functional Performance Testing. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.

C. Construction Checklists for each type of equipment and system shall be provided to the installation contractors by the CxA for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.

D. For equipment and system components requiring a manufacturer's representative for Construction Checklists and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the CxA.

E. Functional Testing Procedures for each type of equipment and system shall be provided to the installation contractors by the CxA for use by the contractor in documenting the performance of the Contractor Pre-Testing. Refer to Section 01 91 14 - Functional Testing Requirements for further information.

F. Completed Start-up checklists and Contractor Pre-Testing for all pieces of equipment shall be submitted by contractors to the CxA through the General Contractor prior to the scheduling of the final Functional Performance Testing that is witnessed by the CxA.

3.02 TRAINING

A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of 01 79 13 - Demonstration and Training and 01 79 13A - Demonstration and Training Sample Agenda.

3.03 OPERATIONS AND MAINTENANCE DATA

A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

3.04 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing

(1) Refer to Sections 01 91 13 - General Commissioning Requirements and 01 91 14 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment systems.

END OF SECTION 22 08 00

SECTION 22 11 18 - WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section covers interior domestic cold water, domestic hot water (125°F), domestic hot water return, tempered water, and nonpotable cold water to a point 5 ft outside building wall.

B. All components shall comply with NSF-61 and NSF-372 to be compliant with requirement for lead content of ≤0.25% maximum weighted average.

1.02 RELATED WORK

A. Section 01 81 13 - Certification Requirements

B. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment

C. Section 23 05 14 - Variable Frequency Drive (VFD) Systems

D. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment

E. Section 22 05 53 - Identification for Plumbing Piping and Equipment

F. Section 22 07 00 - Plumbing Insulation

G. Section 22 05 94 - Domestic Water Systems Balance

H. Section 22 21 14 - Plumbing Specialties

I. Section 26 29 13 - Enclosed Controllers

1.03 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.04 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: for adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for adhesive and sealant applications, as per the SCAQMD Rule 1168, October 6, 2017, adhesive and sealant applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.05 LEED SUBMITTAL DOCUMENTATION

A. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant.

1.06 QUALITY ASSURANCE

A. Order pipe with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

E. Before shipping, piping shall be cleaned, free of rust and scale, and chemically treated to protect inside of pipe from rusting and furnished with end caps.

1.08 SUBMITTALS

A. Manufacturer's technical data for the following:

(1) Pipe
(2) Fittings
(3) Joints
(4) Valves
(5) Unions and Flanges
(6) Dielectric fittings
(7) Water hammer arrestors
(8) Expansion joints
(9) In-line Centrifugal Pumps
(10) Pressure Booster Pump

B. Shop Drawings on items specified herein.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials as specified shall be new unless otherwise noted.

B. Materials shall be provided from list of approved manufacturers. Home Market, Generic Broker, or Wholesaler's house brands are not acceptable.

2.02 PIPE, FITTINGS, AND JOINTS

A. Above Ground:

(1) Copper (2-1/2" and Smaller):
(a) Pipe: Copper tube, Type L, hard drawn, ASTM B88
(b) Fittings:
1) Cast copper alloy, solder joint, pressure rated, ANSI B16.18
2) Wrought copper, solder joint, pressure rated, ANSI B16.22
3) Copper, press fit joint, EPDM O-ring, ANSI B16.51, 0° - 250°F, maximum 200 psig (1378.95 kPa). Propress by Viega, ApolloPress by Apollo Flow Controls or Pressystem by Nibco.
(c) Joints:
1) Lead free (<0.2%) solder, ASTM B32, flux, ASTM B813
2) Press fit joint, EPDM O-ring, made with electro-hydraulic crimping tool and jaw correct for pipe size.
(d) Nipples: Red brass pipe, threaded

(2) Copper (3" thru 8"):
(a) Pipe: Copper tube, Type L, hard drawn, ASTM B88
(b) Fittings:
1) Cast copper alloy, solder joint, pressure rated, ANSI B16.18
2) Wrought copper, solder joint, pressure rated, ANSI B16.22
(c) Joints: Brazed, BCuP-3 or BCuP-5 type, AWS A5.8, 1250°F minimum melting point

(3) Stainless Steel 3" and Larger):
(a) Pipe: Stainless steel, Type 304L, Schedule 10, seamless, ASTM A312.
(b) Fittings:

1) Wrought stainless steel, Type 304L, Schedule 10, socket or butt weld pattern, ASTM A312, ASME B16.9

(c) Joints:

1) Welded

2.03 UNIONS AND FLANGES

A. General:

(1) Unions, flanges and gasket materials to have pressure rating of not less than 150 psig (1034.21 kPa) at 180°F.

B. Copper (3" and Smaller):

(1) Wrought copper union, Nibco Figure 633-W. Mueller Brass equal.

C. Copper (4" and Larger):

(1) Cast red brass flanges, alloy 844, ASTM B584, Class 150, Standard bolt pattern, ANSI B16.24 with neoprene gasket

D. Stainless Steel 3" and Larger):

(1) ASTM A182, Type 304L stainless steel raised face flange, welding neck, Class 150, ASME B16.5 with EPDM gasket.

2.04 VALVES

A. Shutoff Valves:

(1) Ball Valves (3" and smaller):

(a) Acceptable manufacturers: Apollo, Hammond, Milwaukee, Nibco, Stockham and Watts with indicated features and equal to model listed. Note that not all manufacturers make all sizes. Basis of design valves have threaded or soldered ends. Equivalent valves with press ends are acceptable when press fit joints and fittings are allowed.

(b) Full Port, 2 Piece: Bronze body, ASTM B584, stainless steel ball and stem, teflon seats, stem extension with length according to installed system insulation thickness, 600 psi (4136.86 kPa) CWP pressure rating, Nibco 585-66-LF.

(c) Insulated Handle: For insulated systems to prevent condensation on valve body with thermal and vapor seal, equal to Nibco Nib Seal

(2) Butterfly Valves (4"and larger):

(a) Acceptable Manufacturers: Apollo, Hammond, Kitz, Milwaukee, Nibco, and Stockham with indicated features and equal to model listed. Note that not all manufacturers make all sizes or styles.

(b) Threaded or Solder Ends: Bronze body, stainless steel disc and stem, viton disk seal, Milwaukee Series BB2

(c) Lug Type: Ductile iron body, 316 stainless steel disc mounted without pins or bolts, EPDM liner, stainless steel stem, copper or glass reinforced epoxy resin bushings (lower, upper and collar), 200 psi (1378.95 kPa) CWP pressure rating, 10 position lever handle through 6", gear operator 8" and larger, Apollo LD141 or Nibco LD-2012.

(d) Wafer Type: Ductile iron body, 316 stainless steel disc mounted without pins or bolts, EPDM liner, stainless steel stem, copper or glass reinforced epoxy resin bushings (lower, upper and collar), 200 psi (1378.95 kPa) CWP pressure rating, 10 position lever handle through 6", gear operator 8" and larger, Apollo WD141 or Nibco WD-3222.

B. Swing Check Valves:

(1) Size 2" and Smaller:

(a) Bronze body, ASTM B62, Y pattern, PTFE resilient disc, horizontal swing, 200 psi (1378.95 kPa) CWP rating, Nibco 413-Y-LF

(2) Valves 2-1/2" and Larger:

(a) Nickle iron body, horizontal swing, stainless steel or nickel iron disc, stainless steel replaceable seat, 200 psi (1378.95 kPa) CWP rating, Nibco F-918-13

C. Spring Check Valves:

(1) Valves 2" and Smaller:

(a) Bronze body, ASTM B584, in-line lift type with spring, Buna-N or PTFE disc, 250 psi (1723.69 kPa) CWP rating, Nibco 480-Y-LF

(2) Valves 2-1/2" and Larger:

(a) Cast iron body, wafer type, Buna-N seat, aluminum bronze disc, in-line type with stainless steel spring, 250 psi (1723.69 kPa) CWP rating, Nibco W-960-W-LF

(3) Size 1/2" thru 2":

(a) Stainless steel body, in-line pattern, stainless steel seats, spring and valve disc. DFT, Inc. Basic Check, Model BSS, rated for 300 psi (2068.43 kPa) WSP.

(b) Manufacturers: Nibco, Watts, Mission, DFT, Inc., Circle Seal, Milwaukee, Stockham

D. Balancing Valves:

(1) Circuit Setter:

(a) Acceptable Manufacturers: Bell and Gossett, Victaulic, Watts or approved equal

(b) 2" and Smaller: Shall be of lead-free brass or bronze construction with glass and carbon-filled TFE seat rings and have differential pressure read-out ports across valve seat area. Read-out ports to be filled with internal EPT insert and better connection with check valve. Valve bodies to have 1/4" NPT tapped drain/purge port. Valves to have memory stop feature and calibrated nameplate to assure specific valve setting. Valve to be leak-tight at full-rated working pressure and temperature 300 psi (2068.43 kPa)/250°F). B&G Circuit Setter Model CB, Victaulic TA Series 78BL, Watts LFCSM-61-S, or approved equal.

E. Mixing Valves

(1) Electronic Thermostatic Master Mixing Valves

(a) Acceptable manufacturers: Armstrong Brain, Leonard Nucleus, Powers Intellistation or approved equal

(b) Master digital thermostatic mixing valve, capable of maintaining mixed water temperature within 4°F of setpoint at zero demand and peak flow with recirculated flow for temperature maintenance. Valve assembly shall be capable of sensing temperature in recirculated water temperature and returning water to main distribution if temperature is adequate or diverting partial flow to heater when temperature falls below setpoint.

(c) Mixing valve station shall be factory assembled on single frame with single point of connection for each piped service and single point of power connection.

(d) Mixing valve station shall be digitally controlled to maintain output setpoint with minimum flow rate of 0.5 gpm. Mixing station shall include color touch screen controller, isolation valves on each service pipe, check valves on cold and hot water inlet and return to water heater, strainers on inlet piping and transmitters for pressure and temperature within the assembly.

(e) Valve shall be rated for 125 psig (861.84 kPa) operating pressure, 180°F maximum inlet temperature and be certified under ASSE 1017.

(2) Thermostatic Point of Use Tempered Water Mixing Valve

(a) Acceptable manufacturers: Bradley, Lawler, Leonard, Powers or approved equal

(b) Emergency fixture thermostatic mixing valve, capable of maintaining mixed water temperature within 5°F of setpoint. Valve shall fail to cold water supply only on loss of hot water supply. Valve shall fail closed on loss of cold water supply.

(c) Mixing valve shall be bronze construction with dual thermostatic elements, high temperature limit stop, locked temperature regulator and integral thermometers on inlet, outlet and mixed water lines. Valve shall be rated for 125 psig (861.84 kPa) operating pressure and be certified per ANSI Z358.1 requirements.

F. Pressure Reducing Valves – Point Of Use

(1) Manufacturers: Apollo, Cla-Val Company, Watts Regulator Company, or Wilkins Regulator Division

(2) High Temperature/Low Pressure Regulators:

(a) Self-contained regulator with cast bronze body, renewable stainless steel seat, spring loaded diaphragm, integral stainless steel strainer, union connection, 160°F maximum temperature rating, 200 psi (1378.95 kPa) maximum inlet pressure rating, and 25 to 75 psi (517.11 kPa) adjustable reduced pressure range. Regulator shall be Apollo 36ELF or approved equal.

2.05 WATER METERS

A. Compound Flow Meter

(1) Acceptable Manufacturers: Badger, Neptune, Sensus Metering Systems or approved equal

(2) Meter shall be in-line compound meter type consisting of one positive displacement chamber and one turbine chamber. Meter shall have integral or remote converter with graphic display and keypad. Meter shall be factory sized and programmed for its specific application and flow range. Meter shall be reprogrammable using converter keypad without use of special interface device or computer.

(3) Meter body shall be lead-free bronze construction with stainless steel trim. Meter shall have thermoplastic piston, turbine chamber and turbine. Meter materials and finish shall meet AWWA Standard C700.

(4) Meter shall be provided with ANSI Class 150 flanges.

(5) Meter shall be selected for 10:1 turndown. Meter shall be wet-calibrated and accurate to within ±1.5% of reading. Meter shall be shipped with certification of calibration.

(6) Meter shall have programmable pulse output signal.

(7) Meter shall have integral lead-free bronze or stainless steel plate type strainer. Strainer shall have access cover for cleaning of strainer grid.

(8) Meter shall provide totalized flow in gal.

(9) Refer to schedules on drawings for meter performance requirements.

B. Positive Displacement Flow Meter

(1) Acceptable Manufacturers: Badger, Niagara Meters or approved equal

(2) Meter shall be in-line nutating disc positive displacement type. Meter shall have integral analog totalizer. Meter shall be factory sized and programmed for its specific application and flow range.

(3) Meter body shall be lead-free bronze construction with non-metallic trim. Meter materials and finish shall meet AWWA Standard C700.

(4) Meter shall be provided with threaded end connections.

(5) Meter shall be selected for 10:1 turndown. Meter shall be wet-calibrated and accurate to within ±2% of reading. Meter shall be shipped with certificate of calibration.

(6) Meter shall have transmitter with programmable pulse output signal.

(7) Meter shall have integral polymer strainer on meter inlet. Strainer shall have access cover for cleaning of strainer grid.

(8) Meter shall provide totalized flow in gal.

(9) Refer to schedules on drawings for meter performance requirements.

C. Turbine Flow Meters

(1) Acceptable Manufacturers: Badger, Neptune, Onicon, or Sensus

(2) Meter shall be in-line turbine type. Meter shall have integral analog totalizer. Meter shall be factory sized and programmed for its specific application and flow range.

(3) Meter body shall be lead-free bronze construction with stainless steel trim. Meter shall have thermoplastic rotor with stainless steel rotor pivots. Meter materials and finish shall meet AWWA Standard C701.

(4) Meter shall be provided with ANSI Class 150 flanges.

(5) Meter shall be selected for 10:1 turndown. Meter shall be wet-calibrated and accurate to within ±2% of reading. Meter shall be shipped with certificate of calibration.

(6) Meter shall have transmitter with programmable pulse output signal.

(7) Meter shall have integral stainless steel strainer on meter inlet. Strainer shall have integral cover plate for cleaning of strainer grid.Meter shall provide totalized flow in gal.

(8) Refer to schedules on drawings for meter performance requirements.

2.06 DIELECTRIC FITTINGS

A. Insulating nipple, metal casing, inert thermoplastic lining; Anvil Figure 7090, Clearflow dielectric fitting by Perfection Corporation or Victaulic Style 47.

B. Dielectric unions 2” and smaller; dielectric flanges 2-1/2” and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig (1206.58 kPa) at 180°F. Watts Regulator Company, Lochinvar, Wilkins or Epco Sales, Inc.

2.07 WATER HAMMER ARRESTORS

A. Mechanical Water Hammer Arrestors:

(1) Piston-compressed air column type, with sealed air chamber.

(2) Manufacturers: Watts, Sioux-Chief, and Precision Plumbing Products (PPP), Inc., equal to size shown. Provide access panels when mechanical shockstops are installed in non-accessible concealed locations.

2.08 EXPANSION JOINTS/LOOPS

A. Copper Tubing:

(1) Use expansion loops where space is available. Size expansion loops as listed in the following table:

Pipe Size	Length of Each Loop	Number of Legs
3/4”	38”	3
1”	40”	3
1-1/4”	42”	3
1-1/2”	46”	3
2”	50”	3
2-1/2”	54”	3
3”	60”	3
4”	68”	3

B. Copper Tubing:

(1) Mechanical expansion fittings, size 3/4” thru 4”, copper tube sweat ends, stainless steel laminated internal bellows, 200 psi (1378.95 kPa) working pressure, 600°F rated; Keflex Model 7QT.

(2) Mechanical expansion fittings, sizes 3/4” thru 4”, copper tube sweat ends, stainless steel laminated internal bellows, 175 psig (1206.58 kPa) working pressure, 500°F rated, Hyspan Model 8509 or 8510.

(3) Allowable length of copper tube per mechanical expansion fitting shall be in accordance with the following table:

System Operating Temperature	Length of Pipe
110°F	300 ft
120°F	275 ft
130°F	250 ft
140°F	225 ft
150°F	175 ft
160°F	175 ft
170°F	150 ft
180°F	140 ft

C. Pre-manufactured expansion loop will be allowed: Metraflex Model MLS Series for sweat ends, MLT Series for threaded ends and MLF Series for flanged or groove ends. Verify pipe size required, laying length, and face-to-face dimension required. Coordinate location with other trades.

2.09 IN-LINE CENTRIFUGAL PUMPS FOR TEMPERATURE MAINTENANCE OF POTABLE HOT WATER

A. Manufacturers: Bell and Gossett, Grundfos, Wilo or approved equal

B. Pumps shall be wet rotor inline pump with lead free bronze body construction. Pump shall be specifically designed for quiet operation with working pressure of 175 psig (1206.58 kPa) and operating temperature of 225°F continuous with electronically commutated magnet motor (ECP/PM).

C. Impellers shall be stainless steel and shall be directly hung from motor shafts without using flexible couplings.

D. Pump shafts shall be stainless steel, sealed and gasketed from pumped fluid.

E. Bearing assemblies and motor shall be permanently oil lubricated and maintenance free.

F. Pump shall be controlled by onboard user interface. Pump shall be capable of following operating modes:

(1) Proportional Pressure: Pump differential pressure shall be continuously monitored and increased or decreased along linear curve based on flow demand.

(2) Constant Pressure: Pump shall maintain constant differential pressure at any flow demand until maximum speed is reached. Set point shall be adjustable through onboard interface.

(3) Constant Speed: Pump shall maintain constant speed at any flow rate.

(4) Night Set Back: Pump shall recognize 18°F water temperature reduction and shall switch to nighttime operation.

(5) T-Constant: Pump speed shall vary to maintain constant fluid temperature based on PI algorithm.

(6) Delta-T Constant: Pump speed shall vary to maintain constant differential temperature between built-in temperature sensor and external temperature sensor based on PI algorithm.

(7) Delta-P-T: This pump control mode is paired with proportional or constant pressure mode. Nominal differential pressure setpoint shall vary according to fluid temperature.

(8) Delta-P/Delta-T: This pump control mode is paired with proportional or constant pressure mode. Nominal differential pressure setpoint shall vary according to differential temperature between built-in temperature sensor and external temperature sensor.

G. Refer to schedule on Drawings for capacity requirements of pumps.

2.10 PRESSURE BOOSTER PUMP

A. Pump Manufacturers: Armstrong, Bell and Gossett, Ebara, Grundfos, Peerless Pumps

B. Pump Skid Integrator: Armstrong, Bell and Gossett, Canariis, Delta P Carver, Flow Therm Systems, Metropolitan Pump company, Quantum Flo, SyncroFlo, or Tigerflow.

C. Booster pump package shall have components frame mounted, piped, painted, wired and factory tested. Package shall include triplex pumps, hydro-pneumatic bladder tank and control panel. Pumps shall be configured to run in lead-lag-lag sequence. Package shall have single 480 V 3 Ph power connection with transformer provided for lower voltage requirement. Pump package shall be provided with auto-restart function on loss of power.

D. Pumps:

(1) Pumps shall be vertical close coupled end suction type.

(2) Pumps shall have iron volute, backplate and bronze wearing rings; brass or bronze impeller, single suction enclosed type, keyed to shaft, hydraulically and dynamically balanced; stainless or carbon steel shaft with stainless steel or bronze sleeve; mechanical seals with carbon rotating against stationary ceramic seat.

(3) Pumps shall be rated at 125 psig (861.84 kPa) maximum working pressure and 225°F continuous temperature. Manufacturer shall certify ratings.

(4) Pumps shall run without excessive noise or vibration.

(5) Provide spare pump seals for each pump.

E. Each pump shall have open drip-proof high efficiency motor sized for non-overloading over entire pump curve.

F. Each pump and motor to have nameplate listing manufacturer's name, pump serial number, capacity in gpm and ft of head at design conditions, motor horsepower, voltage, frequency, speed and full load current.

G. Pump shall have manufacturer supplied VFD for each pump.

H. Provide isolation valves at inlet and outlet of each pump. Valves shall be butterfly or ball valves as specified previously.

I. Pump manifold piping shall be Type L copper tube, hard drawn, ASTM B88 or schedule 10, type 304 stainless steel pipe, ASTM A312.

J. Pumps shall have flexible suction and discharge braided pipe connectors, suction and discharge pressure gauges and common thermal relief valve. Discharge from relief valve shall be piped to 3” above floor at floor drain.

K. Package shall be controlled by skid mounted, UL listed NEMA 1 control panel with following components:

(1) Magnetic starter for each motor with overload protection, external resets, and starter failure interlocks
(2) Single door interlocked disconnect
(3) H-O-A switch for each pump
(4) Control circuit transformer with protected secondary
(5) Time delays
(6) Minimum run timers
(7) Adjustable solid-state current sensing relays
(8) Low suction pressure cutout
(9) High suction pressure shutdown
(10) Two sensor differential temperature no-flow shutdown
(11) Pump operation and warning lights, and alarm horn
(12) Automatic pump alternation of pumps 1, 2 and 3
(13) Provide necessary components in control panel to integrate via BACnet to Building Automation System for transmission of general fault alarm, run indicator for each pump, high pump pressure alarm, and low suction pressure alarm.
(14) Refer to Section 26 29 13 – Enclosed Controllers.

L. Hydro-pneumatic bladder tank shall be ASME rated with ring stand base and replaceable bladder. Tank shall include inlet and outlet pressure gauge, bladder charge pressure gauge and pressure switch for pump control.

M. Refer to schedule on Drawings for capacity requirements of pumps.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

B. Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.

C. Include connections to plumbing fixtures, to equipment by others, and to equipment requiring water. Provide proper backflow and back siphonage protection to safeguard potable water system from contamination.

D. Lay out water system so as to conform to intent of drawings. Coordinate piping with building features and work of other trades. Install water piping plumb and square with building. Plans indicate, general routing, provide additional offsets as required. Install piping with necessary swing joints and offsets to allow for expansion.

E. Install shut-off valves on branch lines near mains to avoid long dead-leg branches when valves are closed.

F. Install shut-off valves where indicated and at base of risers to allow isolation of portions of system for repair.

G. Do not install water piping within exterior walls.

H. Provide drain valves at base of risers and at low points of trapped piping 2” and larger where trapped water volume exceeds 5 gallons.

I. Install pressure reducing valves where indicated on drawings. Provide pressure gauges on both inlet and outlet sides of valve. Flush strainer and adjust to outlet pressure as scheduled.

J. Provide protective sleeve covering of elastomeric pipe insulation where copper or steel piping is embedded in masonry or concrete.

K. Provide dielectric fittings between dissimilar piping materials.

L. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

M. Install valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to equipment, fixtures and systems installed by others where same requires piping services indicated in this Section.

N. In-line pumps 3 hp and larger shall be independently supported from building structure.

O. Install water pipe using proper pipe and fittings. Use reducing fittings for changes in pipe size.

3.02 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:

(1) Use non-acidic and lead free flux on cleaned pipe and fittings for soldered joints.

(2) Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.

(3) Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.

(4) Apply heat carefully to prevent damage to pipe, fittings and valves.

(5) Follow manufacturer's recommendations when heating valves and equipment for soldered connections.

C. Brazed Copper Joints:

(1) Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.

(2) Joints shall be cleaned and polished before brazing.

(3) Flux of any type shall not be used.

(4) Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.

D. Press Fit Copper Joint:

(1) Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.

(2) Tubing shall be clean and dry before inserting into fittings.

(3) Insert pipe fully into fitting and mark on pipe at shoulder of fitting.

(4) Check fitting alignment against mark on pipe to ensure pipe is fully engaged.

(5) Crimp joint with pressing tool approved by fitting manufacturer.

E. Mechanically Formed Tee Fittings:

(1) Form mechanically extracted collars in continuous operation consisting of drilling pilot hole and drawing out tube surface to form collar, having height of not less than 3 times thickness of tube wall. Use adjustable collaring device. Notch and dimple branch tube.

(2) To form couplings, anneal end of tubing to be expanded - insert expander and reform tube to accept size OD. Socket expansion shall be at least 3 times base tube wall thickness in depth.

(3) Braze joints and couplings in accordance with American Welding Society "lap-joint" weld, and Copper Development Association copper tube handbook using BCuP filler metal. (Note: soft soldered joints will not be permitted.)

3.03 STAINLESS STEEL PIPE

A. Welded Pipe Joints:

(1) Shop-fabricate major piping assemblies to keep field welds to minimum.

(2) Prepare ends of pipe for welding by machining, abrasive cutting, grinding, sawing, or combination of these methods using stainless steel saw blades and cutting and grinding tools suitable for stainless steel pipe.

(3) Thoroughly clean weld areas and remove burrs and scale. Remove foreign substances such as cutting oils, metal particles, grinding compounds, etc. Clean only with stainless steel wool, stainless steel wire brushes, or other noncontaminating media.

(4) Align work accurately in jigs or fixtures. Keep aligning benches clean. Do not allow stainless steel to come in contact with carbon steel benches, jigs, or fixtures. Place sheet of stainless steel between bench and stainless steel pipe. Carbon steel jig or fixture surfaces that come in contact with stainless steel pipe will be galvanized.

(5) Make welds using Tungsten Inert Gas (TIG) welding process. Fusion weld only; use no filler metal. Use tungsten nonconsumable electrodes and 100% commercially dry and pure argon gas for internal pipe purging, and use 100% commercially dry and pre argon gas for electrode shielding. Purge paper must be physically removed from systems prior to cleaning of systems. Welds will be purged using inlet gas backup. Passivation will be performed on welds.

(6) Manual fusion welding will start and end with tungsten arc adjacent to weld joint to prevent joint contamination.

(7) Perform welding of piping systems with qualified welders and/or welding operators. Qualify welders and/or welding operators in accordance with ANSI Standard B31.1.

(8) Maintain qualification weld records in accordance with ANSI Standard B31.1. Provide Owner's Project Representative with copy of records and keep records current.

(9) Prior to beginning fabrication of any welded piping system, Contractor and each subcontractor required to do welding as specified, shall prepare and submit to Owner's Project Representative for approval, 3 quality control samples of pipe joints made in accordance with applicable specifications.

(10) Additional samples will be prepared and submitted as required until 3 samples of each pipe system are approved by Owner's Project Representative. One approved sample will be returned to Contractor.

(11) Approved samples will be basis of minimum acceptable quality of pipe joints furnished under this Contract and for welder qualification tests.

(12) Architect or Engineer reserves right to test work of any welder employed on project, at Contractor's expense. If work of welder is found to be unsatisfactory, welder shall be prevented from doing further welding on Project.

(13) Welds must have 100% penetration and smooth lines of fusion on exterior and interior.

(14) Interior must be flush and smooth, and weld concavity shall not exceed 10% of pipe wall thickness.

(15) Clean interior and exterior of welds which are accessible. Use stainless steel wire brushes, resinoid, or rubber-bonded aluminum grinding wheels, which are free of carbon particles. Do not use carbon steel tools or brushes, or grinding wheels for use on carbon steel material.

(16) Provide plugs or caps for openings during construction phase. Temporary plug shall be plastic cap or equivalent.

(17) Support piping drops through finished ceiling from structure above to prevent any lateral or up/down movement. Other outlet drops shall be supported from walls, columns, or workbenches using appropriate hangers, anchors, or Unistrut.

3.04 SPRING LOADED CHECK VALVES

A. Provide spring loaded check valve in each pump discharge line.

3.05 WATER METERS

A. Provide minimum of 5 pipe diameters of straight pipe on inlet of meter and minimum of 2 pipe diameters of straight pipe on outlet of meter.

B. Provide strainer on inlet to meter.

C. Refer to instrumentation points list for monitoring data points required from transmitter.

3.06 WATER HAMMER ARRESTORS

A. Use water hammer arrestors to control water hammer. Installed devices shall be sized and located according to manufacturer's recommendations, PDI Standards, or as shown on drawings.

B. Use water hammer arrestors with flush valves and quick-closing valves. Provide access panels when water hammer arrestors are installed in non-accessible concealed locations.

3.07 DIELECTRIC UNIONS AND FLANGES

A. Install dielectric unions or flanges at points where copper-to-steel pipe connection is required in domestic water systems.

B. Install unions on equipment side of shutoff valves for items such as: water heaters, water softeners, pumps, filters, and similar equipment requiring periodic replacement.

3.08 EXPANSION JOINTS

A. Install one anchor on either side of expansion joint, opposite direction of expansion.

B. Install pipe guides on each side of mechanical expansion fittings.

3.09 VALVE ACTUATORS

A. Install chain operators on ball, gate and butterfly valves (2-1/2” and larger).

3.10 CLEANING

A. Flush and clean piping prior to testing. Remove corrosion by mechanical or chemical means. Use chemicals that are non-toxic.

3.11 TESTING

A. Refer to Testing paragraph of Section 20 00 00 - General Mechanical Requirements.

B. Water test system may be applied to system in its entirety or in sections. Test piping with water to pressure of 100 psi (689.48 kPa) for 2 h. No decrease in pressure allowed. Provide pressure gauge with shutoff and bleeder valve at highest point of system tested. Inspect joints in system under test.

C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

D. Do not conceal pipe until satisfactorily tested.

E. Testing with air will not be allowed.

3.12 BALANCING

A. Balance water distribution system. Adjust control valves for proper operation. Set balancing valves to maintain hot water in hot water system.

B. Balance flush valves, flow control valves and mixing valves for adequate flow and temperature to plumbing fixtures and equipment.

3.13 DISINFECTION

A. Disinfect water piping in the following manner:

(1) Clean and flush water pipe with water until water at remote tap is clear.

(2) Fill water systems with solution containing 50 ppm of chlorine (minimum concentration). Allow solution to stay in water system for 24 h. Alternately use solution of 200 ppm of chlorine (minimum concentration) for 3 h.

(3) Flush water system of chlorine solution.

(4) Allow clean water to stand in system for 24 h. Take sample from remote tap for bacteriological test.

B. Do not use water system for potable water supply until safe bacteriological test is obtained. Repeat steps 1 through 4 until safe water system is obtained.

3.14 BACTERIOLOGICAL TESTS

A. Take representative water samples and test to ensure bacteriologically safe water supply system. Include HPC (Heterotrophic Plate Count) test and test for presence of Pseudomonas aeruginosa as well as regular coliform bacteria test. HPC test maximum containment level of 500 organisms/ml. Perform bacteriological tests shortly before Owner's acceptance of building. If tests fail, make corrections and retest.

B. When connecting to existing water supply of unknown quality, sample for analysis and comparison with finished water system analysis shall be taken prior to making new connection. This will allow isolating source of contamination from within scope of work or pre-existing water supply. Final conditions shall meet criteria specified above for areas within scope of work.

END OF SECTION 22 11 18

SECTION 22 13 14 - SANITARY WASTE AND STORM DRAINAGE SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section includes materials and methods for sanitary waste and vent storm drainage, and overflow storm drainage piping systems within and including piping to 5 ft outside building wall.

1.02 RELATED WORK

A. Section 01 81 13 - Certification Requirements

B. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment

C. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment

D. Section 22 07 00 - Plumbing Insulation

E. Section 22 21 14 - Plumbing Specialties

F. Section 22 40 00 - Plumbing Fixtures

G. Section 26 29 13 - Enclosed Controllers

1.03 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.04 QUALITY ASSURANCE

A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure material is undamaged and complies with Specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.06 SUBMITTALS

A. Manufacturer's technical data for the following:

(1) Pipe and fittings
(2) Joints
(3) Cleanouts
(4) Floor drains and floor sinks
(5) Roof drains
(6) Downspout nozzles
(7) Air gap fittings
(8) Discharge check valves
(9) Discharge isolation valves
(10) Traps
(11) Sump pumps

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials herein specified shall be new, unless otherwise noted.

2.02 PIPE, FITTINGS, AND JOINTS

A. Interior Above Ground:

(1) Cast Iron (Storm, Overflow Storm, Sanitary Waste):

(a) Pipe: Hubless cast iron pipe, ASTM A-888, CISPI 301, NSF certified
(b) Fittings: Hubless cast iron fittings, ASTM A-888, CISPI 301, NSF certified

(c) Joints: Heavyweight no-hub couplings with stainless steel clamps, FM 1680 Class 1, ASTM C-1540, Mission Heavyweight, Husky Series HD 2000, Ideal Tridon "MD", or Clamp-All Hi-Torq 80.

(2) Copper (Indirect Waste):

(a) Pipe: Type M copper tube, ASTM B88

(b) Fittings:

1) Cast copper drainage fittings (DWV), ANSI B16.23

2) Wrought copper drainage fittings (DWV), ANSI B16.29

(c) Joints: Lead free (<0.2%) solder, ASTM B32; flux, ASTM B813

(3) Polyvinyl Chloride (PVC) (Sanitary Vent, not in return air plenums):

(a) Pipe: Schedule 40, Class 12454 (PVC 1120), ASTM D1785

(b) Fittings: Drain, waste and vent (DWV) pattern fittings, ASTM D2665; socket fitting patterns, ASTM D3311. Fabricated fittings 10" and larger shall be per ASTM F1866.

(c) Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564

B. Pressurized Interior Above Ground:

(1) Copper (2 1/2" and smaller):

(a) Pipe: Type L copper tube, hard drawn temper, ASTM B88

(b) Fittings:

1) Cast copper drainage fittings (DWV), ANSI B16.23

2) Wrought copper drainage fittings (DWV), ANSI B16.29

(c) Joints: Lead free (<0.2%) solder, ASTM B32; flux, ASTM B813

C. Adapter Couplings for Joining Dissimilar Pipe Materials:

(1) Acceptable Manufacturers: Fernco, Mission

(2) 1" through 6" diameter: Fernco Proflex 3000 Series shielded coupling with neoprene gasket, stainless steel shield, and stainless steel clamping bands. Adapter couplings shall be specifically designed for pipe materials being joined.

(3) 8" through 27" diameter: Fernco 1000 Series flexible coupling with elastomeric PVC or neoprene gasket and stainless steel clamping bands. Adapter couplings shall be specifically designed for pipe materials being joined.

2.03 VALVES

A. Pump Discharge Check Valves:

(1) Acceptable Manufacturers: Hammond, Milwaukee, Nibco and Stockham with indicated features and equal to model listed

(2) Size 2" to 4", Horizontal Installation:

(a) Cast iron body, swing check, bronze disc and ring, brass pin, Class 125, threaded ends, Nibco T-918-B

(3) Size 2-1/2" and Larger, Vertical Installation:

(a) Cast iron body, swing check, bronze disc to 4" and cast iron disc with bronze disc face rings or bronze disc for 5" and up, lever and spring operator, brass pin, Class 125, flanged ends, Nibco F-918-BLS

B. Pump Discharge Isolation Valves:

(1) Ball Valves:

(a) Acceptable Manufacturers: Apollo, Hammond and Nibco with indicated features and equal to model listed

(b) Size 2" to 3":

1) Full Port, 2 Piece: Bronze body, ASTM B584, stainless steel ball, teflon seats, stem extension, 600 psi (4136.86 kPa) CWP pressure rating, Nibco 585-70-66

2.04 CLEANOUTS

A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed in Drains and Cleanout Schedule.

B. Provide recessed, solid brass, cleanout plugs where fittings are used as cleanouts. Provide taper-thread plug with Teflon tape thread wrap.

C. Floor Cleanouts: Cleanout with cast iron ferrule, adjustable top, nickel-bronze scoriated cover and frame, bronze taper-thread plug, equal to J.R. Smith 4033L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4033L-F-C.

D. Floor Cleanouts, Carpeted Areas: Cleanout with cast iron ferrule, adjustable round top, nickel-bronze scoriated cover and frame, bronze taper-thread plug, and small stainless steel carpet marker, equal to J.R. Smith 4033L-Y. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4033L-F-C-Y.

E. Floor Cleanouts, Tiled Areas: Cleanout with cast iron ferrule, adjustable square tile top, nickel-bronze scoriated cover and frame, and bronze taper-thread plug, equal to J.R. Smith 4053L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4053L-F-C.

F. Floor Cleanouts, Unfinished Floors and Areas Outside Building: Cleanout with cast iron ferrule, adjustable round top, scoriated cast iron tractor cover, and bronze taper-thread plug, equal to J.R. Smith 4239L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4239L-F-C.

G. Floor Cleanouts, Areas with Heavy Traffic: Cleanout with cast iron ferrule, adjustable housing, heavy-duty ductile iron scoriated top, and brass taper-thread plug, equal to J.R. Smith 4233L-M. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4233L-M-F-C

H. Wall Cleanouts: Cleanout with cast iron counter sunk ferrule, bronze or brass taper-thread plug, secured stainless steel access cover, equal to J.R. Smith 4472T.

2.05 FLOOR DRAINS AND FLOOR SINKS

A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed herein or in Drains and Cleanout Schedule.

B. Floor drains shall be in accordance with ANSI A112.21.1. Provide with caulked or no-hub connection. Floor drains shall have internal seepage collar for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Include trap seal insert at all floor drains unless otherwise indicated on drawings.

2.06 ROOF DRAINS AND OVERFLOW DRAINS

A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed in Drain Schedule.

B. Roof drains and overflow drains shall have cast iron body with adjustable collar, cast iron flashing ring, gravel stops, 10” diameter cast iron dome strainer, and cast iron underdeck clamp. J.R. Smith 1010Y-RC-CID.

2.07 AIR GAP FITTINGS

A. Air gap fittings constructed of cast iron with integral air gap having free area of at least twice the inlet area. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to J.R. Smith 3950 or 3951.

2.08 DOWNSPOUT NOZZLES

A. Acceptable Manufacturers: Josam, Smith, Wade or Zurn equal to number listed

B. Downspout nozzles shall be fabricated stainless steel body, wall flange and threaded inlet, secured hinged perforated grate, equal to J.R. Smith #1775.

2.09 TRAPS

A. Same material as pipe or fittings unless specified with fixtures. Refer to Section 22 40 00 - Plumbing Fixtures. Provide 17 ga brass, chrome plated traps for exposed traps.

2.10 ELEVATOR SUMP PUMPS

A. Acceptable manufacturers: Aurora/Hydromatic, Liberty, Stancor, Weil, or Zoeller

B. Pump shall be submersible type constructed of epoxy coated cast iron shell, cast iron volute, two vane enclosed semi-open non-clog bronze impeller, stainless steel shaft, stainless steel fasteners, upper sleeve and lower ball bearing factory sealed grease lubricated, and ceramic mechanical seal.

C. Pump shall be hermetically sealed, capacitor start, built-in thermal overload protection sized for no-overloading entire pump curve.

D. Pump shall be of capacity and electrical service as indicated in the equipment schedules on the drawings.

E. Pump controls shall include:

(1) Single on/off UL listed float switch

(2) Oil sensor to terminate operation on oil

F. Pump accessories shall include:

(1) Discharge check valve

(2) Full port ball valve

(3) Union for each pump

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

B. Provide rigid bracing to resist movement of upstream pipe for horizontal pipes 4” and larger with changes in direction greater than 45 degrees.

C. Connect piping to fixtures, each piece of equipment, and drains. Install required piping as shown on drawings.

D. Grade horizontal lines with minimum of 1/8” per ft, except piping 2” diameter or smaller which shall be run at 1/4” per ft slope.

E. Install piping parallel with building lines and at heights, which do not obstruct any portion of window, doorway, stairway, or passageway, except, as may be shown on plans. Install overhead piping as high as possible.

F. Grade vent pipe for complete drainage by gravity to soil or waste pipes. Vent terminations shall be set true and level. Locate vent piping at least 10 ft away from window, door or intake openings. Coordinate closely with roofing contractor to prevent damage to roofing membrane. Flashing shall be in accordance with requirements of roofing manufacturer.

G. Where interferences develop, offset or reroute piping as required to clear interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

H. Provide protective sleeve covering of elastomeric pipe insulation, where piping and/or fittings are embedded in masonry or concrete.

I. Maintain piping in clean condition internally during construction.

J. Mitered ells, notched tees, and orange peel reducers are not allowed. Bushings are not allowed on threaded piping.

K. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

L. Set cleanouts true and level and protect properly throughout construction.

M. Set floor drains and floor sinks true and level and protect properly throughout construction. Weep holes shall be filled with removable material and kept free from concrete and other debris during construction. Weep holes shall be cleaned out for final working order. Provide safing for floor drains installed in elevated slabs.

N. Trap each fixture and piece of equipment requiring sanitary drainage connections. Trap seals shall be standard depth, except when deep seals are required by code. Traps shall be set true and level and located within limits of code requirements. Traps shall not be used as separator, interceptor or other type of device to retain solids. Traps shall be provided with thread type approved cleanout plugs when specified. Protect traps during construction and seal off to prevent stones, debris and other foreign matter from entering before use. Locate running traps for full accessibility with double cleanout.

O. Provide plugs or caps for pipe openings during construction to prevent debris from entering pipe. Temporary plug shall be plastic cap or equivalent.

3.02 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:

(1) Use non-acidic and lead free flux on cleaned pipe and fittings for soldered joints.

(2) Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.

(3) Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.

(4) Apply heat carefully to prevent damage to pipe, fittings and valves.

(5) Follow manufacturer’s recommendations when heating valves and equipment for soldered connections.

3.03 POLYVINYL CHLORIDE (PVC) PIPE

A. Pipe Joints:

(1) Install in accordance with ASTM D2855 "Making Solvent Cemented Joints with PVC pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if fitted with wheels designed for use with PVC pipe that do not leave raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and scratches. Bevel ends 10-15 degrees and deburr interior. Check dry fit of pipe and fittings. Reject materials, which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.

(2) Maintain pipe, fittings, primer and cement between 40°F and 100°F during application and curing. Apply primer and solvent using separate daubers (3” and smaller piping only) or clean natural bristle brushes about 1/2 size of pipe diameter. Apply primer to fitting socket and pipe surface with scrubbing motion. Check for penetration and reapply as needed to dissolve surface to depth of 4-5 thousandths. Apply solvent cement to fitting socket and pipe in amount greater than needed to fill gap. While both surfaces are wet, insert pipe into socket fitting with quarter turn to bottom of socket. Solvent cement application and insertion must be completed in less than 1 minute. Minimum of 2 installers is required on piping 4” and larger. Hold joint for 30 seconds or until set, whichever is longer. Reference manufacturer's recommendations for initial set time before handling and for full curing time before pressure testing.

B. Install plastic pipe and fittings as recommended by manufacturer. Include adequate offsets or expansion joints to allow for pipe expansion.

C. Do not install plastic pipe in plenum space.

3.04 CAST IRON PIPE

A. No-hub Piping: Place gasket on end of one pipe of fitting and clamp assembly on end of other pipe or fitting. Firmly seat pipe or fittings ends against integrally molded shoulder inside neoprene gasket. Slide clamp assembly into position over gasket. Tighten fasteners to manufacturer's recommended torque.

B. Install cast iron pipe and fittings as recommended by CISPI in their publication "Installation of Cast Iron Soil Pipe and Fittings".

C. Support piping at every coupling. Locate hanger within 18” of coupling.

D. Installations with multiple joints within a 4 ft developed length shall be supported at every second joint.

E. Secure base of risers with thrust restraints to prevent joint separation. Restraint shall be in accordance with CISPI recommendations.

F. Brace horizontal piping 5” and larger to prevent horizontal movement. Install bracing at every branch connection and every change of direction in accordance with CISPI recommendations.

3.05 TESTING

A. Refer to Testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Gravity Systems:

(1) Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at highest point. Provide separate standpipe above highest point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 30 minutes before inspection starts.

C. Pressurized Systems:

(1) Water test system may be applied to system in its entirety or in sections. Test piping with water to pressure of 25 psi (172.37 kPa) for 2 h. No decrease in pressure allowed. Provide pressure gauge with shutoff and bleeder valve at highest point of system tested. Inspect joints in system under test.

D. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

E. Testing with air will not be allowed.

END OF SECTION 22 13 14

SECTION 22 14 14 - BUILDING SUBSOIL DRAINAGE

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies pipe and materials to provide subsoil drainage system for building.

1.02 RELATED WORK

A. Section 22 05 20 - Plumbing Excavation and Backfill

1.03 SUBMITTALS

A. Shop drawings and Product Data on items specified herein.

PART 2 - PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

A. Interior Underground

(1) Vitrified Clay:

(a) Pipe: Extra strength, perforated, ASTM C700

(b) Joints: PVC Nobell collar ASTM D1784, compression gasket, ASTM C425

(c) Cover: Polypropylene filter fabric, design flow rate range from 110 to 220 gpm (6.9 to 20.8 L/s) per square foot when tested according to ASTM D4491/D4491M

(2) Concrete:

(a) Pipe: Perforated, ASTM C444

(b) Joints: Flexible plastic coupling

(c) Cover: Polypropylene filter fabric, design flow rate range from 110 to 220 gpm (6.9 to 20.8 L/s) per square foot when tested according to ASTM D4491/D4491M

(3) Corrugated Steel:

(a) Pipe: Galvanized, bituminous coated, perforated, AASHTO M 36

(b) Joints: Corrugated steel band

(c) Cover: Polypropylene filter fabric, design flow rate range from 110 to 220 gpm (6.9 to 20.8 L/s) per square foot when tested according to ASTM D4491/D4491M

(4) Polyvinyl Chloride (PVC):

(a) Pipe: Perforated, ASTM D2729

(b) Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564

(c) Cover: Polypropylene filter fabric, design flow rate range from 110 to 330 gpm per square foot when tested according to ASTM D4491/D4491M

(5) Plastic Corrugated Tubing:

(a) Pipe: Polyethylene corrugated drainage and footing type, ASTM F405 or AASHTO M 252, ASTM F405, Type C similar to product by Advanced Drainage System (ADS)

(b) Joints: Plastic snap coupling meeting soil tightness requirements of AASHTO M 252 or AASHTO M 294

(c) Cover: Polypropylene filter fabric, design flow rate range from 110 to 220 gpm (6.9 to 20.8 L/s) per square foot when tested according to ASTM D4491/D4491M

(6) Heavy Duty Polyethylene:

(a) Pipe: Corrugated tubing, Hancor Hi-Q perforated channel tubing, ASTM F405

(b) Cover: Polypropylene filter fabric, design flow rate range from 110 to 220 gpm (6.9 to 20.8 L/s) per square foot when tested according to ASTM D4491/D4491M

B. Solid Pipe Through Foundation Wall and Under Building

(1) Polyvinyl Chloride (PVC):

(a) Pipe: Schedule 40, Class 12454-B (PVC 1120), ASTM D1785

(b) Fittings: Socket fitting patterns, DWV patterns, ASTM D3311

(c) Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564

C. Pressurized Interior Underground

(1) Polyvinyl Chloride (PVC):

(a) Pipe: Schedule 40, Class 12454-B (PVC 1120), ASTM D1785

(b) Fittings: Socket fitting patterns, ASTM D3311

(c) Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC,ASTM D2564

D. Pressurized Interior Above Ground

(1) Polyvinyl Chloride (PVC):
(a) Pipe: Schedule 40, Class 12454-B (PVC 1120), ASTM D1785
(b) Fittings: Socket fitting patterns, ASTM D3311
(c) Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564

2.02 VALVES

A. Ball Valves:
(1) Acceptable manufacturers: Asahi, Chemtrol, Ipex, Plast-O-Matic, Spears
(2) Size 3" (72 mm) and smaller: PVC body, full port, true union, Teflon seats, EPDM seals, socket ends. Ipex VX Series

B. Check Valves:
(1) Acceptable manufacturers: Asahi, Chemtrol, Hayward, Ipex, Spears
(a) Size 3" (72 mm) and smaller: PVC body, ball check, EPDM seals, socket ends

2.03 FILTER FABRIC

A. Filter fabric shall be non-woven polypropylene fiber bonded at crossing points. Equivalent opening size (EOS) shall be 70 to 100 U.S. Standard sieve size, ASTM D4751. Fabric shall have water flow rate of 55 gal/min/sq ft, ASTM D4491/D4491M.

B. Fabric shall be Typar, Style 3401 by DuPont or Mirafi 140 by TenCate.

2.04 STONE

A. Drainage stone shall be washed rock or gravel evenly graded with stone smaller than 2" (50.8 mm) size and larger than 3/4" (19.05 mm) size.

2.05 CLEANOUT

A. Manufacturers: Josam, Wade, Zurn or Smith equal to item listed in Cleanout Schedule in Section 22 06 00 - Plumbing Schedules.

2.06 STRUCTURES

A. Settling Basin:
(1) Reinforced precast concrete manhole sections, ASTM C478/C478M. Size to accommodate piping shown.
(2) Frames and Covers; ASTM A48/A48M-83, Class 35, gray cast iron frame and cover. See Details, Section 22 06 90 - Plumbing Details. Neenah Foundry Standard.
(3) Frames and Covers; ASTM A536-80, Grade 65-45-12, ductile iron frame and cover. See Details, Section 22 06 90 - Plumbing Details. Neenah Foundry Standard.

2.07 SUMP PUMPS (AIR FILLED)

A. Acceptable pump manufacturers: Ebera, KSB, Paco, and Weil

B. Acceptable control manufacturers: See Water, SJE-Rhombus and Weil

C. Pump shall be _____ submersible type constructed of epoxy or enamel coated cast iron shell, and cast iron volute, ASTM A48/A48M, Class 30, multi-vane enclosed _____ non-clog _____ impeller, stainless steel shaft, stainless steel fasteners, upper sleeve and lower ball bearings permanently lubricated, and ceramic mechanical seal.

D. Motors shall be NEMA 6, submersible, air-filled, hermetically sealed with Class F insulation. Motors shall meet requirements of Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.

E. Pump shall be of capacity and motors shall be of electrical service as indicated in the equipment schedules on the drawings.

F. Pump Removal System:
(1) Removal system shall permit removal and re-installation of pump without disturbing discharge piping and without personnel entering wet well.
(2) Lifting cable shall be braided stainless steel.
(a) Pump shall be provided with lifting bail to permit attachment of cable to pump.
(3) Pump shall be guided by two guide poles provided with system.
(a) The guide poles shall be mounted on floor elbow and 304 stainless steel upper guide bracket.
(4) Pump sliding bracket shall be constructed of heavy duty bronze.
(5) Floor elbow shall be constructed of ASTM A48/A48M-83, class 30, close grain cast iron.
(6) Pump sliding bracket shall act as wedge type coupling between pump and floor elbow to ensure metal to metal, watertight fit.
(7) Systems that require gaskets, diaphragms, or O-rings to ensure a watertight fit shall not be acceptable.

G. Pump controls shall include:

(1) NEMA 4X outdoor alarm panel with warning light, horn, silent switch, test switch and high level float switch, UL Listed

(2) Control panel with HOA switch, pump run light, resettable overload heaters, NEMA 4X, enclosure

(3) Refer to Section 26 29 13 - Enclosed Controllers for starter requirements.

(4) Electrical pump alternator and alarm panel with HOA switch, run light and resettable overload heaters for each pump; warning light; horn; silent switch; test switch; labeled terminal switch and devices; auxiliary dry contacts for remote alarm; NEMA 4X, enclosure.

H. Pump accessories shall include:

(1) 20 foot (6 m) Power cord, as required

(2) NEMA 4 junction box

(3) Dual mechanical seals, seal leak detector probe and warning light in control panel

(4) Dual stainless steel lift out guide rails, stainless steel wall, pump, and sump brackets, bronze and neoprene quick disconnect fitting, corrosion resistant pull chain or cable.

(5) Unions

2.08 SUMP PUMPS (OIL FILLED)

A. Acceptable pump manufacturers: ABS, Aurora/Hydromatic, Bell and Gossett ITT, Gould, Liberty, Myers, and Zoeller

B. Acceptable control manufacturers: See Water, SJE-Rhombus, Hydromatic and Zoeller

C. Pump shall be simplex submersible type constructed of epoxy or enamel coated cast iron shell and volute, ASTM A48/A48M, Class 30, multi-vane enclosed non-clog bronze impeller, stainless steel shaft, stainless steel fasteners, upper sleeve or ball bearings and lower ball bearings, oil lubricated, and carbon ceramic mechanical seals.

D. Motors shall be NEMA design B, filled with non-toxic dielectric oil. Motors shall meet requirements of Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.

E. Pump shall be of capacity and motors shall be of electrical service as indicated in equipment schedules on drawings.

F. Pump Removal System:

(1) Removal system shall permit removal and re-installation of pump without disturbing discharge piping and without personnel entering wet well.

(2) Lifting cable shall be braided stainless steel.

(a) Pump shall be provided with lifting bail to permit attachment of cable to pump.

(3) Pump shall be guided by two guide poles provided with system.

(a) The guide poles shall be mounted on floor elbow and 304 stainless steel upper guide bracket.

(4) Pump sliding bracket shall be constructed of heavy duty bronze.

(5) Floor elbow shall be constructed of ASTM A48/A48M-83, Class 30, close grain cast iron.

(6) Pump sliding bracket shall act as wedge type coupling between pump and floor elbow to ensure metal to metal, watertight fit.

(7) Systems that require gaskets, diaphragms, or O-rings to ensure watertight fit shall not be acceptable.

G. Pump controls shall include:

(1) NEMA 4X outdoor alarm panel with warning light, horn, silent switch, test switch and high level float switch, UL Listed

(2) Control panel with HOA switch, pump run light, resettable overload heaters, NEMA 4X, enclosure

(3) Refer to Section 26 29 13 - Enclosed Controllers for starter requirements.

(4) Electrical pump alternator and alarm panel with HOA switch, run light and resettable overload heaters for each pump; warning light; horn; silent switch; test switch; labeled terminal switch and devices; auxiliary dry contacts for remote alarm; NEMA 4X, enclosure

H. Pump accessories shall include:

(1) 20 foot (6 m) Power cord, as required

(2) NEMA 4 junction box

(3) Dual mechanical seals, seal leak detector probe and warning light in control panel

(4) Dual stainless steel lift out guide rails, stainless steel wall, pump, and sump brackets, bronze and neoprene quick disconnect fitting, corrosion resistant pull chain or cable

(5) Unions

2.09 FIBERGLASS SUMP BASINS

A. Basin shall be constructed of 70-75% fiberglass and 25-30% polyester resin, ASTM D3753, with no fillers with minimum design safety of four. Basin shall have side hub inlet fittings and tapped top outlet flange.

B. Basin shall have bolted galvanized steel gasketed cover with inspection access plate. Access plate shall have discharge pipe flange for each pump and vent pipe, and hole for control cabling.

C. Minimum wall thickness for basins as follows:

Sump Diameter	24" (600 mm)	30" (750 mm)	36" (915 mm)	42" (1070 mm)	48" (1220 mm)	60" (1525 mm)	72" (1830 mm)
Max 10 ft (3 m) Depth	3/16" (4.8 mm)	1/4" (6 mm)	1/4" (6 mm)	1/4" (6 mm)	5/16" (8 mm)	5/16" (8 mm)	3/8" (10 mm)
Max 15 ft (4.5 m) Depth	1/4" (6 mm)	5/16" (8 mm)	5/16" (8 mm)	5/16" (8 mm)	3/8" (10 mm)	3/8" (10 mm)	7/16" (11 mm)
Max20 ft (6 m) Depth	5/16" (8 mm)	5/16" (8 mm)	3/8" (10 mm)	3/8" (10 mm)	7/16" (11 mm)	1/2" (13 mm)	1/2" (13 mm)

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install subsoil drainage system as shown on drawings and details. Placement of drainage stone shall be carefully done to prevent tearing of filter fabric. Pipe shall be pitched at grade of 2" per 100' (50 mm per 30 m).

B. Install jointing systems for pipe to accomplish proper pipe alignment and pitch.

C. Handle and store filter fabric according to manufacturer`s recommendations.

D. Only pipe in stone bedding shall be perforated. Extensions to cleanouts shall be solid pipe material.

E. Install filter fabric as envelope around pipe and stone as follows:

(1) Lay fabric in trench.
(2) Place stone in filter fabric.
(3) Level stone to proper grade and set perforated pipe on stone.
(4) Place remaining stone on side and top of pipe.
(5) Wrap filter fabric around and close with minimum 6" (150 mm) lap.

F. Components (fabric, stone, pipe) form subsoil drain conduit.

G. Where subsoil drains are required to penetrate foundation work, sleeve subsoil drains and use non-perforated sections of piping and place prior to foundation work.

H. Install settling basins base on undisturbed soil with setting pad of level concrete to bed base, build up basin with standard sections and epoxy based concrete mortar joints. Adjust cover slab and access frame to align with poured floor level.

END OF SECTION 22 14 14

SECTION 22 16 00 - NATURAL GAS PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies natural gas piping and accessories to 5 ft (1.5 m) outside the building wall.

1.02 RELATED WORK

A. Section 22 05 20 - Plumbing Excavation and Backfill

B. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment

C. Section 22 05 53 - Identification for Plumbing Piping and Equipment

D. Division 26 - Electrical

1.03 QUALITY ASSURANCE

A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

C. Off-site storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.05 SUBMITTALS

A. Manufacturer's technical data for the following:

(1) Pipe and fittings

(2) Joints

(3) Valves

(4) Valve boxes

(5) Seismic Shutoff Valves

(6) Regulators

(7) Appliance connectors

B. Shop Drawings and Product Data on items specified herein.

1.06 NATURAL GAS SERVICE

A. Contact local gas company for cost of gas service to building, including pressure reducing valves, if required, and gas meter. Include this cost in Bid.

B. All charges for gas service as shown on drawings including connection from main in street or other location to gas meter shall be paid by this Contractor. This includes setting of gas meter and work performed by Gas Company.

C. Gas service, meters and regulating equipment will be installed by gas company on inlet side of meters.

D. Cost of gas service, meters and regulating equipment to inlet side of meters will be paid by Gas Company.

E. Include cost of alterations of existing gas service, meters and reducing valves in Base Bid. This includes work performed by Gas Company to, and including, gas meters.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials herein specified shall be new, unless otherwise noted.

2.02 BELOW GROUND PIPE, FITTINGS AND JOINTS

A. 2" (50 mm) and Smaller:

(1) Pipe: Thermoplastic polyethylene tubing, PE 2708 or PE4710, ASTM D3350, SDR-11, rated for 80 psig (550 kPa) working pressure at 73°F (23°C), ASTM D2513

(2) Fittings: ASTM D2683, socket fusion. Use transition fitting at joints between polyethylene tubing and steel with protective coating. Transition fittings shall have socket joint on polyethylene tubing side and plain beveled end on steel side.

(3) Joints: Socket fusion

(4) Trace Wire: No. 12, copper 600 V, THHN insulation

B. 2-1/2” (65 mm) and Larger:

(1) Pipe: Thermoplastic polyethylene tubing, PE 2708 or PE4710, ASTM D3350, SDR-11, rated for 80 psig (550 kPa) working pressure at 73°F (23°C), ASTM D2513

(2) Fittings: ASTM D3261, butt fusion. Use transition fitting at joints between polyethylene tubing and steel with protective coating. Transition fittings shall have butt joint on polyethylene tubing side and plain beveled end on steel side.

(3) Joints: Socket fusion

(4) Trace Wire: No. 12, copper 600 V, THHN insulation

C. Service Entrance Pipe:

(1) Same as above ground covered with flexible polymer film with coal tar and synthetic elastomeric coating of 36 mil (0.9 mm) thickness or extruded high density polyethylene factory applied coating of 30 mil (0.8 mm) thickness. Wrap fittings with 10 mil (0.25 mm) polyethylene tape, AWWA C105/A21.5, double layer, half-lapped. Minimum dielectric strength exceeding 12 kV. Use compatible primer below polymer film or polyethylene tape.

D. Anodeless Gas Riser:

(1) Acceptable manufacturers: Elster Perfection, Gastite, Georg Fischer, Lyall, or approved equal

(2) Manufactured polyethylene to carbon steel transition fitting, requiring no cathodic protection for buried carbon steel pipe, socket, or butt fusion connection for polyethylene pipe, plain beveled end for carbon steel pipe, electrostatically applied epoxy coating on carbon steel pipe, CSA listed

2.03 ABOVE GROUND PIPE, FITTINGS AND JOINTS (UNDER 5 PSIG (35 KPA))

A. 2” (50 mm) and Smaller:

(1) Pipe: ASTM A53/A53M, Grade A or B, Type E, or ASTM A106/A106M, Grade B, standard weight, (Schedule 40), carbon steel

(2) Fittings: ASTM A197/A197M/ASME B16.3 Class 150, black malleable iron, threaded

(3) Joints: Threaded

B. 2-1/2” (65 mm) and Larger:

(1) Pipe: ASTM A53/A53M, Grade B, Type E or S, standard weight, (Schedule 40), carbon steel

(2) Fittings: ASTM A234/A234M Grade WPB/ASME B16.9, standard weight, (Schedule 40), seamless, carbon steel, welded

(3) Joints: Welded

2.04 ABOVE GROUND PIPE, FITTINGS AND JOINTS (OVER 1 PSIG (7 KPA))

A. 2” (50 mm) and Smaller:

(1) Pipe: ASTM A53/A53M, Grade A or B, Type E, or ASTM A106/A106M, Grade B, standard weight, (Schedule 40), carbon steel

(2) Fittings: ASTM A105/A105M/ASME B16.11, 3000 lb (20,685 kPa) forged steel, socket weld

(3) Joints: Welded

B. 2-1/2” (65 mm) and Larger:

(1) Pipe: ASTM A53/A53M, Grade B, Type E or S, standard weight, (Schedule 40), carbon steel

(2) Fittings: ASTM A234/A234M Grade WPB/ASME B16.9, standard weight, (Schedule 40), seamless, carbon steel, welded

(3) Joints: Welded

2.05 UNIONS

A. Steel Pipe, 2” (50 mm) and Smaller:

(1) Malleable iron, ground brass seat, 150 psi (1035 kPa) steam working pressure; Anvil 2125 or equivalent

(2) Forged steel, spiral wound gasket seats, ASTM A105/A105M, ASME B16.5

2.06 FLANGES

A. Steel Pipe, 2-1/2” (65 mm) and Larger:

(1) ANSI 150 lb (1035 kPa) class forged steel flanges, ASTM A105/A105M/ASME B16.5. Standard bolt pattern, ANSI 150 lb (1035 kPa) class 1/8” (3 mm) thick gasket, Type 304 stainless steel, spiral wound metal with graphite filler.

2.07 VALVES

A. Ball Valves:

(1) Acceptable Manufacturers: Neles-Jamesbury, Apollo, Kerotest, Nibco and Watts equal to manufacturer's Figure number listed

(2) 2” (50 mm) and Smaller:

(a) Bronze body, threaded, quarter turn, chrome plated brass ball, large port, reinforced TFE seat and stem packing, blowout-proof stem, 250 psig (1720 kPa) LP-Gas, UL Listed, CSA certified. Apollo 50 GB series.

(b) Carbon steel body, threaded, quarter turn, 2 piece design, 316 stainless steel ball and stem, full port, spiral wound 316 stainless steel and teflon seats and seals, blowout proof stem, 800 psi (5510 kPa) CWP rated, lever handle, CSA certified. Jamesbury Fire-Tite, Series 2000 Style 23-22.

(c) Carbon steel body, quarter turn, 3 piece design, chrome plated steel ball, full port, TFE seats and seals, blowout proof stem,1000 psi (6895 kPa) CWP, lever handle, CSA certified. Jamesbury Fire-Tite, Series 4000.

(3) 2-1/2” through 8” (65 mm through 200 mm):

(a) Carbon steel body, ASTM A216/A216M-WCB Class 150, quarter turn, carbon steel flanged ends, Type 316 stainless steel ball, stainless steel stem, PTFE seats and seals, API-6D test requirement. Apollo 88A-140-35-59-TD

B. Plug Valves:

(1) Acceptable Manufacturers: DeZurik, Homestead, Key Port, Milliken and Resun equal to manufacturer's Figure number listed

(2) 2” (50 mm) and Smaller:

(a) Cast iron body, threaded, permanently lubricated bearings, bronze plug, corrosion resistant Hycar plug seal, Buna stem seal packing, lever actuator, 175 psi (1205 kPa) CWP, UL Listed. Key Port Figure 425S.

(3) 2-1/2” through 4” (65 mm through 100 mm):

(a) Cast iron body, flanged, permanently lubricated bearings, electroless nickel plated cast iron plug, corrosion resistant Hycar plug seal, Buna stem seal packing, lever actuator, 175 psi (1205 kPa) CWP, UL Listed. Key Port Figure 425F.

(4) 5” (130 mm) and Larger:

(a) Cast iron body, flanged, stainless steel bearings, resilient faced plugs, totally enclosed hand wheel actuators, 200 psi (1380 kPa) CWP. Resun Model R-1431.

(b) Actuator shall be sized based on maximum pressure differential across valve.

C. Vented Gas Pressure Regulators:

(1) Acceptable Manufacturers: Fisher, Rockwell, Sensus, or American meeting capacity and performance as scheduled.

(2) 2” (50 mm) and Smaller Venting: Cast iron body, aluminum spring case, plated steel spring, Nitrile diaphragm and disc, threaded, vent to exterior of building, 150 psi (1035 kPa) CWP, -20°F to 160°F (-29°C to 71°C), listed in compliance with ANSI Z21.80/CSA 6.22, Fisher S200 series. .

D. Non-Vented Gas Pressure Regulators:

(1) Acceptable Manufacturers: Maxitrol 325 with VLimiter, Pietro Fiorentini “Gas Governor”, or approved equal.

(2) 2” (50 mm) and Smaller: Cast iron or cast steel body, plated steel spring, threaded, external vent limiter, 2 psi (14 kPa) maximum inlet pressure, listed in compliance with ANSI Z21.80/CSA 6.22. .

2.08 VALVE BOXES

A. Acceptable Manufacturers: Acorn, Acudor, or approved equal

B. Valve Box: Acudor ARVB, recessed wall mounted, 12” by 12” by 4” (300 mm by 300 mm by 100 mm) size, 16 ga (1.50 mm) stainless steel construction, continuous concealed piano hinge, lever latch or slide latch, #4 satin polish finish, holes for piping penetration

C. Valves: Ball valves as specified above, with lever handles, easily operated without tools.

D. Identification: Engraved plastic plate, “NATURAL GAS SHUTOFF VALVE”. Refer to Section 22 05 53 - Identification for Plumbing Piping and Equipment.

2.09 SEISMIC GAS SHUTOFF VALVE

A. Valve shall have manual reset, selected with minimum pressure drop based on 7” WC (1743 Pa), positive closure, soft seal seating, visual open-close indicator and UL Certified.

B. Valve shall close within 5 seconds when subjected to horizontal, sinusoidal oscillation at peak acceleration of 0.3 G for period of 0.4 seconds.

C. Valve shall not close when subjected for 5 seconds to each of the listed horizontal, sinusoidal oscillations as follows:

Peak Acceleration	Period
0.4 G	0.1 seconds
0.08 G	0.4 seconds
0.08 FG	1.0 seconds

D. Valve shall be either threaded or flanged selected at maximum capacity with minimal pressure drop.

E. Manufacturers:

(1) Koso/California Valves, Tremble Tech Inc., Safe-T-Quake or equal

(2) The following are options available only on Koso/California Valves:

(a) Maximum pressure: 0.5 psi, 7 psi, 20 psi, and 60 psi (3.5 kPa, 48 kPa, 135 kPa, and 415 kPa)

(b) Flanged ends: 2”, 3”, 4”, and 6” (50 mm, 80 mm, 100 mm, and 150 mm)

(c) Three way valve (seismic shut-off for pneumatic controls. Dry air or Nitrogen ONLY)

(d) Electrical switch (seismic shut-off for electrical circuits)

(e) Remote actuator (use with panic switch, smoke/fire alarm)

2.10 NATURAL GAS PRESSURE BOOSTER PUMPS

A. Manufacturers: Eclipse, The Spencer Turbine Company, or approved equal.

B. Natural gas pressure booster pump shall be skid mounted, duplex pump package designed increase service natural gas pressure at ambient temperatures and humidity levels. Package shall consist of two hermetically sealed centrifugal gas booster blowers, each sized for full scheduled load, inlet and outlet piping with flange connectors, accessories, and control system all mounted to single structural mounting base. Package shall be factory assembled, wired, and tested prior to delivery to site.

C. Gas Booster Blower:

(1) Blower shall be hermetically sealed centrifugal type designed to deliver natural gas at constant boosted pressure without surge characteristics.

(2) Minimum booster flow rate shall be sufficient to prevent excessive booster motor temperature.

(3) Blower assembly shall be UL listed including motor.

(4) Gas Booster Casing:

(a) Cylindrical fabricated steel.

(b) Enclosing heads shall be of similar metal, properly braced for strength.

(c) Inlet and outlet connections shall be flanged.

(d) Casing shall be leak tight to 10-3 cc/sec without external shaft seals.

(e) Drive fans shall be contained within casing shell.

(5) Impellers:

(a) Impeller peripheral speed shall not exceed 25,000 fpm.

(b) Minimum of 1/8" (3 mm) clearance between each impeller and all stationary parts.

(c) Fabricated from high strength aluminum alloy.

(6) Deflectors:

(a) Fabricated steel deflectors with properly curved guide vanes for directing natural gas to each succeeding impeller.

(7) Shaft and Bearings:

(a) Motor shall have an oversized, extending shaft supported by two oversized, anti-friction grease lubricated bearings designed to absorb both thrust and radial loads.

(b) Each shaft sized for rotating assembly operating minimum of 20% below first critical speed.

(8) Motor:

(a) Capable of operating continuously in natural gas environment.

(b) Explosion proof per NEMA Class 1, Division 1, Group D classification.

(c) Thermal overload protection.

(d) Motor starter shall be non-reversing type.

(e) Motor and blower shall be balanced for minimum vibration and capable of operation throughout design range without need for hold down or mounting bolts.

D. Flexible Joints:

(1) Flanged, flexible expansion joint suitable for natural gas service shall be provided at gas inlet and discharge connection.

(2) Flexible joints shall be of same diameter as gas inlet and discharge.

E. Low Pressure Switch:

(1) Provide UL Approved, automatic reset type low inlet pressure switch to shut down gas booster skid on low suction pressure.

(2) Low pressure switch shall be set at 3.5” water column (0.87 kPa) (adjustable).

F. Control Panel:

(1) Provide a NEMA 12 control panel for automatic operation and control of gas booster pumps.

(2) Control panel shall be built in accordance with UL508A Standards of Industrial Control Panels.

(3) Control panel shall include all required controls and electrical equipment for operational gas booster pump package.

G. Uninterruptable Power Supply:

(1) Uninterruptable power supply (UPS) shall be provided integral to booster pump skid.

(2) UPS shall provide backup power in case of main power failure and shall maintain gas booster operation for minimum 6 minutes at 100% load.

(3) UPS, including battery system, shall be sized to handle motor starting current and be rated for gas booster pump motor horsepower, voltage and phase.

H. Accessories:

(1) Pressure gauges:

(a) Listed for natural gas service.

(b) Operating range: 0 to 14” water column (0 to 3.5 kPa)

(c) Gauge shall be located at gas supply meter and at each pump discharge.

(d) Gauges shall be installed in an upright position and shall include shut-off cocks.

(2) Check valves shall be provided on outlet of each pump.

(3) Isolation valves shall be provided on inlet and outlet of each pump.

(4) Factory mounted flow control kit.

(5) Automatic bypass valve for operation under adequate pressure or no flow conditions with manual valve adjustment for start-up and valve test procedures. All electronics associated with bypass valve shall be housed in skid control panel.

(6) Provide unit with complete factory testing over full range of operation.

2.11 METERS

A. Thermal Dispersion Flow Meter

(1) Acceptable Manufacturers: Fluid Components International, Kurz Instruments, Magnetrol, Sage Metering, or Sierra Instruments

(2) Insertion Flow Sensor:

(a) Thermal dispersion type flow sensing element consisting of all welded 316 stainless steel probe assembly with male compression fitting.

(b) Element shall be designed to sense flow of natural gas with specific gravity of 0.60.

(c) Flow sensor and body:

1) Accuracy: ±1% of Reading

2) Repeatability: ±1% of Reading

3) Pressure Rating: 150-300 psig

4) Process Temperature Range: -40°C to 125°C

5) Calibrated Range: 0-5000 ft/min

(3) Transmitter:

(a) Power Requirement: 15 VDC, 24, VDC, or 120 VAC, 60 Hz

(b) Enclosure: Epoxy Coated Aluminum

(c) Enclosure Rating: NEMA 4X

(d) Display: Back-lit LCD display, 2 lines, 12-16 characters per line

(e) Output: 4-20 mA DC or 0-5 VDC

(f) Output Resolution: 0.5% of selected range

(g) Output Units: Totalized mass flow in cubic feet

(h) Ambient Temperature: -25°C to 65°C

(4) Refer to schedules on drawings for meter performance requirements.

B. Positive Displacement Flow Meter

(1) Acceptable Manufacturers: Actaris, American Meter, Dresser Roots, or Itron

(2) Positive displacement diaphragm type meter, aluminum case, with temperature compensation.

(3) Totalizing register with pulse output signal for transmission of signal to Building Automation System. Calibrate for standard cubic feet (cubic meters) of natural gas at 60°F (15°C).

(4) Meters shall be capable of measuring average hourly flow with readings taken every minute and total gas consumption.

(5) Refer to schedules on drawings for meter performance requirements.

2.12 APPLIANCE CONNECTORS

A. Appliance connectors shall be corrugated stainless steel tubing with protective exterior coating, brass valve with non-displaceable rotor, brass outlet fitting, and CSA certified. Connector length shall be as required to allow servicing of appliance. Inside diameter of connector shall be 3/8" (10 mm) for appliances up to 60,500 btu/h (17,700 W), 1/2" (15 mm) for appliances up to 106,000 btu/h (31,050 W). Connectors shall be Brass-Craft CSSD44 Series or CSSC44 Series.

2.13 CASEWORK FLEXIBLE GAS PIPING

A. 2" (50 mm) and Smaller:

(1) Tubing: Flexible gas piping shall be UL Listed, FM approved, 300 series corrugated stainless steel tubing (CSST) fabricated in accordance with ASTM A240/A240M and conforming to ANSI/CSA LC-1. Tubing shall be suitable for operation with natural gas or LP (propane) gas.

(2) Fittings and Joints: Yellow brass mechanical fittings and joints with stainless steel AutoFlare pilot insert for ID tubing

(3) Jacket: Fire retarded, UV resistant, extruded polyethylene with ASTM E84 flame and smoke density rating of 25/50

B. Manufacturer: OmegaFlex TracPipe or equal

2.14 CATHODIC PROTECTION

A. Provide complete galvanic anode type cathodic protection system for underground steel gas piping, including devices to electrically isolate system being protected.

B. Corrosion protection system shall be provided by Contractor regularly engaged in installation and testing of cathodic protection systems. Contractor's personnel shall be experienced and shall be supervised by Engineer who is accredited as Corrosion Specialist by National Association of Corrosion Engineers. Calculations, design and testing shall be performed by Corrosion Specialist. Procedures shall conform to NACE Standards.

C. Submit catalog cuts and shop drawings for the following:

(1) Anodes
(2) Permanent Reference Cells
(3) Cable and wire
(4) Test stations
(5) Terminal boxes
(6) Isolating flanges, unions, coatings, easing seals
(7) Exothermic welding devices
(8) Layout drawings, wiring diagrams
(9) Test instruments
(10) Dielectric tape
(11) Test connection points
(12) Accreditation of Corrosion Specialists by National Association of Corrosion Engineers
(13) Calculations from field survey, performed by Corrosion Specialist

D. Foreign Metallic Contacts:

(1) No foreign metal shall be allowed to contact electrically isolated sections of pipe between flange insulators. Where pipe passes through building walls, manholes, valve pits, etc., caution shall be exercised to ensure that pipe does not contact reinforcing steel. Pipe anchors and supports shall not be permitted in contact with metallic structures. Flange insulators shall be placed as close as possible to building and manhole entrances to avoid shorting to other metallic members.

(2) Upon completion of installation, system shall be tested to ensure system performance. One year service agreement shall be included in base price. Cathodic protection system must be certified by NACE Accredited Corrosion Specialist.

E. Field Quality Control:

(1) Provide system with calculated design life exceeding 40 yrs.

(2) Corrosion Specialist shall perform soil resistivity survey. Survey shall include entire length of proposed right-of-way. Soil survey shall include soil pH and presence of chlorides. Stray current investigation shall also be conducted prior to cathodic protection design.

(3) Corrosion Specialist shall provide engineering calculations to verify design of system. Calculations shall follow format published by recognized corrosion expert.

(4) Corrosion Specialist shall inspect work at least twice to ascertain that there is no grounding, short circuits, coating damage, and that installation is in accordance with standards and methods specified herein.

PART 3 - EXECUTION

3.01 GENERAL

A. Install gas piping according to requirements of this Section, local gas utility, NFPA 54 National Fuel Gas Code, AGA pamphlets and as shown on drawings.

B. Piping through roof to be run through approved roof penetration with flashing and counter flashing.

C. Install buried/underground polyethylene gas piping with trace wire taped to pipe along its entire route. Secure wire to pipe to prevent movement during backfilling. Extend trace wire to valve boxes and service entrance.

D. Transition from polyethylene piping to steel piping shall occur below grade. Provide cathodic protection and corrosion protection pipe wrap for underground steel pipe.

E. Install underground polyethylene gas piping exterior to building according to pipe manufacturer's recommendations and to meet local gas utility company's installation standards.

F. Manufacturer's representative shall instruct workmen in proper techniques for installation of underground polyethylene gas piping and provide certification to Owner that instructions have been given and proficiency been demonstrated by Contractor for installation of that piping system. Joints must be made by "Qualified" personnel proficient in joining methods of ASTM D2513 thermoplastic gas pressure pipe.

G. Grounding to gas piping is prohibited.

H. Gas piping shall be installed with dirt legs adjacent to equipment. The dirt legs shall have drain tees and plugs at low points.

I. Gas piping in plenum ceilings shall have welded joints.

J. Install gas piping above ground in buildings. Gas piping shall not be installed below building floor or footings.

K. Pitch horizontal piping downward at 1” per 60 ft (25 mm per 18 m) in direction of flow toward risers or appliances. Install minimum of 4” (100 mm) deep dirt leg at bottom of each vertical run and at each appliance. When installing mains and branches, cap gastight each tee or pipe end, which will not be immediately extended. Take branch connections to main from top or side of main.

L. Coat underground piping with corrosion resistant tape equal to Tapecoat H-30 and cathodically protected as specified herein. Repair breaks in tape coating caused by installation process.

M. Make threaded joints by cutting pipe square and reaming inside. Threads shall be cut so exposed threads do not exceed 3 in number. Protect exposed threads against corrosion. Use only joint compounds approved for gas piping.

N. Seismic shut-off valve must be installed upright, level, plumb, and downstream of regulator or main gas meter (prior to structure it protects). Valve must be rigidly mounted to earth foundation or structure so that seismic movements will be transmitted to acceleration trigger mechanism within valve assembly.

O. Do not exceed maximum torque (inch-pounds) specified by valve Manufacturer during installation of seismic shut-off valve.

P. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless piping is serving this equipment.

3.02 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried gas lines per Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.03 PRESSURE REGULATORS

A. Install regulators in accordance with manufacturer's instructions.

B. Regulator shall be accessible for maintenance and protected from fire and mechanical damage. Regulator shall be supported from structure by brackets and supports.

C. Vent(s) from vented pressure regulators or pressure safety valves shall be piped to outside. Terminate vent with protection screen and return bend. If above ground vent terminates in area subject to snow accumulation, terminate line at least 5 ft (1.5 m) above grade. Coordinate vent routing with other trades to point of termination. Size vents in accordance with regulator manufacturer's requirements for regulator flow rate and length of run.

D. Provide unions on both sides of regulators for removal and maintenance.

E. Provide gas cock for pressure verification.

3.04 BOOSTER PUMPS

A. Install pumps in accordance with manufacturer's instructions to avoid stress and misalignment.

B. Provide necessary concentric reducers/increasers for vertical piping at pump connection and eccentric reducers/increasers for horizontal piping at pump connection where pump connection size and indicated line sizes are not identical. Install eccentric reducers/increasers with top of pipe level.

C. Valves and piping specialties shall be full line size as indicated on drawings.

D. Start-up:

(1) Verify that piping system has been flushed, cleaned and filled.

(2) Prime pump, vent air from casing and verify that rotation is correct. Do not start or run pump in dry condition to avoid damage to mechanical seals.

(3) Lubricate motor and pump bearings in accordance with manufacturer's recommendation and Section 22 00 00 - General Plumbing Requirements, Part 3, under LUBRICATION.

(4) Verify removal of disposable startup strainer in suction diffuser and turn them over to Owner after several days' operation.

(5) Perform field mechanical balancing, if necessary, to meet vibration tolerance specified in Section 23 05 50 - Vibration Isolation.

3.05 METERS

A. Verify transmission of signal to Building Automation System.

3.06 VALVE BOXES:

A. Mount bottom of box at 60" (1520 mm) above finished floor. Adjust height as required to match wall material pattern.

B. Orient valve to allow closing the door when valve is both open and closed.

C. Seal pipe penetrations with silicone caulk.

D. Mount identification placard onto valve box door.

3.07 CONNECTIONS

A. Provide appliance connectors at ranges, ovens and other appliances, which require that they be relocated before accessing gas connection. Do not use appliance connectors for water heaters or for other equipment or appliances, which do not require that they be relocated before accessing gas connection.

B. Install shut off valve at each appliance. Provide valved connection at main for equipment and appliances furnished by others.

C. Shutoff valves shall be accessible in case of emergency; installed minimum of 5 ft (1.5 m) from equipment. Provide shutoff valves at each piece of equipment.

3.08 WELDER QUALIFICATIONS

A. Welding procedures, welders, and welding operators for building service piping to be in accordance with certified welding procedures of National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing.

B. Before metallic welding is performed, submit Welding Procedure Specification together with Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.

C. Before polyethylene fusion welding is performed, submit certification that welders to be used on this project have successfully demonstrated proper welding procedures in accordance with Code of Federal Regulations, Title 49, Part 192, Section 192.285.

D. Before welding is performed, submit Standard Welding Procedure Specification together with Procedure Qualification Record as required by Section IX of ASME Boiler and Pressure Vessel Code.

E. Welded joints shall be made in conformance with latest provision of Code for Pressure Piping, ANSI Standard B31-8 - Gas Transmission and Distribution Systems. elds to be made by qualified welders experienced in piping work. Welding, piping fabrication, etc. shall be in accordance with ASME Code, State Codes, and Welding Manual of Mechanical Contractors Association of America.

F. Architect or Engineer reserves right to test work of welder employed on Project, at Contractor's/Owner's expense. If work of welder is found to be unsatisfactory, welder shall be prevented from doing further welding on project and defective welds replaced at no additional cost to Owner.

3.09 TESTING

A. Test above ground steel gas piping with dry compressed air at 50 psi (345 kPa) for 2 h. Soap test of each joint shall be done to detect leaks during 2 h period. No loss of pressure allowed during test period. No piping shall be concealed until successfully tested.

B. Test underground polyethylene gas piping at 50 psi (345 kPa) with dry air for 2 h. No loss in pressure allowed. Defective joints shall be cut out, pipe repaired, and retested. No piping may be backfilled until successfully tested.

C. Types and extent of non-destructive examinations required for pipe welds are as shown in Table 136.4 of ASME Code for Pressure Piping, ANSI/ASME B31.1 - Power Piping. If requirements for non-destructive examination are to be other than that stated above, degree of examination, and basis for rejection shall be matter of prior written agreement between fabricator, or Contractor and purchaser.

D. Local regulating and governing agencies may require periodic testing of seismic valve's ability to shut-off gas flow during seismic event. Follow procedures specified by local governing agency for test.

3.10 CLEANING

A. Before actuation of gas system, flush system with dry nitrogen to ensure clean system free of oil and construction debris.

END OF SECTION 22 16 00

SECTION 22 21 14 - PLUMBING SPECIALTIES

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section covers material specialties for piping systems.

B. All components installed on water systems defined in Section 22 11 18 shall comply with NSF-372 to be compliant with requirement for lead content of <0.25% maximum weighted average.

1.02 RELATED WORK

A. Section 01 81 13 - Certification Requirements

B. Section 22 05 94 - Domestic Water Systems Balance

C. Section 22 11 18 - Water Distribution System

D. Section 22 13 14 - Sanitary Waste and Storm Drainage Systems

1.03 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.04 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.05 LEED SUBMITTAL DOCUMENTATION

A. VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant.

1.06 SUBMITTALS

A. Manufacturer's technical data for the following:

(1) Thermometers

(2) Pressure gauges

(3) Pressure relief valves

(4) Strainers

(5) Backflow preventers

(6) Flexible connections

(7) Air vents

(8) In-line trap sealers

(9) Flashings

(10) Safings

B. Shop drawings on items specified herein.

C. Certificates: Submit performance testing certificates for reduced pressure backflow preventers and double check backflow preventers.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials herein specified shall be new unless otherwise noted.

2.02 THERMOMETERS

A. Manufacturers: Miljoco, Taylor, Trerice, Weksler, Winters and Weiss equal to Trerice number listed

B. Thermometers shall be 9” die cast aluminum case and frame, double strength glass window, adjustable angle stem, permanently stabilized glass tube with mercury free indicating fluid, readable scale with gradations from 30°F to 240°F. Provide brass extension neck sockets of appropriate length. Trerice Series No. A400 (old catalog number BX91400).

2.03 THERMOMETER SOCKETS AND TEST WELLS

A. Brass construction with threaded connections suitable for thermometer bulbs and control sensing devices, well length suitable for pipe diameter with extended neck as required to suit pipe insulation. Trerice 5550 Series.

B. Test wells for stainless steel piping shall be same material as piping.

2.04 PRESSURE GAUGES

A. Manufacturers: Ashcroft, Marsh, Marshalltown, Miljoco, Taylor, Trerice, U.S. Gauge, Weiss, and Winters, equal to Trerice number listed

B. Pressure gauge shall be 4-1/2” die cast aluminum case, double strength glass window, readable dial scale with gradations from 0 to 200 psi (1378.95 kPa), phosphor bronze bourdon tube, brass socket. Provide shutoff valve with pressure gauge, Trerice Series No. 600.

C. Gauge accuracy shall meet ASME B40.1 Grade 1A (1% full scale).

D. Pressure gauges shall be calibrated for the following pressure ranges:

(1) Domestic Water: 0 to 160 psi (1103.16 kPa) at 2 psi (13.79 kPa) increments

(2) Medical Air: 0 to 100 psi (689.48 kPa) at 1 psi (6.89 kPa) increments

2.05 PRESSURE RELIEF VALVE

A. Manufacturers: Apollo, Cash-Acme, Consolidated, Kunkle, Lonergan, and Watts

B. Bronze body, resilient seat/seal, ASME Section VIII, stainless steel spring

2.06 STRAINERS

A. Manufacturers: Apollo, Hoffman, Keckley, Metraflex, Mueller, Watts, Wheatley or Zurn

B. Strainers shall be comparable to regulator or control valve specified. Strainers shall be "Y" type for liquid service to 300 lbs WOG at 210°F, with 20 mesh stainless steel screen. Body material shall be compatible with installed piping, stainless steel, or FDA approved, heat fused, epoxy coated interior.

2.07 BACKFLOW PREVENTER

A. Reduced Pressure Zone Backflow Preventers:

(1) Manufacturers: Apollo, Cla-Val, Febco, Watts or Zurn, equal to model listed in schedules on drawings

(2) 3/4” through 2”: Lead free cast copper silicon body, resilient check valve seats, shut-off valves, Y-pattern strainer with bronze body and stainless steel screen, drain line air-gap fitting, bronze test cocks, certified in accordance with ASSE 1013 and AWWA C511

(3) 2-1/2” through 10”: Lead free body, stainless steel housing, EPDM elastomers, OS&Y isolation valves, drain air-gap fitting, bronze test cocks, certified in accordance with ASSE 1013 and AWWA C511

B. Double Check Valve Backflow Preventers:

(1) Manufacturers: Cla-Val, Febco, Apollo or Watts, equal to model listed

(2) 2-1/2” through 10”: Cast iron body, bronze trimmed check valves, OS&Y gate valves, bronze test cocks, certified in accordance with ASSE 1015 and AWWA C506, UL listed or FM approved

C. Double Check with Vent (DCV) Backflow Preventers:

(1) All bronze construction with stainless steel trim, union connections, 175 psi (1206.58 kPa) pressure rating, 250°F temperature rating, and conforming to ASSE Standard 1012. Watts No. 9D.

2.08 IN-LINE TRAP SEALER

A. Manufacturers: Mi-Gard by Mifab, Quad Close Trap Seal by Jay R. Smith, Sure Seal by Rector Seal, Trap Guard by Proset, Green Drain by Green Drains Inc., or ZShield by Zurn

B. Inline trap sealer shall be ABS plastic housing and neoprene rubber diaphragm, silicone, or Elastomeric PVC material with self-closing bottom. In-line trap sealer shall conform to ASSE 1072.

2.09 FLEXIBLE CONNECTIONS

A. Bronze, braided flexible hose or neoprene twinsphere connectors by Mason Industries with 150 psi (1034.21 kPa) WOG working pressure rating.

B. Alternate manufacturers are Redflex, Resistoflex and Flexonics.

2.10 AIR VENTS

A. Manual Air Vents: Bell and Gossett Model 4V, 125 psi (861.84 kPa) pressure at 210°F temperature, or approved equal. Use 1/2” ball valve for main pipes.

2.11 FLASHINGS

A. Elastomer Membrane Roofing:

(1) Pipe clamps, Fernco Series 1056 flex coupling with Series 300 stainless steel clamps.

B. Built-Up Roofing:

(1) 4 lb/ft2 sheet lead, to 18” beyond drain perimeter.

(2) Preformed lead vent collar, 4 lb/ft2 sheet lead, to 18” beyond vent perimeter; 18” minimum square base flange.

(3) Nobleflex roof drain flashing of Chloraloy and 20 lb/ft2 asphalt saturated roofing felt bonded together.

2.12 SAFINGS

A. 4 lb/ft2 sheet lead, to 18” beyond edge of drain on all sides.

B. Chlorinated polyethylene (CPE) as manufactured by Noble Company under trade name Chloraloy 240.

C. Polyvinyl Chloride (PVC) shower pan line, 40 mil (1.016 mm) thickness, ASTM D4551.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide thermometers where indicated on drawings. Thermometers shall be easily read from floor or maintenance platforms. Calibrate thermometers to ensure accuracy.

B. Install pressure gauges where indicated on drawings. Gauges shall be easily read from floor or maintenance platforms. Provide extensions as required to make gauges easily readable. Calibrate gauges to ensure accuracy.

C. Install backflow preventers as indicated on drawings. Flush debris from strainers. Certified tester shall test reduced pressure zone backflow preventers to verify that functions are operational. Route vent line to adjacent hub drain.

D. Install strainers for equipment including pumps, meters, backflow preventers, reducers and regulators, and as shown on drawings.

E. Install in-line trap sealer as recommended by manufacturer.

F. Install flexible connections for base mounted pumps and other vibrating equipment.

G. Install air vents at high points in water systems where air may collect.

H. Safing:

(1) Install safing for floor drains. Extend safing to 18” from edge of drain. Safing shall be clamped to floor drain body and pitched to drain to weep holes. Floor drains installed in unexcavated areas do not require safing.

(2) Where core drilled floor drain installation into existing floor slab has been approved by A/E, drain strainer inlet shall be grouted in place with non-shrink epoxy concrete approved by Structural Engineer.

(3) Install safings for showers. Concrete floor shall be smooth and free of dirt. Seal joints per manufacturer's recommendations and turn up sides minimum of 6” above curb or maximum water level. Safing shall clamp into drip pan of floor drain and be secured by flashing clamp to assure drainage into weep holes of drain body. Inside vertical corners of showers shall have 12” strips 6 ft above floor, extend 6” in each direction and bottom to overlap pan 3”.

(4) Membrane roofing material, preformed elastomer pipe pots, and flashing seams are provided by Roofing Contractor for pipe penetrations and drain flashing. Plumbing Contractor shall provide drain flashing clamps and stainless steel strap clamps for piping penetrations. Coordinate with General Contractor to facilitate sealing drain flashing and pipe penetrations.

I. Flashing:

(1) Coordinate flashings on roof closely with Roofing Contractor. Install flashings as required to insure proper vapor barrier and as directed by Architect.

(2) Install flashing for roof drains and overflow drains. Flashing shall extend minimum of 18” beyond edge of drain and shall be clamped into drain body.

(3) Roof penetrations for corrosive or acid vent systems shall be preformed EPDM vent pot with flex coupling pipe clamp collar.

3.02 TESTING

A. Safings shall be subject to standing water test to detect leaks and proper drainage to weep holes of floor drain.

END OF SECTION 22 21 14

SECTION 22 33 14 - WATER HEATING EQUIPMENT

PART 1 GENERAL

1.01 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions of Contract, Supplementary Conditions, and sections under Division 01 General Requirements.

1.02 QUALITY ASSURANCE

A. Water heating equipment shall conform to State and Local Codes, meet national standards, and be certified by respective organization and bear its stamp.

1.03 SUBMITTALS

A. Shop drawings on items specified herein.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials specified herein shall be new unless otherwise noted.

2.02 HEAT EXCHANGERS (PLATE AND FRAME TYPE)

A. Manufacturers: Aerco, Bell and Gossett, Cemline, Lochinvar, PVI, or approved equal

B. Heat exchangers shall be plate and frame or brazed plate type with removable gasketed plates constructed and stamped in accordance with the latest ASME Code. Each unit shall be registered with National Board of Boiler and Pressure Vessel Inspectors.

C. Heat exchangers shall be suitable for working pressure of 150 psi (1034.21 kPa) and test pressure of 195 psi (1344.48 kPa).

D. Heat exchange plates shall be 304 or 316 stainless steel with gasketing material suitable for potable water systems and compatible with hot water heating system chemical treatment.

E. End plate shall be stainless steel, studded for flange connection.

F. Furnish units with epoxy coated structural steel framework as required to adequately support assembled plates.

G. Heat exchangers used for domestic water heating shall be double wall type construction and be lined with same material as plate.

H. Construct nozzles, where used, of same material as plates.

I. Fouling margin shall be 10% minimum.

J. Refer to Water Heater Schedule for water heater capacity.

2.03 HOT WATER STORAGE TANK

A. Manufacturers: Same as heat exchanger manufacturer.

B. Domestic hot water storage tanks shall be commercial, UL-listed, vertical storage tank with ASME pressure and temperature relief valve.

C. Tank shall be glass-lined steel or stainless steel, ASME rated for 150 psi (1034.21 kPa). Tank shall have removable magnesium anode rod (if required), pressure and temperature relief valve, drain valve, polyurethane insulation, and painted steel jacket.

D. Provide thermometers on inlet and outlet to tank.

E. Refer to Water Heater Schedule for water heater storage tank capacity.

2.04 THERMAL EXPANSION TANK

A. Manufacturers: Amtrol, Goulds, Wessels

B. Expansion tank shall be precharged, diaphragm-type tank designed for hot water systems. Tank shall be ASME rated for 125 psig (861.84 kPa) and come with fixed rubber bladder, air charge fitting, steel base ring stand (floor mounted tanks only), factory primed and enamel painted exterior, and ASME relief valve. Materials exposed to water to be NSF or FDA approved for potable water service.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install water heaters as recommended by manufacturer. Provide final connections as required. Coordinate water heater location with other Contractors.

B. Initial start up and balancing service shall be provided by representative of manufacturer.

END OF SECTION 22 33 14

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section lists plumbing fixtures and accessories including method of installation.

1.02 RELATED WORK

A. Section 01 81 13 - Certification Requirements

B. Section 22 11 18 - Water Distribution System

C. Section 22 13 14 - Sanitary Waste and Storm Drainage Systems

1.03 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.04 LEED PERFORMANCE REQUIREMENTS

A. All water closets (toilets), urinals, private lavatory faucets, and showerheads must be WaterSense labeled.

B. All plumbing fixtures must meet the following baseline flow rates:

(1) Water closets (toilets): 1.28gpf

(2) Urinals: 0.125gpf

(3) Public lavatory (restroom faucet): 0.35gpm

(4) Private lavatory faucet: 0.35gpm

(5) Kitchen faucet: 1.5gpm

(6) Showerhead: 1.5gpm

C. Purchase product from manufacturer that has an EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, use products that have a compliant embodied carbon optimization report or action plan.

1.05 LEED SUBMITTAL DOCUMENTATION

A. Provide plumbing fixture cutsheet with WaterSense label.

B. Provide manufacturer's cutsheet with the fixture's flowrate.

C. Provide manufacturers EPD conforming to ISO 14025 and EN 15804, or ISO 21930 and having at least a cradle to gate scope. If applicable, provide a compliant embodied carbon optimization report or action plan.

1.06 SUBMITTALS

A. One package of manufacturer's technical data for all items. Submittal shall be assembled brochure, showing cuts and full detailed descriptions for each item.

B. Shop drawings on items specified herein.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials as specified shall be new unless otherwise noted.

B. Vitreous china fixtures shall be of highest quality, non-absorbent, hard-burned, and vitrified throughout.

C. Enameled ware shall be quality cast iron of uniform thickness and density, glazed to uniform depth and high gloss rubbed smooth, without chips or flaws, craze, or cracks, and completely acid resisting.

D. Stainless steel fixtures shall be 302/304 types of non-corrosive steel, 18 ga self-rim for cabinet sinks, 14 ga for free standing compartment type sinks. Sink material shall have satin finish and coved corners, with faucet holes punched to match specified faucet fitting.

E. Precast receptors and shower basins shall be "terrazzo" concrete (stainless steel in vivarium). Receptor and basin colors shall be standard colors unless otherwise noted. Assembly of drain to waste piping shall be made from floor level on which basin or receptor is installed.

F. Insulation for traps and supplies shall be molded closed cell vinyl insulation and shall meet ASTM E84 for flame and smoke spread. Insulation shall be vandal resistant and be color as listed.

2.02 MANUFACTURERS

A. Plumbing fixtures shall be provided from list of approved manufacturers. Home Market, Generic Broker, or Wholesaler’s house brands are not acceptable.

B. Water closets, urinals, and lavatories: American Standard, Kohler, Sloan, TOTO, or Zurn equal to number listed

C. Water Closet Seats: Bemis, Beneke, Centoco, Olsonite or Zurn equal to number listed

D. Flush Valves: American Standard, Kohler, Sloan, TOTO, or Zurn equal to number listed

E. Stainless Steel Sinks: Advance Tabco, Elkay or Just equal to number listed

F. Electric Water Coolers: Elkay, Halsey-Taylor, Haws, or Oasis equal to model listed

G. Mop Basins (Janitor Sinks): Fiat, Mustee, Stern-Williams, or Zurn equal to number listed

H. Emergency Eyewashes and Showers: Acorn, Bradley, Chicago Faucets, Guardian, or Speakman, equal to number listed

I. Manual Faucets: Chicago Faucet, T and S Brass, or Zurn equal to number listed

J. Sensor Activated Faucets: American Standard, Chicago Faucets, Kohler, Sloan, TOTO or Zurn equal to model listed

K. Fixture Traps: Engineered Brass Company, Kohler, McGuire, or Zurn equal to number listed

L. Insulated Traps and Supplies: McGuire or True-Bro equal to model listed

M. Supplies and Stops: Brasscraft, Engineered Brass Company, Kohler, LSP Aqua-Flo or McGuire equal to number listed

N. Shower Valves and Mixing Valves: Acorn, Leonard, Powers or Symmons equal to number listed

O. Hose bibs and wall hydrants: Zurn or approved equal

2.03 CARRIERS AND SUPPORTS

A. Carrier manufacturers shall be Josam, J.R. Smith, Wade, Watts or Zurn, as outlined herein, with models suitable to fixture and use intended. Provide carriers with adjustable faceplate, rectangular steel uprights and at least 3 bolt lugs for securing carrier to floor. Adjustable water closet carriers shall be either right or left, single or double, horizontal or vertical as suggested by drawings and riser diagrams.

(1) Water Closet: Adjustable face plate, rear support for single carries, barrier-free fixtures mounted with top of bowl at 17” from finished floor, .

(2) Urinal: Rectangular uprights, bearing plate, barrier-free fixtures mounted with rim 17” maximum from finished floor, J.R. Smith 0637.

(3) Lavatory: Concealed arms, rectangular steel uprights, J.R. Smith 700-M31.

2.04 WATER CLOSETS AND URINALS

A. Provide appropriate gaskets for fixture installation.

B. Provide bolts with chromium plated caps, nuts and washers.

2.05 WATER CLOSET SEATS

A. Heavy duty, elongated bowl, open front, plastic seat less cover, with stainless steel self-sustaining hinge, white, Bemis 1955-SSCT.

2.06 DRAINS

A. Lavatories: Chrome plated brass grid drain, 1-1/4” seamless tailpiece, McGuire 155A

B. Barrier-free Lavatories: Chrome plated brass offset grid drain, 1-1/4” seamless tailpiece, McGuire 155WC

C. Stainless Steel Sinks: Chrome plated brass grid drain, 1-1/2” seamless tailpiece, McGuire 152

D. Stainless Steel Scullery Sinks: Stainless steel, 1-1/2” diameter tailpiece with perforated grid strainer, Elkay LK18

E. Laboratory Sink: Refer to Division 12.

2.07 TRAPS

A. Lavatories: P-traps shall be chrome plated brass body with cleanout plug, 17 ga seamless tubular wall bend, cast brass slip nuts and wall escutcheon. Trap size to match fixture connections.

B. Sinks: P-traps shall be chrome plated brass body with cleanout plug, 17 ga seamless tubular wall bend, cast brass slip nuts and wall escutcheon. Trap size to match fixture connections.

C. Laboratory Sinks: Corrosion resistant p-trap, refer to Section 22 66 53 for material.

2.08 STOPS AND SUPPLIES

A. Lavatories: Angle pattern, lock shield cap, loose key handle, copper alloy control valve body, stem and gland nut, 1/2” NPT inlet x 3/8” compression outlet, McGuire LF2165LK

B. Sinks: Angle pattern, lock shield cap, loose key handle, copper alloy control valve body, stem and gland nut, 1/2” NPT inlet x 1/2” compression outlet, McGuire LF2167LK

C. Electric Water Cooler: Angle pattern, lock shield cap, loose key handle, copper alloy control valve body, stem and gland nut, 1/2” NPT inlet x 1/2” compression outlet, McGuire LF2167LK

D. Laboratory Sinks: Angle pattern, lock shield cap, loose key handle, copper alloy control valve body, stem and gland nut, 1/2” NPT inlet x 1/2” compression outlet, McGuire LF2167LK

2.09 PROTECTIVE PIPE INSULATION COVERS

A. Manufactured plastic wraps for covering plumbing fixture hot and cold water supplies, trap and tailpieces shall comply with Americans with Disabilities Act (ADA) requirements.

B. Lavatories: Offset strainer, p-trap and angle stop and supply insulation cover, white, True-Bro Lav Guard 2

2.10 PLUMBING FIXTURES

A. Refer to Schedule on drawings for detailed fixture selection criteria not contained herein.

2.11 LABORATORY FIXTURES

A. Refer to Schedule on drawings for detailed fixture selection criteria not contained herein.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing fixtures as recommended by manufacturer. Caulk around fixtures mounted on irregular surfaces such as tile or stone with silicone sealant, same color as fixture.

B. Support fixtures with proper carrier for each use. Ensure that carrier is solidly anchored to prevent rocking whatever piping is used. Anchor bolts in carrier foot shall extend 3” minimum into concrete slab.

C. Fixture carriers shall be suitable for securing each plumbing fixture in place solidly, yet allowing its removal when necessary. Carriers shall be capable of mounting "Barrier Free" fixtures at suitable heights.

D. Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.

E. Install barrier free fixtures in compliance with local code and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27” above finished floor to avoid contact by wheelchair users.

F. Return fixture waste and supply piping into wall as high as practical under fixture. Provide accessible shutoff in fixture supply. Protect "barrier free" supply and drain piping with white colored wrap neatly trimmed to prevent contact with hot or sharp surfaces by user.

G. Coordinate with Electrical Contractor for electronic sensor wiring necessary to install "sensor" operated fixtures. Provide "shockstops" at supplies to solenoid activated fixtures.

H. Provide individual supplies to fixtures and rough-in fixture piping with adequate support to prevent movement fore, aft and laterally. Provide additional blocking as required.

I. Install flush valves for barrier-free water closets with operator handle facing wide side of toilet stall.

J. Provide unions at water connections to drinking fountains and electric water coolers.

3.02 PROTECTION

A. Protect finished surfaces of fixtures from accidental damage or discoloration by use of protective covering.

3.03 CLEANING

A. Prior to Owner acceptance, clean fixtures with compounds recommended by manufacturer and remove stains and marks from surrounding walls and countertops.

END OF SECTION 22 40 00

SECTION 22 40 14 - EQUIPMENT BY OTHERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Items specified herein shall be provided by Plumbing Contractor to make equipment provided by others and Owner functional.

1.02 RELATED WORK

A. Section 22 11 18 - Water Distribution System

B. Section 22 13 14 - Sanitary Waste and Vent System

C. Section 22 21 14 - Plumbing Specialties

1.03 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions of Contract, Supplementary Conditions, and sections under Division 01 General Requirements.

1.04 SUBMITTALS

A. One package of manufacturer's technical data for all items. Submittal shall be assembled brochure, showing cuts and full detailed descriptions for each item.

B. Shop drawings on items specified herein.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials specified herein shall be new unless otherwise noted.

2.02 GENERAL LAB EQUIPMENT

A. Provide isolation valves at all points-of-connection to lab equipment for domestic water, non-potable water, compressed air, laboratory vacuum, and lab gases. Refer to 22 11 18, 22 61 14, 22 62 14, and 22 63 14 for specific information.

2.03 ICE MACHINES

A. Provide isolation valve on domestic water supply. Refer to Section 22 11 18 for specific information.

B. Provide water hammer arrestor on domestic water supply. Refer to Section 22 11 18 for specific information.

C. Provide dual check backflow preventer on domestic water supply. Refer to Section 22 21 14 for specific information.

D. Provide indirect waste pipe from ice machine to local drain. Refer to Section 22 13 14 for specific information.

2.04 DISHWASHERS

A. Provide isolation valves on domestic water supplies. Refer to Section 22 11 18 for specific information.

B. Provide water hammer arrestors on domestic water supplies. Refer to Section 22 11 18 for specific information.

PART 3 EXECUTION

3.01 INSTALLATION

A. Plumbing Contractor shall install items specified herein as recommended by respective manufacturers. Final connections of waste, water, air, gas, etc., shall be installed by Plumbing Contractor as directed by equipment manufacturer. Incidental items, such as, adapters and unions required to make final connection shall be provided by Plumbing Contractor.

B. Coordinate rough-in sizes and elevations with equipment supplier before proceeding with work.

END OF SECTION 22 40 14

END OF DIVISION 22

DIVISION 23 - HEATING, VENTILATING AND AIR CONDITIONING

SECTION 23 00 00 **GENERAL HVAC REQUIREMENTS**

SECTION 23 05 13 **MOTORS FOR MECHANICAL EQUIPMENT**

SECTION 23 05 14 **VARIABLE FREQUENCY DRIVE (VFD) SYSTEM**

SECTION 23 05 29 **MECHANICAL PIPING AND EQUIPMENT SUPPORTING DEVICES**

SECTION 23 05 50 **VIBRATION ISOLATION**

SECTION 23 05 94 **WATER SYSTEMS TEST AJUST BALANCE**

SECTION 23 05 95 **AIR SYSTEMS TEST ADJUST BALANCE**

SECTION 23 07 00 **MECHANICAL SYSTEMS INSULATION**

SECTION 23 08 00 **COMMISSIONING OF HVAC SYSTEMS**

SECTION 23 09 01 **CONTROL SYSTEMS INTEGRATION**

SECTION 23 09 02 **CONTROL VALVES AND DAMPERS**

SECTION 23 09 03 **CONTROL INSTRUMENTATION**

SECTION 23 09 23 **DIRECT DIGITAL CONTROLLERS AND NETWORKS**

SECTION 23 21 16 **PIPE AND PIPE FITTINGS**

SECTION 23 21 18 **VALVES**

SECTION 23 21 20 **PIPING SPECIALTIES**

SECTION 23 21 23 **PUMPS**

SECTION 23 31 14 **DUCTWORK**

SECTION 23 33 14 **DUCTWORK SPECIALTIES**

SECTION 23 34 00 **FANS**

SECTION 23 36 00 **AIR TERMINAL DEVICES**

SECTION 23 37 13 **DIFFUSERS, REGISTERS AND GRILLES**

SECTION 23 41 14 **FILTERS**

SECTION 23 72 14 **HEAT RECOVERY EQUIPMENT**

SECTION 23 73 25 FACTORY FABRICATED HEAT RECOVERY UNITS

SECTION 23 73 28 FACTORY FABRICATED CUSTOM AIR HANDLING UNITS

SECTION 23 81 26 SPLIT-SYSTEM AIR CONDITIONERS

SECTION 23 82 14 HEATING AND COOLING TERMINAL DEVICES

SECTION 23 82 16 COILS

SECTION 23 82 39 UNIT HEATERS

SECTION 23 00 00 - GENERAL HVAC REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. Specification requirements defined in Division 20 of this Specification apply to, and are in addition to the work associated with equipment, systems, materials, and installation requirements specified in Division 23. Contractor shall provide the requirements specified in Division 20 to obtain complete systems, tested, adjusted, and ready for operation.

1.02 RELATED WORK

A. Section 01 8113 – Certification Requirements

B. Section 20 0000 - General Mechanical Requirements

C. Section 20 0513 - Motors

D. Section 20 0514 - Variable Frequency Drives

E. Section 20 0529 - Piping and Equipment Supporting Devices

F. Section 20 0553 - Mechanical Systems Identification

G. Section 20 0573 - Mechanical Systems Firestopping

H. Section 20 0700 - Mechanical Systems Insulation

1.03 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and sealants used to install HVAC, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants used to install HVAC, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

C. HVAC equipment and ductwork shall be protected and operated in accordance with the project's Indoor Air Quality During Construction Management Plan (IAQMP).

1.04 LEED SUBMITTALS

A. Complete provided Product Data Reporting Form in spec section 01 8113 and provide the following:

(1) VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

(2) VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant.

PART 2 PRODUCTS

2.01 NOT APPLICABLE TO THIS SECTION.

PART 3 EXECUTION

3.01 NOT APPLICABLE TO THIS SECTION.

END OF SECTION 23 00 00

SECTION 23 05 13 - MOTORS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 23 05 14 - Variable Frequency Drive (VFD) System

B. Section 26 29 13 - Enclosed Controllers

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents, including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

A. Product Data including the following:

(1) Manufacturer
(2) Motor nominal power (hp (kW)), voltage, phase, frequency (hz), rotational speed (rpm)
(3) Motor type
(4) Enclosure type
(5) Frame type
(6) Insulation class
(7) NEMA design designation
(8) Service factor
(9) Nominal efficiency at full load
(10) Power factor at full load
(11) Full load amperes
(12) Bearings
(13) Mountings
(14) Dimensions
(15) Weight
(16) Shaft grounding brush for motors driven by Variable Frequency Drives (VFD)

1.04 PRODUCT CRITERIA

A. Motors covered by this Specification shall conform to applicable requirements of NEMA, IEEE, ANSI, and NEC Standards and shall be UL Listed where applicable for service specified.

B. Motors shall be designed for conditions in which they will be required to perform, i.e., general purpose, splash proof, explosion proof, standard duty, high torque, or other special type as required by equipment manufacturers.

C. Select motors so they do not exceed nameplate rating nor operate into service factor to meet specified duty.

D. Motors located inside air handling units or exposed located in outdoor or wash down environments shall have totally enclosed fan cooled (TEFC) or totally enclosed air over (TEAO) enclosures.

E. Motors shall be furnished for starting in accordance with utility requirements and be compatible with starters specified hereinafter or under Division 26 Specifications.

(1) Refer to Section 26 29 13 - Enclosed Controllersfor reduced voltage starting requirements.
(2) Starters for NEMA rated 200 or 230 V motors, 25 hp (18.5 kW) and above shall be reduced voltage starting type.
(3) Starters for NEMA rated 460 V motors, 60 hp (45 kW) and above to be reduced voltage starting type.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials shall be new and guaranteed for service intended.

2.02 ELECTRICALLY COMMUTATED MOTORS (ECM)

A. Motor assembly shall be designed for use on direct drive fans or pumps and shall be electrically commutated, DC, brushless type, specifically designed for use with 120 V or 208-230/277 V, 60 Hz single-phase electrical input or three-phase, 60 Hz electrical input as scheduled.

B. Motor speed shall be variable via compatible input signal and shall be complete with and operated by single-phase integrated controller/inverter that operates wound stator and senses rotor position to electronically commutate stator. Motor shall maintain minimum of 70% efficiency over entire operating range.

C. Motors shall:

(1) have permanently lubricated ball bearings.
(2) be designed for synchronous rotation.
(3) be permanent magnet type with near-zero rotor losses.
(4) be able to be mounted with shaft in horizontal or vertical orientation.
(5) be controllable from local and remote speed-control adjustments.
(6) be designed to overcome reverse rotation without affecting life expectancy.

D. Provide Power Factor Correction / Harmonic Correction module to limit harmonic distortion to less than 10% THDi at input of the filter.

E. Speed Control (Drive):

(1) Motor manufacturer shall provide factory installed PWM speed control drive for local (manual) and remote speed adjustment. Local PWM drive shall be field adjustable with standard screwdriver. Drive shall also be capable of receiving 0-10 VDC signal from DDC controller to control fan or pump speed.
(2) Drive shall provide soft start and adjustable speed change ramp rate.
(3) Drive shall provide motor protection consisting of locked rotor, over-current, and thermal overload protection at minimum.

2.03 INDUCTION MOTORS

A. Voltage Ratings

(1) Refer to equipment schedules and specification sections for voltages required.
(2) Unless otherwise indicated, motors 1/3 hp (0.25 kW) and smaller shall be rated 115 V for operation on 120 V, 1 Ph, 60 Hz service.
(3) Unless otherwise indicated, motors 1/2 hp (0.37 kW) and larger shall be rated:
(a) 460 V for operation on 480 V, 3 Ph, 60 Hz service.
(b) 200 V for operation on 208 V, 3 Ph, 60 Hz service.
(c) 230 V for operation on 240 V, 3 Ph, 60 Hz service.

B. Motors shall be 4 pole (approximately 1750 rpm) unless otherwise noted.

C. Single-phase motors shall be furnished with built-in thermal overload protection.

D. Use NEMA Design B motors, normal starting torque with regreasable ball bearings, and Class B insulation unless specified otherwise or unless manufacturer of equipment on which motor is being used has more stringent requirements.

(1) Bearings shall be rated for minimum AFBMA 9, L-10 life of 26,280 hours (belted) and 200,000 hours (direct-coupled) at full-load.

E. Motors shall be rated continuous duty and have 1.15 service factor unless otherwise noted.

F. Motors Driven by Variable Frequency Drives (VFD)

(1) Motors shall comply with the latest NEMA MG 00001, Section IV, Part 31.
(2) Motors shall have service factor not less than 1.0 at rated load.
(3) Insulation shall be Class F or H.
(4) Furnish each motor with shaft grounding ring utilizing conductive microfiber similar to AEGIS SGR to protect motor bearings from electrical damage.

G. Vibration shall not exceed 0.15" (3.8 mm) per second, unfiltered peak unless otherwise noted.

H. Motors (180 frames and larger) shall have provisions for lifting eyes or lugs capable of safety factor of 5.

I. Full load nominal efficiency of motors 1 hp (0.75 kW) and larger, except special-purpose motors including 2-speed or multi-speed motors, and rewound motors, shall meet or exceed listed values when tested in accordance with IEEE Standard 112 Method B as defined by NEMA MG 00001-12.6C. Efficiency values listed are based on NEMA Premium Efficiency Electric Motors of NEMA MG 00001-2011, Table 12-12.

	Open Drip-Proof Motors			Totally Enclosed Fan-Cooled Motors		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
(hp) ((kW))	(6 pole)	(4 pole)	(2 pole)	(6 pole)	(4 pole)	(2 pole)
1 hp (.75 kW)	82.5	85.5	77.0	82.5	85.5	77.0
1.5 hp (1.1 kW)	86.5	86.5	84.0	87.5	86.5	84.0

	Open Drip-Proof Motors			Totally Enclosed Fan-Cooled Motors		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
(hp) ((kW))	(6 pole)	(4 pole)	(2 pole)	(6 pole)	(4 pole)	(2 pole)
2 hp (1.5 kW)	87.5	86.5	85.5	88.5	86.5	85.5
3 hp (2.2 kW)	88.5	89.5	85.5	89.5	89.5	86.0
5 hp (3.7 kW)	89.5	89.5	86.5	89.5	89.5	88.5
7.5 hp (5.5 kW)	90.2	91.0	88.5	91.0	91.7	89.5
10 hp (7.5 kW)	91.7	91.7	89.5	91.0	91.7	90.2
15 hp (11 kW)	91.7	93.0	90.2	91.7	92.4	91.0
20 hp (15 kW)	92.4	93.0	91.0	91.7	93.0	91.0
25 hp (18.5 kW)	93.0	93.6	91.7	93.0	93.6	91.7
30 hp (22 kW)	93.6	94.1	91.7	93.0	93.6	91.7
40 hp (30 kW)	94.1	94.1	92.4	94.1	94.1	92.4
50 hp (37 kW)	94.1	94.5	93.0	94.1	94.5	93.0
60 hp (45 kW)	94.5	95.0	93.6	94.5	95.0	93.6
75 hp (55 kW)	94.5	95.0	93.6	94.5	95.4	93.6
100 hp (75 kW)	95.0	95.4	93.6	95.0	95.4	94.1
125 hp (90 kW)	95.0	95.4	94.1	95.0	95.4	95.0
150 hp (110 kW)	95.4	95.8	94.1	95.8	95.8	95.0
200 hp (150 kW)	95.4	95.8	95.0	95.8	96.2	95.4
250 hp (185 kW)	95.4	95.8	95.0	95.8	96.2	95.8

J. Single-phase motors for hard starting applications including outdoor applications shall be capacitor start type. Motors for fans and pumps located indoors may be split phase or permanent split-capacitor. Motors shall be equipped with permanently lubricated and sealed ball bearings and shall be selected for quiet operation. Motors 1/8 hp (0.09 kW) and below may be shaded pole type.

(1) Refer to individual equipment section for additional requirements or specific type of motors.

K. 3 Ph, 2-speed motors shall be one winding, consequent pole, variable torque type and 1 Ph, 2-speed motors shall be capacitor start capacitor run type.

L. When submersible pumps are specified, each pump shall include in addition to controls specified, all necessary controls, relays, wiring, etc. that may be required for safety features incorporated in motor design. No submersible motor shall be run or activated until all requirements of motor manufacturer's recommendations have been complied with.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install materials in accordance with drawings, approved Shop Drawings, and manufacturer's recommendations.

END OF SECTION 23 05 13

SECTION 23 05 14 - VARIABLE FREQUENCY DRIVE (VFD) SYSTEM

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 23 05 13 - Motors for Mechanical Equipment
B. Section 23 09 01 - Control Systems Integration
C. Section 23 09 93 - Control Sequences
D. Section 23 21 23 - Hydronic Pumps
E. Section 23 34 00 - Fans
F. Section 23 73 13 - Packaged Indoor Air Handling Units
G. Section 23 73 28 - Factory Fabricated Custom Air Handling Units(Standard or High-End Units)
H. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
I. Section 26 28 16 - Enclosed Switches and Circuit Breakers
J. Section 26 29 13 - Enclosed Controllers

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SYSTEM DESCRIPTION

A. Provide Variable Frequency Drives (VFD) for each pump, fan or other driven equipment sized to accommodate motors shown on drawings or schedules. Provide all VFDs from same manufacturer.
B. VFD manufacturer shall review driven equipment and motors for VFD compatibility. Submit written statement from manufacturer of driven equipment along with VFD shop drawing submittals, indicating verification of compatibility.
C. VFD shall vary speed of its respective fan, pump, or other driven equipment motor in response to either 4-20 mA or 0-10 VDC control signal provided by Control Contractor.
D. VFD system shall consist of the following:
   (1) Variable frequency drive(s)
   (2) UL Listed disconnect device
   (3) Electrical noise attenuation device _____.
   (4) Motor starter for bypass mode operation with VFD/OFF/BYPASS selector and drive input and output isolation contactors where VFD bypass starters are scheduled.
   (5) Internal reactor with minimum 5% impedance or equivalent input line reactor.
   (6) dV/dt Output filter as required to protect motor, based on total length of conductor from VFD to motor(s).
E. Drives shall have SCCR (short circuit current rating) of _____ kA.

1.04 QUALIFICATIONS

A. VFD system shall be furnished by a manufacturer with at least 10 yrs experience in design, construction, and application of VFD.

1.05 SUBMITTALS

A. Product Data for each VFD system including the following:
   (1) Manufacturer's name.
   (2) Identification of system components.
   (3) Type of enclosure, front elevation and plan view, equipment weight, conduit access locations.
   (4) Capacities/ratings/SCCR.
   (5) Warranty.
   (6) System wiring and block diagram showing system components.
   (7) Performance, control, and protection data with specified features clearly shown.
   (8) Operating and monitoring devices with specified features clearly indicated.
   (9) Start-up operation, maintenance, spare parts, and field tests.
   (10) Manufacturer's installation instructions.
   (11) BACnet point mapping table including point adresses, and read only or writable status.
   (12) Other appropriate data.

B. After quality assurance tests are complete, submit written certification that drive and components have passed factory quality assurance tests.

C. Submit product and performance data on electrical noise attenuation device if required to meet electrical noise criteria specified. Isolation transformer is not electrical noise attenuation device.

D. Submit printed list of settings for all items that require setting during startup or list of Factory Default Parameters.

1.06 ELECTRICAL NOISE CRITERIA

A. Provide harmonic mitigation components as scheduled. Refer to VFD Schedule for components required.

1.07 START-UP OPERATION AND MAINTENANCE DATA

A. Provide services of factory trained engineer or technician to approve installation; start-up test and adjust for proper operation; and instruct and train Owner's representative in operation and maintenance of VFD systems. Provide minimum of 4 h of Owner training for VFD system.

B. Should drive operation be deficient, make changes necessary to bring units into compliance with specified performance requirements. Cost of changes and retest shall be borne by drive manufacturer.

C. Upon completion of this service, submit report signed by manufacturer's service representative, including start-up and test log. _____

D. Include additional 2 yr (total 3 yrs) warranty for VFD system, covering parts, labor, and travel expenses.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Manufacturers: ABB, Allen Bradley/Rockwell Automation, Emerson, Eaton, Danfoss, GE, Schneider Electric, Yaskawa, or Toshiba

2.02 FABRICATION

A. VFD shall be variable torque, solid state, microprocessor-based control, modular design for standard induction AC motor.

B. VFD components shall be factory mounted and wired in NEMA _____ enclosure with lockable door handle.

C. VFD components shall be factory mounted and wired in Motor Control Center enclosure.

D. VFD components shall be factory mounted and wired in Plenum Rated Enclosure with lockable door handle.

E. Circuitry shall be plug-in, plug-out modular. Printed circuit boards shall have protective coating to reduce corrosion.

F. Unit shall conform to NEMA and NEC standards and be CSA, UL or ETL Listed. Control circuitry shall be electrically isolated from power circuitry. Entire assembly panel shall have UL or equivalent panel sticker.

G. Invertor section shall be pulse width modulated (PWM) design and most current insulated gate bipolar transistors (IGBTs) technology.

H. For motors 600 hp (450 kW) or larger, inverter section may be current source design.

2.03 PERFORMANCE REQUIREMENTS

A. Input: 460 (+10%, -15%) VAC, 3 Ph, 60 (± 2) Hz

B. Output: 460 VAC, 3 Ph, 10 to 60 Hz

C. Operating Environment: VFD Manufacturer shall rate VFDs for specific environment in which they will operate.

(1) Ambient temperature:

(a) Indoor applications: _____

(b) Outdoor applications: ____

(2) Relative humidity: 95% non-condensing.

(3) Elevation above sea level: _____

D. Linear acceleration and deceleration adjustable from 5 to 60 seconds. Provide adjustable v/Hz ratio and low speed boost features.

E. Output Current Rating: Continuous full load output current rating of drive shall not be less than that listed for motor of equivalent horsepower (kilowatts) in NEC table 430-150.

F. Drive overload capacity to be minimum 110% of motor FLA based on NEC ratings for one minute.

G. Time to Shutdown: Inversely proportional to square of overload current (t = k/I2).

H. Motor Regeneration Protection: Unit shall have capacity of dissipating regeneration energy up to VFD current rating without damage to or shutdown of drive.

I. Output Frequency Stability: ± 0.5% of base frequency in 24 h throughout range of rated operating conditions.

J. Output Voltage Regulation: ± 2% of maximum rated output voltage.

K. Output voltage rise time shall be no faster than 1000 V/micro sec measured at the motor terminals. If power and control cable between VFD and motor is more than100 ft (30.5 m), provide dv/dt output filter.

L. Power Loss Ride-Through: 1 cycle.

M. Linearity (speed reference to output frequency): ±1.0%

N. Input Power Factor: Minimum of 0.95 regardless of speed and load.

O. Minimum drive efficiency as percent of input power shall be as follows:

Percent Load	Frequency (Hz)			
	60	50	30	15
100	97	96	95	90

2.04 CONTROL FEATURES

A. VFD speed control circuit shall accept either 4-20 mA DC or 0-10 VDC isolated ungrounded transmitter signal in automatic mode and from manual speed control keypad in manual mode.

B. Provide adjustable minimum and maximum speed settings (0 - 100%) for both auto and manual mode. Initial minimum setting shall be 25%.

C. Provide adjustable automatic reset for fault trips, except short circuit type faults. After selected number of unsuccessful restart attempts, drive shall be shut down. Number of restart attempts and time interval between resets shall be selective.

D. When unit shuts down due to power outage, unit shall be capable of being restarted manually or automatically.

E. VFD shall be capable of starting into rotating loads spinning in any direction.

F. Provide critical frequency avoidance circuit with at least 3 field adjustable bands to avoid operation at speeds, which cause excessive vibration in driven equipment.

G. Provide isolated ungrounded output signal to indicate drive percent of speed or drive frequency.

H. _____

2.05 COORDINATION WITH BUILDING AUTOMATION SYSTEM (BAS)

A. Furnish each VFD with digital communication bus card for BAS use. Coordinate with Control Contractor for specific interface requirement.

B. Provide contacts (1 NO and 1 NC contact) for remote input control of start/stop function for VFD mode.

C. Provide three pre-programmed relay/contacts (1 NO and 1 NC contact each) for remote output indication of VFD fault condition, motor run status based on current or torque above minimum threshold, and bypass mode if bypass is specified.

D. Provide analog input point for hardwired direct speed control.

2.06 PROTECTION FEATURES

A. Power circuits shall be protected by electronic protection circuits. Electronic protection circuits shall provide orderly shutdown without blowing fuses and prevent component loss under the following abnormal conditions.

(1) Instantaneous overcurrent and over voltage trip of output.

(2) Solid state protective circuit shall provide NEC motor running overload protection tested in accordance with UL 991.

(3) Power line overvoltage or undervoltage.

(4) Phase sequence detection or insensitivity to incoming power phase sequence.

(5) Single and 3 Ph short circuit protection.

(6) Control circuit malfunction.

(7) Overtemperature.

(8) Ground fault for all 3 phases.

B. VFD shall protect itself from damage due to phase-to-phase or phase-to-ground faults without fuse blowing or use of isolation transformers. VFDs which require isolation transformers to provide ground fault protection are not acceptable.

C. In addition, provide the following protection features.

(1) Input line-to-line and line-to-ground transient protection up to 3000 V

(2) Control circuit transformer fusing

(3) Grounded control chassis

(4) Diagnostic indication

(5) One set of three (3) spare fuses for each size or type of VFD

D. VFD shall employ adjustable torque limit control, which shall override speed command and decrease frequency while maintaining correct volts/hertz ratio whenever load level surpasses VFD design level or set point.

2.07 OPERATING AND MONITORING DEVICES

A. The following functionality shall be provided and may be controlled via touchscreen/keypad:

(1) Hand-Off-Auto device

(2) Operating mode selector device marked "Hand-Off-Auto"

(3) Manual speed control keypad

(4) Power on indication

(5) Drive run indication

(6) Drive fault indication with testable feature

(7) Fault reset device

B. Speed indicating meter or digital indication (0 - 100%) calibrated in percent speed or frequency meter with 0 to 90 Hz scale to indicate motor speed.

C. Integral digital programming and operating display which shows Hz, Percent Output Current, Output Voltage, Percent Output Power, Operating Parameters and their values, and Diagnostic Fault Codes. In addition, Keypads shall be incorporated to facilitate digital programming of drive adjustments. Analog potentiometer adjustments are not acceptable.

D. Provision shall be included to provide selectable programming security by inhibiting program parameter changes with password security.

E. Control shall incorporate microprocessors for operator interface, diagnostics, and fault managements, and power management.

F. Optional programming software, which includes provision for serial communication with drive, shall be available for shipment at time of equipment order placement.

G. Fault buffers to sequentially store last 4 faults. Parameter and fault information to be stored in non-volatile memory.

H. VFD with Manual Bypass Starter:

(1) Manual selector switch to select power through VFD or bypass line with label marked "VFD/OFF/BYPASS".

(2) Electrically-interlocked VFD/BYPASS contactors with padlocking capability on input side of VFD and bypass starter. Interlock shall be accomplished such that shorting together of any 2 control circuit points cannot cause non-selected device to be energized. Provide electrically-interlocked device that connects only output of selected starting device (VFD or bypass starter) to VFD system output lug. Single shorting of any 2 control circuit points shall not cause both VFD and bypass starter outputs to be interconnected.

I. Redundant VFDs:

(1) Manual selector switch to select power through VFD1 or VFD2 with label marked "VFD1/AUTO/VFD2".

(2) Electrically-interlocked VFD1/VFD2 contactors with padlocking capability on input side of VFDs. Interlock shall be accomplished such that shorting together of any 2 control circuit points cannot cause non-selected device to be energized. Provide electrically-interlocked device that connects only output of selected starting device to system output lug. Single shorting of any 2 control circuit points shall not cause both VFD outputs to be interconnected.

2.08 QUALITY ASSURANCE TESTS

A. Complete drive assembly shall be factory tested with actual AC induction motor, 100% load and temperature cycled within environment chamber at 104°F (40°C). Documentation of test shall be furnished to verify successful completion of test at Engineer's request.

2.09 DISCONNECT DEVICE

A. Provide integral switch to disconnect incoming electrical power to units. Disconnect device shall be UL Listed devices:

(1) Enclosed molded case breaker; ampere rated and providing over current protection.

(2) Fused switch may be used as option. Fused switch shall be ampere rated and provide overcurrent protection. Non-time delay fuses shall be sized for connected drive and motor.

B. Disconnect device shall be capable of being padlocked in OFF position and complying with OSHA Requirements. Operating handle shall indicate whether switch is “ON” or “OFF”.

C. Switch shall have cover interlock to prevent unauthorized opening of switch door when handle is in “ON” position and to prevent closing of switch mechanism with door open. Provide defeater mechanism to defeat the interlock for user required access.

2.10 MOTOR CONTROL EQUIPMENT (BYPASS STARTERS)

A. Bypass starter shall be NEMA or IEC Rated device of the following:

(1) Electromechanical across-the-line starter with solid state overload protection for 50 hp (37 kW) or smaller.

(2) Solid-state reduced voltage starter consisting of SCR based power section, logic control board, and solid state overload protection for 60 hp (45 kW) or larger.

(3) Reduced voltage auto transformer - electromechanical starter with solid-state overload protection for 60 hp (45 kW) or larger.

(4) Bypass shall include high speed fuses for VFD (not in bypass circuit).

(5) Service switch to disconnect power to VFD (not in bypass circuit).

2.11 VFD BYPASS EQUIPMENT (DUTY/STANDBY DRIVES)

A. Provide redundant drive bypass where scheduled. Drive assembly shall include two individual VFDs of the scheduled capacity, _____

B. VFD Bypass equipment shall include the following:

(1) All harmonic mitigation, control features, protection features, operation and monitoring devices and disconnecting means shall be provided independent of the bypass drive.

(2) Provide input and output contactors to disconnect the non-operational drive. Either VFD shall be fully serviceable when not operating, without interrupting operation of functional drive.

(3) _____

(4) Remote transfer to bypass functionality.

(5) Manual selector switch to select VFD A or VFD B operation.

(6) Manual selector switch to allow testing, adjustment, and programming of either VFD A or VFD B while the alternate VFD is operating.

(7) Indication lights to annunciate VFD A Fault, VFD B Fault, VFD A Run, VFD B Run

(8) Bypass shall include high speed fuses for input protection of each VFD.

C. Primary/Redundant drive assembly shall be provided with _____ points of electrical connection for input conductors, and _____ points of electrical connection for output conductors to motors. _____.

2.12 INPUT LINE REACTORS

A. Series line reactors shall be designed for harmonic filtering service and shall be UL component recognized. Construction shall be copper wire wound on steel cores. Inductors shall be 3-phase. Series line reactors shall be sized per harmonic analysis and appropriately for total connected load. Design maximum temperature rise for inductors shall be 239°F (115°C).

B. Inductors shall be air-gapped to avoid saturation. Inductance shall be measured under full load and shall be within ± 5% of design value.

C. Line reactor shall be included integral to drive enclosure.

(1) Where mounting line reactor in VFD enclosure is not possible, enclosure shall be steel with enamel finish and no knockouts. Enclosure shall match construction of VFD enclosure and shall have hinged lockable cover. Screened openings shall be provided for enclosure ventilation. Enclosure shall be built with integral mounting brackets for platform or wall mounting. Coordinate location with other trades. Provide disconnect switch for line side filters.

D. Internal DC bus chokes are acceptable when providing equivalent performance to AC line reactors specified.

2.13 PASSIVE HARMONIC FILTER

A. Tuned passive harmonic filter shall be designed to remove harmonics generated by a 6-pulse VFD in a power distribution system. The filter shall be designed to minimize the possibility of resonance and other system problems associated with power factor correction in the presence of harmonic distortion.

B. Inductive and capacitive elements shall be arranged in a series configuration and tuned to resonate just below the harmonic frequency for which it is designed to filter. The inductance internal to the filter combined with the series line reactor shall act to limit current surges between the capacitor and other plant electrical equipment and shall minimize the possibility of equipment or capacitor damage due to such surges.

C. Capacitors shall be high-endurance cells with a voltage rating capable of handling the nominal system voltage plus 10% over voltage. Capacitors shall be contained in sealed metal cans. The RMS current in each capacitor cell at full load shall not exceed 150% of the current at no load to limit the stress on capacitors.

D. Both tuning inductors and series line reactors shall be designed for harmonic filtering service and for slowing the rate of rapid current changes. The core shall be made of laminated, magnetic steel. Windings shall consist of copper wire or copper foil. Completed inductors shall be impregnated using solid epoxy resin.

E. Filter shall be housed internal to drive enclosure.

F. Filter shall include contactor to disengage circuit capacitor if VFD is operating at 50% electrical power capacity or less. Set point shall be field programmable. Activation of contactor shall leave inductor in circuit for benefits of added circuit impedance. _____

2.14 DV/DT OUTPUT FILTER

A. dV/dt motor-protecting output filter shall be a low-pass filter consisting of a gapped, three phase iron core inductor, AC-rated capacitor and wire-wound resistors.

B. The filter shall be rated for application at a maximum fundamental system frequency of 60 Hz at nominal system voltages up to 600V.

C. Ambient temperature of operation shall be 104°F (40°C).

D. The combined inductance, capacitance and resistance of the Output Filter shall be specifically designed to reduce voltage waveform dV/dt.

2.15 SPARE PARTS

A. Additional enclosure cooling fan for each different type of drive.

B. Additional keypad/touch screen for each different type of drive.

PART 3 - EXECUTION

3.01 INSPECTION

A. Visually inspect equipment and components at time of delivery. Submit report to Engineer with list of items or deficiencies to be corrected.

3.02 PROTECTION

A. Protect VFD cabinets from dust/dirt during storage and operation until turned over to Owner.

B. If VFDs are not furnished with internal air filter racks, provide temporary filter media to protect VFD cabinets and replace filter media as required.

3.03 INSTALLATION

A. Install VFD system in accordance with details, approved submittals and manufacturer's instructions and recommendations.

B. Provide field low voltage wiring of VFD system components. Provide field interconnecting wiring between VFD and filters, line reactors and/or by-pass starter if bypass starter is specified and the wiring is not installed at factory. Install wiring in metal conduit and in accordance with Electrical sections of this Specification and applicable Electrical Code.

C. Provide control wiring between interlocks in VFD control circuits and driven motor's disconnect switches. Interlock VFD control circuits with driven motor's disconnect switches where such motor disconnect switches are provided. Disconnecting on-line motor shall shut down VFD. VFD shall restart upon reconnection of motor.

D. Do not connect ground from one unit to another unit's cabinet.

E. Use separate conduits for incoming and outgoing power conductors from each unit.

F. Use separate conduit for control wiring for each unit. Do not combine control wiring with power wiring.

G. Use minimum 18 ga shielded wiring with ground for control wiring.

H. Unless otherwise indicated, mount VFD so that display and keypad are at approximately 5 '-0" (1.5 m) to 5 '-6" (1.7 m) above floor.

I. Install floor mounted drives on 3-1/2" (90 mm) high concrete housekeeping pad.

3.04 START UP

A. VFD manufacturer shall perform field inspection, start-up and testing of VFD in accordance with procedures as defined by manufacturer for proper operation.

B. Adjust critical frequency avoidance feature to step over frequencies which cause excessive vibration in driven equipment.

C. Where provided, adjust passive harmonic filter capacitor contactor setpoint to ensure drives do not present leading power factor to electrical systems during low-load conditions.

END OF SECTION 23 05 14

SECTION 23 05 29 - MECHANICAL PIPING AND EQUIPMENT SUPPORTING DEVICES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 23 05 48 - Mechanical Seismic Anchorage and Restraints

B. Section 23 07 00 - Mechanical Systems Insulation

C. Section 23 05 50 - Vibration Isolation

D. Section 23 31 14 - Ductwork

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

A. Provide all supporting devices not provided as part of building structure or indicated on structural drawings or structural details, as specified and as required for proper supporting, anchoring, and guiding of piping, equipment, materials, and systems.

B. Support for all conditions of operation, including variations in installed and operating weight of equipment, piping, and ductwork, to prevent excess stress and allow for proper expansion and contraction.

1.04 SUBMITTALS

A. Product Data for each piping system for all pipe sizes and all applicable equipment including the following:

(1) Manufacturer's name

(2) Model numbers

(3) Materials of construction and load ratings lbs (kg).

(4) Schedule of hangers and support devices with pipe support spacing.

(5) Insulated pipe supports along with application chart or table including pipe support spacing.

(6) Insulation protection saddles and weight bearing insulation table.

(7) Details and calculations for sizing supplementary steel utilized for trapeze or specially designed supports.

(8) Structural attachments, concrete inserts, and concrete anchors. Submit ICC-ES Evaluation Report for each type of concrete insert and anchor.

(9) Calculations and drawings for concrete inserts and anchors for each application shall be submitted when requested by Owner or Engineer.

(10) Drawings showing specific locations of any weld attachments to structure, including weight supported by such attachments.

(11) Drawings showing specific locations of any suspended loads which exceed 100 lbs (45 kg) within joist chord panel to be attached to open web steel joist structural members. Include weight supported by such attachments. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord.)

(12) Equipment mounting devices

(13) Pipe guides and anchors

(14) All other appropriate data

B. Submittals in PDF format shall be organized using PDF bookmarks per detailed instructions on assembling submittal packages identified under Submittal Requirements section of 23 00 00 - General Mechanical Requirements.

C. Calculations and drawings prepared by the Contractor's structural engineer shall be submitted bearing the stamp of a licensed Structural Engineer registered in project jurisdiction for approval.

1.05 DESIGN CRITERIA

A. Materials and application of pipe hangers and supports shall conform to the latest requirements of ANSI B31/ASME B31.1 Code for Pressure Piping and MSS Standard Practice SP-58-2018 (Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation), except as supplemented or modified herein.

B. Support materials shall be steel or stainless steel unless specifically indicated.

C. Support devices shall be factory fabricated and have published load ratings.

D. Unless otherwise indicated, design supports, anchors, and related components with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.

E. Determine maximum deflection using the following equation.

F. Maximum deflection of support members, including trapeze supports, shall be in accordance with the following equation, but shall not exceed 0.3" (7.5 mm):

(1) D = L/240

D = Max deflection in inches (millimeters)

L = Support member length in inches (millimeters)

G. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard black, primed, galvanized, or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application and corrosive atmospheres. Coat cut edges, welds, or any damaged finish with galvanized paint.

(1) Corrosive atmospheres include the following locations:

(a) Exterior locations

(b) Chemical storage and hazardous waste storage rooms

(c) Food service/kitchen areas

(d) Locker/shower rooms

(e) Meter pits

(f) Utility tunnels

(g) Cage wash rooms (dirty and clean)

(h) Sterilizer/autoclave rooms

H. Materials in contact with pipe shall be galvanically compatible with piping material to eliminate conductive path for galvanic corrosion. Where piping and support materials have galvanic potential, provide galvanic separation, such as nonmetallic coating or inserts between piping and metallic supports. Pipe insulation is acceptable galvanic separation. Galvanic potential shall be determined by table below:

	Galvanized Steel	**Carbon Steel**	**Stainless Steel (Type 304 or 316)**	**Copper Brass Bronze**
Copper, Brass, Bronze	Yes	Yes	No	NA
Stainless Steel (Type 304 or 316)	Yes Note (1)	Yes Note (1)	NA	
Carbon Steel	No	NA		
Galvanized Steel	NA			

(1) Required where stainless steel surface area near interface is equal or greater than steel surface area

I. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish. Paint type shall be approved by Architect.

J. Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe. Coordinate with work specified in Section 23 07 00 - Mechanical Systems Insulation.

K. In addition to hangers specified in this Section, piping connected to pumps, compressors, and similar rotating or reciprocating equipment shall have vibration isolation hangers or supports for specified distance from such equipment. Refer to Section 23 05 50 - Vibration Isolation for required distance.

L. Piping connected to coils, which are in assembly mounted on vibration isolators, shall have vibration isolation hangers or supports as indicated above. Piping connected to coils, which are in equipment where fan assembly is separately isolated by vibration isolators and flexible connections, does not require additional vibration isolation hangers or supports. Refer to Section 23 05 50 - Vibration Isolation for flexible connections, vibration isolators and additional requirements.

M. Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

N. Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.

O. Unless otherwise indicated, continuous insert channels are not allowed.

P. Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.

Q. Refer to Structural Documents and ICC-ES Evaluation Report for application of concrete inserts and concrete anchors.

R. Lateral braces shall be designed and detailed to apply loads as directly as possible to structural floor slabs, roof decks, or other building lateral elements. Braces shall not be applied to bottom flanges of steel beams or bottom chords of open web steel joists.

S. Coordinate proposed weld attachments to building structure. This may result in use of welding codes or standards, which may apply to "structural work" and may necessitate repair of fireproofing and/or extension of fireproofing to support members. Cost for this workshall be the responsibility of Contractor.

T. Top or bottom chords of open web steel joists may be used to support loads, provided total load within panel does not exceed 100 lbs (45 kg) and load is placed concentric to joist. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord.)

U. Where fire rated fiberglass products are used for channel and support devices, the following properties shall apply:

(1) Flame Spread Properties

(a) Polyester Fiberglass (PF) Class 1 ASTM E84

(b) Vinylester Fiberglass (VF) Class 1 ASTM E84

V. Fasteners including concrete anchors for seismic application shall have ICC Evaluation Service Report (ESR) and meet requirements of local authorities.

PART 2 - PRODUCTS

2.01 STRUCTURAL SUPPORTS

A. Unless specifically indicated on structural drawings, design and provide all supporting devices including miscellaneous steel (angles, channels, beams, etc.), required for proper support of piping, equipment, and materials.

B. Supporting steel _____ shall be stainless steel.

2.02 PIPE HANGERS AND SUPPORTS (METALLIC)

A. Manufacturers: Anvil, Erico, Tolco, PHD, National Pipe Hanger Corporation, or B-Line, equal to Anvil figures listed. Corresponding MSS Type is indicated where applicable.

B. Clevis and Roller Type Hangers:

System	Pipe Size	Clevis	Roller
Hot Pipes with Insulation (105°F (41°C) and above)	2" (50 mm) and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2" (65 mm) to 6" (150 mm)	---	171 (MSS Type-41), 181 (MSS Type-43)
	8" (200 mm) and larger	---	171 (MSS Type-41)
Ambient Bare Pipes (61°F (16°C) to 104°F (40°C))	2" (50 mm) and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2" (65 mm) and larger	260 (MSS Type-1), 216 (MSS Type-4)	---
Cold Pipes with Insulation (33°F (1°C) to 60°F (15°C))	2" (50 mm) and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2" (65 mm) and larger	260 (MSS Type-1), 295 (MSS Type-1)	---
Cold Pipes with Insulation (32°F (0°C) and below)	2" (50 mm) and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2" (65 mm) to 6" (150 mm)	260 (MSS Type-1)	171 (MSS Type-41), 181 (MSS Type-43)
	8" (200 mm) and larger		171 (MSS Type-41)

(1) For pipe size 2-1/2" (65 mm) and larger, where there is transverse movement at support points due to thermal expansion/contraction, clevis type hangers similar to Anvil Figure 260 (MSS Type-1) may be used if vertical angle of hanger rod is less than 4°.

C. Flat Surfaces (Trapeze, Rack Type):

(1) Use structural steel members such as struts, angles, channels, and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Refer to Part 1 for design criteria. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers, or slides indicated below at each support point.

System	Pipe Size	Straps or Clamps	Rollers	Slides
Hot Pipes with Insulation (105°F (41°C) and above)	2" (50 mm) and smaller	Anvil Klo-Shure	---	---
	2-1/2" (65 mm) and larger	---	171 or 177(MSS Type-41), 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only. Type 4, 5 or 6 for both longitudinal and transverse movement
Ambient Bare Steel Pipes (61°F (16°C) to 104°F (40°C))	6" (150 mm) and smaller 8" (200 mm) and larger	B-Line BVT Unistrut Cush-a-Clamp	---	---
Ambient Bare (Copper) pipes (61°F (16°C) to104°F (40°C))	6" (150 mm)and smaller	B-Line BVT Unistrut Cush-a – Clump		
Cold Pipes with Insulation (33°F (1°C) to 60°F (15°C))	10" (250 mm) and smaller	137 (MSS Type-24)	---	---
	12" (300 mm) and larger	432	171 or 177 (MSS Type-41), 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement.
Cold Pipes with Insulation (32°F (0°C) to 59°F (15°C)) and below)	2" (50 mm) and smaller	243, 244	---	---
	2-1/2" (65 mm) and larger	---	171 or 177 (MSS Type-41), 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement.

D. Vertical Pipe within Wall Cavities

(1) Use clamps, straps, inserts or channels to support pipes concealed in wall cavity. Select members for pipe support types and loading conditions. Refer to Part 1 for design criteria.

(2) Provide clamps, strut channels, insulated supports, or brackets and inserts equal to manufacturer indicated below:

System	Pipe Size	Supports	Clamps, Brackets/Inserts	Pre-insulated Inserts
Hot and Cold Pipes with Insulation	All sizes	Anvil 137	HoldRite 260 series with SBIS bracket, Anvil 262	Anvil Klo-Sure, Pipe Shields A2000
Ambient Bare Steel Pipes (61°F (16°C) to 104°F (40°C))	All sizes	Anvil 137, 138-R	Anvil 262	---

System	Pipe Size	Supports	Clamps, Brackets/Inserts	Pre-insulated Inserts
Ambient Bare Copper Pipes (61°F (16°C) to 104°F (40°C))	All sizes	Anvil CT-138R	HoldRite 260 series with SBIS bracket	---

2.03 INSULATION PROTECTION SHIELDS

A. Anvil Fig. 167 (MSS Type-40) constructed of galvanized carbon steel. Per the latest edition of Standard MSS SP-58, select shield to accommodate outer diameter of insulation. Shield length and gauge for insulation compression strength not less than 15 psi (103 kPa), shall be as follows:

Pipe Size	Length	Gauge
1/4" (8 mm)thru 3" (80 mm)	12" (300 mm)	18 (1.316 mm)
4" (100 mm)	12" (300 mm)	16 (1.621 mm)
5" (130 mm)thru 6" (150 mm)	18" (450 mm)	16 (1.621 mm)
8" (200 mm) thru 14" (350 mm)	24" (600 mm)	14 (2 mm)
16" (400 mm) thru 24" (600 mm)	24" (600 mm)	12 (2.758 mm)

2.04 INSULATED PIPE SUPPORTS

A. Description:

(1) Products designed specifically for weight-bearing support of insulated pipes. Apply products in accordance with manufacturer’s recommendations and requirements indicated below:

(2) Refer to PART 3 – EXECUTION for application of Type A, Type B, and Type C Insulated Pipe Supports specified below.

B. General:

(1) High compressive strength inserts utilized to support loads shall encircle circumference of pipe. Block-style inserts are not allowed.

(2) Supports shall be suitable for hot or cold pipe service as applicable.

(3) Submit chart or table indicating selected model along with pipe sizes, rated loads, support device types and support spacing for each piping system.

(4) Pipe support spacing shall be in accordance with manufacturer's recommendations but shall not exceed maximum spacing indicated under Hanger and Support Spacing in Part 3 of this Section.

(5) Testing of insulation for compressive strength properties shall comply with ASTM D1621.

(6) Insulation thickness shall match adjacent pipe insulation thickness.

(7) Integrity of vapor barrier jacket shall be maintained continuously through support assembly.

(8) Insulated pipe support style shall be specifically selected for the application and shall consider the following criteria at minimum:

(a) Vertical, lateral, and axial support design load limits.

(b) Vertical, lateral, and axial support design travel limits.

(c) Temperature of support, at pipe surface, and ambient conditions.

(d) Test or pre-operational loads that may exceed normal operating conditions.

(e) Material for any items that will be welded directly to the pipe.

(f) Loading and displacements caused by seismic, hydraulic surge, or other forces.

(g) Temperature at support steel.

C. Type A Insulated Pipe Supports (Light Duty)

(1) Description:

(a) Pipe insulation specified in Section 23 07 00 - Mechanical Systems Insulation with insulation protection shields specified in this Section. Weight-bearing inserts are not required.

(b) Type B or Type C supports may be utilized in lieu of Type A supports.

D. Type B Insulated Pipe Supports (Standard Duty):

(1) Manufacturers:

(a) SNAPP ITZ insulation inserts by KB Enterprise, Tru-Balance Insulated Saddles by Buckaroos, Inc., Value Engineered Products, or approved equal.

(b) Klo-Shure 7-series or 9-Series insulation couplings by Hydra-Zorb 7-series for pipes with elasomeric insulation or approved equal.

(c) Type C supports may be utilized in lieu of Type B supports

(d) Contractor may propose to utilize contractor-fabricated insulated pipe supports in lieu of manufactured Type B Supports. Use of contractor-fabricated assemblies is subject to approval of appropriate submittal data. Submit detail drawings of assemblies and product data showing equivalency to specified manufactured products for approval.

(2) Description:

(a) Load-rated assembly consisting of high compressive strength insulation material completely encompassing circumference of pipe, vapor barrier jacket, and insulation protection shield.

(b) Insulation protection shield shall conform to ANSI/MSS SP-58. Shield shall be G90 galvanized steel and shall span full circumference of pipe insulation. Half-shields spanning lower 180 degrees arc of insulation outer circumference will be acceptable when used with clevis hangers.

(c) Axial length of insulation material shall be not less than 9" (230 mm) or 2" (50 mm) longer than insulation protection shields (1" (25 mm) minimum on each end), whichever is longer.

(3) Insulation Materials:

(a) Hot Pipes 105°F (41°C) to 250°F (120°C):

1) Rigid closed cell, polyisocyanurate or phenolic insulation by ITW, Resolco, or Kingspan. Minimum compressive strength shall be 100 psi (690 kPa).

(b) Hot Pipes 251°F (121°C) to 1200°F (650°C):

1) High-density calcium silicate insulation similar to Johns Manville Thermo-12 Gold. Minimum compressive strength shall be 100 psi (690 kPa).

(c) Cold Pipes 60°F (16°C) and below:

1) Rigid closed cell, polyisocyanurate, phenolic insulation similar to ITW, Resolco, Kingspan, or cellular glass insulation similar to Pittsburgh Corning Foamglas.

E. Type C Insulated Pipe Supports (Heavy Duty):

(1) Manufacturers:

(a) Pipe Shields, Inc., Bergen Pipe Supports, or Rilco equal to Pipe Shields models listed.

(b) Unless otherwise indicated, pre-insulated pipe supports shall be as indicated in the following schedule. Model numbers are based on Pipe Shields, Inc.

1) Pipe supported on hangers: Model “A” Series and Model “D” Series

2) Pipe supported on flat surfaces and pipe rollers: Models “A” Series

3) Pipe supported on slides: Model "B" Series with lateral guide or restraint

4) Pipe anchors: Model “C” Series

5) Riser clamps: Model “E” Series with thrust plates. Select proper model for restraint for downward load or upward load.

(c) Contractor may propose to utilize contractor-fabricated insulated pipe supports in lieu of manufactured Type C Supports. Use of contractor-fabricated assemblies is subject to approval of appropriate submittal data. Submit detail drawings of assemblies and product data showing equivalency to specified manufactured products for approval.

(2) Description:

(a) Load-rated assembly consisting of high compressive strength insulation material completely encircling circumference of pipe, vapor barrier jacket system incorporating structural inserts and insulation protection shield/casing where applicable.

(3) Insulation Material:

(a) Water-resistant high density calcium silicate with minimum density of 13 lb/ft³ (208 kg/m³) and compressive strength not less than 100 psi (690 kPa). Thermal conductivity shall be not more than 0.38 Btu in/(hr sq ft °F (0.055 W/m°C at 24°C) at 75°F (23.89°C).

(b) Structural Inserts:

1) Structural inserts used by manufacturer to reinforce between pipe and insulation jacket for clamping devices shall be water-resistant high compressive strength inorganic materials selected by manufacturer for desired combination of structural strength and insulating properties. Structural inserts shall have minimum compressive strength of 600 psi (4140 kPa). Thermal conductivity shall be not more than 0.58 Btu in/(hr sq ft °F (0.84 W/m°C at 24°C) at 75°F (23.89°C).

(c) Jacket:

1) Jacket shall consist of G90 galvanized steel conforming to ASTM A653/A653M and shall provide complete vapor barrier around insulation and bearing surface for protection of insulation.

2) When recommended by manufacturer, use reinforced insulation protection shield at support bearing surface. Insulation shall extend 1" (25 mm) beyond insulation protection shield to maintain vapor barrier integrity.

2.05 HANGER RODS (METALLIC)

A. Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.

B. Rods shall have electroplated zinc or hot dip galvanized finish.

C. Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule. Rod size may be reduced one size for double rod hangers. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated.

Max. Pipe Size With Single Rigid Rod	Rod Diameter	Max Load of Hanger Rod (Not exceeding 650°F (340°C) Service Temp.)
2" (50 mm)	3/8" (10 mm)	730 lbs (330 kg)
3" (80 mm)	1/2" (13 mm)	1350 lbs (610 kg)
5" (130 mm)	5/8" (16 mm)	2160 lbs (610 kg)
8" (200 mm)	3/4" (20 mm)	3230 lbs (1460 kg)
12" (300 mm)	7/8" (24 mm)	4480 lbs (2030 kg)
18" (450 mm)	1" (25)	5900 lbs (2670 kg)
30" (750 mm)	1-1/4" (33 mm)	9500 lbs (4310 kg)

D. Threaded rods are not allowed in clean rooms.

2.06 BOLTS, NUTS, STUDS AND WASHERS

A. ASTM A307, electroplated zinc finish

2.07 ROD ATTACHMENTS

A. Anvil Fig. 290 (MSS Type-17), galvanized finish

2.08 U-BOLTS

A. Anvil Fig. 137 (MSS Type-24), galvanized finish

2.09 BEAM CLAMPS

A. Beam Clamps: Anvil Fig. 133/134 (MSS Type-21), 218 (MSS Type-30), 228 (MSS Type-28 or 29), and 292 (MSS Type-28 or 29)

B. Top Beam Clamps: Anvil Fig. 227 (MSS Type-25)

C. C-Clamps: Anvil Fig. 86, 92 or 93 (MSS Type-19 or 23) with set screw and lock nut

2.10 ADJUSTABLE PIPE SADDLE SUPPORTS

A. Anvil Fig. 264 (MSS Type-38), galvanized finish. Provide Anvil Fig. 63 Type T stanchion with base, galvanized finish, where applicable.

2.11 RISER CLAMPS (BARE PIPE)

A. Anvil Fig. 261 (MSS Type-8), galvanized finish

B. B-Line B3373C, PVC coated carbon steel, in area at pipe contact, for bare copper tubing

C. Proset system, proseal plug and fire-fill for sleeved and cored holes.

2.12 RISER CLAMPS (INSULATED PIPE)

A. Unless otherwise indicated, insulated pipe riser clamps shall be Type C insulated pipe supports. Refer to Insulated Pipe Supports in Part 2.

B. Contractor may propose to utilize contractor-fabricated riser supports. Use of contractor-fabricated riser supports is subject to approval of appropriate submittal data. Submit support detail drawings, bearing stamp of Structural Engineer registered in project jurisdiction for approval. Supports shall be engineered to withstand static and dynamic forces with minimum safety factor of 2.0. Submit insulation details addressing thermal break from building structure and vapor barriers.

2.13 CONCRETE INSERTS (WOODEN FORMED CONCRETE)

A. Anvil Fig. 281 or 282, or Hilti KCM-WF or DeWalt Wood-Knocker II+, suitable for rod diameter and weight supported.

2.14 CONCRETE INSERTS (METAL DECK FORMED CONCRETE)

A. Tolco No. 109DD, DeWalt Pan-Knoker II+, "Bang-It+", Hilti KCM-MD or KCM-PD, or MSCO No. MX34.

2.15 CONCRETE ANCHORS

A. Manufacturers: Hilti, DeWalt or Red Head

B. Anchors shall be selected, sized, and detailed by Contractor's structural engineer registered in project's jurisdiction based on project conditions and in accordance with project building code.

C. Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.

D. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.

E. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.

F. Anchors for seismic load application shall be approved by ICC-ES Evaluation Reports to resist seismic loads and selected to meet project seismic design requirements. Refer to Section 23 05 48 - Mechanical Seismic Anchorage and Restraints and Structural drawings.

G. Anchors shall be zinc plated in accordance with ASTM B633.

H. Select anchors with load ratings based on cracked concrete conditions.

2.16 CONTINUOUS INSERT CHANNELS

A. Manufacturers: Unistrut, Anvil, B-Line, Michigan, Halfen, Hilti, or Kindorf. Brackets inserts and accessories shall be suitable for channel insert selected.

2.17 METAL FRAMING SUPPORT SYSTEM (STRUT SYSTEM)

A. Manufacturers: Unistrut, B-Line Strut Systems, Anvil-Strut, Power-Strut, Erico, Superstrut, Kindorf, Hilti, and Hydra-Zorb

B. Channels shall have epoxy paint or electroplated zinc finish.

C. Channels shall not be lighter than 12 ga (2.5 mm).

2.18 PIPE MOUNTING PEDESTALS

A. Equal to Roof Products & System Corporation consisting of equipment rail, "U" shaped mounting brackets, galvanized threaded rod and cast-iron pipe rollers. Rail shall have built-in raised cant to match roof deck insulation.

2.19 EQUIPMENT RAILS

A. Manufacturers: Roof Products & Systems, ThyCurb, Custom Curb, Inc., or Vent Products equal to Roof Products & Systems Model ER-4 with raised cant style for built-up roofing system. Mounting rails shall be galvanized steel with integral base plate, continuous welded corner seams, factory installed 2" (50 mm) x 4" (100 mm) wood nailer and 18 ga (1.2 mm) galvanized steel counter flashing.

B. Manufacturers: Roof Products & Systems, ThyCurb, Custom Curb, Inc., or Vent Products equal to Roof Products & Systems Model ER-2 for elastic sheet roofing system. Mounting rails shall be galvanized steel with integral base plate, continuous welded corner seams, factory installed 2" (50 mm) x 4" (100 mm) wood nailer and 18 ga (1.2 mm) galvanized steel counter flashing.

C. Mounting rail gauge shall be selected to support equipment adequately but shall be not less than 18 ga (1.2 mm).

D. Height shall be as detailed, but not less than 8" (200 mm) above finished roof.

E. Equipment rails shall span minimum of 2 joists and not cantilever more than 6" (150 mm) where joists are used. Rails shall be level at top with pitch built in when deck slopes 1/4" per ft (21 mm per m) or greater.

2.20 PIPE ROOF PENETRATION PROTECTIONS

A. Manufacturers: Roof Products & Systems, ThyCurb, or Vent Products equal to Roof Products & Systems "RPS-Pipe Portals" consisting of 12" (300 mm) OD prefabricated roof curb, laminated acrylic coated ABS plastic curb cover with EPDM protective rubber cap and stainless steel clamp.

2.21 PIPE GUIDES

A. Unless otherwise indicated, guides shall be equal to Pipe Shields "B" Series, selected by load and movement. Refer to Insulated Pipe Supports in Part 2.

2.22 PIPE ANCHORS

A. Unless otherwise indicated, anchors shall be Type C Insulated Pipe Supports. Refer to Insulated Pipe Supports in Part 2.

B. Contractor may propose to utilize contractor-fabricated anchors. Use of contractor-fabricated anchors is subject to approval of appropriate submittal data. Submit anchor system detail drawings, bearing stamp of Structural Engineer registered in project jurisdiction for approval. Anchors shall be engineered to withstand static and dynamic forces with minimum safety factor of 3.0. Submit insulation details addressing thermal break from building structure and vapor barriers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend piping hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping and ductwork shall be supported independently from other piping or ductwork.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Do not support equipment, or piping from metal roof decking or ceiling grid.

H. Install adequate supports so as not to over stress either piping or equipment to which piping is connected.

I. Refer to Section 23 00 00 - General Mechanical Requirements for requirements of personnel injury protection guards for supporting devices.

J. Where pipe weight-distributing shields are installed exposed in open spaces, firmly affix shields to insulated piping at minimum two points with zip ties to prevent shields from shaking loose and falling.

3.02 HANGER AND SUPPORT SPACING

A. Space pipe hangers and supports for horizontal pipe accordance with the following schedule, with exceptions as indicated herein:

B. Steel Pipe (Standard Weight and Extra Strong):

Pipe Size	Max Spacing
1-1/4" (32 mm) and smaller	7 ft (2.1 m)
1-1/2" (40 mm)	9 ft (2.7 m)
2" (50 mm)	10 ft (3.0 m)
2-1/2" (65 mm)	11 ft (3.3 m)
3" (80 mm)	12 ft (3.6 m)
4" (100 mm)	14 ft (4.2 m)
6" (150 mm)	17 ft (5.1 m)
8" (200 mm)	19 ft (5.8 m)
10" (250 mm) and larger	20 ft (6.0 m)

C. Steel Pipe (Standard Weight and Extra Strong):

Pipe Size	Max Spacing
1-1/4" (32 mm)	7 ft-0" (2.1 m)
1-1/2" (40 mm)	9 ft-0" (2.7 m)
2" (50 mm)	10 ft-0" (3.0 m)
2-1/2" (65 mm)	11 ft-0" (3.3 m)
3" (80 mm)	12 ft-0" (3.6 m)

D. Copper Tube (Unless Otherwise Noted):

Pipe Size	Max Spacing
3/4" (19 mm) and smaller	5 ft (1.5 m)
1" (25 mm) 1-1/4" (32 mm)	6 ft (1.8 m)
1-1/2" (40 mm)2-1/2" (65 mm)	8 ft (2.4 m)
3" (80 mm) and larger	10 ft (3.0 m)

E. Plastic Pipe

(1) PP-R Pipe:

Pipe Size	Max Spacing
2" (50 mm) and smaller	4 ft (1.2 m)
3" (80 mm)	6 ft (1.8 m)

(2) PEX-a Pipe:

Pipe Size	Max Spacing
3" (80 mm) and smaller	2 ft-8" (810 mm)

(a) Pipe can be supported with PEX-a Pipe Channel as an alternate. Spacing for supports with pipe channel shall be 6 ft (1.8 m) for pipes 3/4" (19 mm) and smaller and 8 ft (2.4 m) for pipes 1" (25 mm) and larger.

(b) Provide copper tube size riser clamps at base of each floor and at top of every other floor with mid-floor guides for hot water systems.

(c) Provide copper tube size riser clamps at base of each floor and top of every 4 floors with mid-floor guides for cold water systems.

(3) Support plastic pipe at all changes of direction. Adequate consideration shall be given to piping expansion.

F. Maximum spacing shown above may be restricted by strength of attachment to building structure. Submit data with calculations with published load ratings showing attachment to be utilized and maximum spacing allowable for that type of attachment and pipe size.

G. Spacing less than indicated above may be required to conform to building structure design or loading limitations.

H. Spacing less than indicated may be required depending on compressive strength of pipe insulation and insulated pipe supports.

I. If pipe size changes between support points, maximum spacing shall be based on the smaller pipe size.

J. If trapeze hangers are used to support multiple services, spacing shall be based on the most restrictive pipe size and material on trapeze hanger.

K. For non-metallic pipe, follow manufacturer's installation recommendations in addition to requirements noted herein.

L. Install supports for vertical piping and anchors as recommended by pipe manufacturer.

M. Place hangers and supports to meet requirements of Section 23 21 16 - Pipe and Pipe Fittings or specific pipe system sections, with regard to pitch for drainage and venting and clearance between services.

N. Hangers and supports shall bear on outside of insulation when pipes are to be insulated.

O. Place hangers and supports within 1 ft (0.3 m) of each fitting, such as elbows and tees, and at each valve, strainer, and other piping specialty for piping 4" (100 mm) and larger.

P. Place hanger or support at first elbow upstream of pump inlet and first elbow downstream of pump outlet.

3.03 RISER SUPPORTS

A. Insulated Piping:

(1) Unless otherwise indicated, support vertical piping as indicated below:

(2) Support vertical piping at _____ of riser, secured and anchored to building structure. Provide guides on vertical piping. Use spring hangers at _____ of riser and at take offs from riser at each floor. Use spring hangers for minimum 3 hangers away from top and bottom elbows and from each take off at riser.

(3) Guide vertical piping 2-1/2" (65 mm) and smaller at every floor. Guide 2-1/2" (65 mm) and larger at every other floor. Spring hangers (Type 6) and guides (Type VSG) are specified in Section 23 05 50 - Vibration Isolation.

B. Bare Piping:

(1) Unless otherwise indicated, maximum vertical support spacing for ambient bare steel and cast-iron pipes shall be 15 ft (4.6 m).

(2) Maximum vertical support spacing for other piping including copper tubing and plastic piping shall be 10 ft (3 m).

(3) Install riser clamps and intermediate supports as required.

(4) Rest riser clamps on floor or on pipe sleeve.

(5) Bare piping above 120°F (50°C) such as steam vents shall be supported per insulated piping requirements.

3.04 INSULATED PIPE SUPPORTS APPLICATION

A. Install insulated pipe support at each support point of insulated pipe.

B. Pipe Size 1-1/2" (40 mm) and Smaller:

(1) Use Type A insulated pipe support. Pipe insulation specified in Section 23 07 00 - Mechanical Systems Insulation shall be continuous through support points.

(2) Use one shield (bottom) for clevis hanger.

(3) Use 2 shields (top and bottom) for roller hanger/support or strap/clamp support. Apply 2 metal straps to hold top and bottom shields onto insulation jacket.

(4) Type B or Type C insulated pipe supports may be used in lieu of Type A support.

C. Pipe Size 2" (50 mm) through 5" (125 mm):
   (1) Use Type B insulated pipe supports. Refer to Part 2 for acceptable products.
   (2) Type C insulated pipe supports may be used in lieu of Type B supports.
D. Pipe Size 6" (150 mm) and Larger:
   (1) Use Type C insulated pipe supports. Refer to Part 2 for applicable products.

3.05 PIPE FLOOR SUPPORTS

A. Unless specifically shown otherwise, use adjustable pipe saddle supports with associated stanchion similar to Anvil Fig. 264/63. Select supports properly for weight and height of pipe stand.

3.06 CONCRETE INSERTS

A. Concrete insert application, size, loading, and placement shall be this Contractor’s responsibility.
B. Coordinate placement of inserts before concrete pour. Minimize use of inserts and anchors after concrete pour.

3.07 BEAM CLAMPS

A. Provide locknut for hanging rod at clamp.
B. C-clamps are allowed for rod size 3/8" (9 mm) or smaller and only for static loading such as air piping, cold water piping, fire protection piping and, other similar piping. C-clamps are not allowed for hot water piping and steam and steam condensate piping, except hot water runouts to terminal heating devices.
C. C-clamps are not allowed for open web steel joist application.
D. C-clamps are not allowed for seismic application.

3.08 TRAPEZE SUPPORTS

A. Construct trapeze supports with struts, angles, or channels and hang them by inserts or welded beam attachments and rods.
B. If trapeze supports are used to support multiple services, support spacing shall be based on the most restrictive pipe size and material on trapeze supports.
C. Refer to Part 1, Design Criteria for maximum deflection allowed for trapeze supports.

3.09 PIPE MOUNTING PEDESTALS

A. Use for all piping on roof. Install bottom of pedestal flat on roof deck, insulate exterior of pedestal, flash, and counter flash.

3.10 EQUIPMENT RAILS

A. Provide equipment rails with sufficient height to provide code required space for roof servicing below the supported equipment.
B. Provide supplemental roof/structure framing for the required anchoring of the rail bases per wind load requirements.
C. Provide supplemental lateral wind bracing between rails when supporting outdoor condensing units or similar items to meet wind load design requirements.
D. Flashing shall be by Division 07. Provide counter flashing as specified and secure to wood nailer with stainless steel truss head screws.

3.11 CONCRETE ANCHORS

A. Anchor application, size, and placement shall be Contractor’s responsibility.

3.12 PIPE ROOF PENETRATION PROTECTIONS

A. Install at points where pipes are penetrating roof. Install as shown and according to manufacturer's installation instructions.

3.13 PIPE GUIDES

A. Install where shown on drawings.
B. For manufactured expansion devices, install minimum of 2 pipe guides at each side of manufactured pipe expansion device. Locate first guide no more than 4 pipe diameters from expansion device and second guide at 14 pipe diameters from first guide. Install intermediate guides in accordance with guide spacing data recommended by manufacturer or the following table, whichever is more stringent.

MAXIMUM DISTANCE BETWEEN INTERMEDIATE GUIDES				
Pipe Size	**Pipe Operating Pressure**			
	0-50 psig (0-345 kPa)	51-100 psig (350-690 kPa)	101-150 psig (695-1035 kPa)	151-200 psig (1040-1380 kPa)
3" (80 mm)	21 ft (6.4 m)	19 ft (5.8 m)	17 ft (5.2 m)	16 ft (4.8 m)
4" (100)	35 ft (10.6 m)	29 ft (8.8 m)	25 ft (7.6 m)	22 ft (6.7 m)

MAXIMUM DISTANCE BETWEEN INTERMEDIATE GUIDES				
Pipe Size	**Pipe Operating Pressure**			
6" (150 mm)	57 ft (17.0 m)	44 ft (13.0 m)	37 ft (11.0 m)	32 ft (9.7 m)
8" (200 mm)	66 ft (20.0 m)	52 ft (15.0 m)	45 ft (13.0 m)	40 ft (12.0 m)
10" (250 mm)	91 ft (27.0 m)	69 ft (21.0 m)	58 ft (17.0 m)	51 ft (15.0 m)
12" (300 mm)	107 ft (32.0 m)	79 ft (24.0 m)	66 ft (20.0 m)	58 ft (17.0 m)
14" (350 mm)	115 ft (35.0 m)	85 ft (25.0 m)	71 ft (21.0 m)	62 ft (18.0 m)
16" (400 mm)	127 ft (38.0 m)	94 ft (28.0 m)	78 ft (23.0 m)	68 ft (20.0 m)

C. If anchor is located within 4 pipe diameters from expansion joints, guides need not be installed on anchor side.

3.14 PIPE ANCHORS

A. Install anchors where shown on drawings or in conjunction with expansion joints, loops and swing joints as required to allow proper expansion and contraction of piping without damage to structure, equipment or piping.

B. Do not anchor piping to concrete block walls, wood, or partition walls.

END OF SECTION 23 05 29

SECTION 23 05 50 - VIBRATION ISOLATION

PART 1 GENERAL

1.01 RELATED WORK

A. Section 20 0529 - Piping and Equipment Supporting Devices

B. Section 23 3314 - Ductwork Specialties (Duct Flexible Connections)

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESIGN CRITERIA

A. Isolate all motor driven mechanical equipment, unless otherwise noted, from building structure, and from systems that they serve, to prevent equipment vibrations from being transmitted to structure. Unless specifically indicated, follow the latest edition of ASHRAE Application Handbook - Sound and Vibration Control, or manufacturer's recommendations for isolator selection whichever is more stringent.

B. Select and locate isolators to produce uniform loading and deflection. Use minimum of 4 isolators to support each piece of equipment.

C. Select vibration isolation devices based on the lowest operating speed of equipment.

D. Vibration Criteria:

(1) All rotating equipment shall operate at speeds less than 80% of their true critical speed. Unless otherwise required, equipment shall be balanced according to recommendations given in the following schedules.

(2) Vertical vibration of rotating equipment shall not be greater than levels indicated. Vibration shall be measured on equipment. If equipment has inertia base, allowable vibration level is reduced by ratio of equipment weight alone to equipment weight plus inertia base weight.

	Maximum Allowable
Equipment Speed	Vibration Displacement
rpm	Peak-to-Peak (mil)
100 to 200	10
200 to 300	6
300 to 600	4
600 to 1000	3
1000 or 2000	2
over 2000	1

E. Following field installation, each fan and pump over 25 hp shall be balanced in accordance with the following maximum rms velocity levels:

(1) Fans: 0.15 inch (3.81 mm)/sec

(2) Pumps:

0.16 inch (4.06 mm)/sec	for 30 hp and smaller
0.18 inch (4.57 mm)/sec	for 40 through 60 hp
0.20 inch (5.08 mm)/sec	for 75 through 100 hp

1) Allowable field pump vibration values above are based on HI 9.6-2000, Figure 9.6.4.12.

F. Final in-field balance shall be measured with each fan over 25 hp installed on springs specified for unit. Fans shall be loaded with design static pressure. Measurement shall be carried out in vertical, horizontal and axis planes at impeller shaft bearing location.

G. Submittals in PDF format shall be organized using PDF bookmarks per detailed instructions on assembling submittal packages identified under Submittal Requirements section of 20 0000.

1.04 SUBMITTALS

A. Submit Shop Drawings including, but not limited to, the following:

(1) Manufacturer's name

(2) Isolator type and model number

(3) Materials of construction and finish

(4) Dimensional data

(5) Load ratings (lbs)

(6) Isolator free and operating heights
(7) Static deflections
(8) Isolation efficiency based on lowest operating speed
(9) All other appropriate data

1.05 SUPERVISION, INSPECTION AND CERTIFICATION

A. Vibration isolation manufacturer or qualified representative shall provide supervision to assure correct installation and adjustment of isolators. Upon completion of installation and after system is put into operation, manufacturer or manufacturer's representative, shall make final inspection, adjustment, and submit report to Engineer in writing, certifying correctness of installation and compliance with Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials used shall retain their isolation characteristics for life of equipment served. Elastomeric materials shall comply with ASTM D2240 and shall be oil-resistant industrial grade neoprene.

B. Isolators shall be treated to resist corrosion.

C. Isolation devices subject to weather shall have either hot-dip or cold-dip galvanized, cadmium plated, or neoprene coated finish after fabrication and be furnished with limit stops to resist wind.

D. Vibration isolator springs shall have minimum additional travel to solid equal to 50% of rated deflection.

E. Ratio of lateral to vertical stiffness of vibration isolators shall not be less than 0.8 or greater than 2.0.

F. Coordinate selection of devices with isolator and equipment manufacturer.

2.02 MANUFACTURERS

A. Mason Industries, Amber/Booth Co., Aeroflex-VMC-Korfund. Vibration Eliminator, Vibro-Acoustics, or Kinetics equal to manufacturer's model listed, except flexible pipe connections.

B. Mason, Metraflex, Proco, Twin City Hose, Engineered Flexible Products (EFP) or Flex-Weld/Keflex for flexible pipe connections.

2.03 TYPE 1 MOUNTS (NEOPRENE PAD)

A. Mason Type Super W, neoprene waffle pads, 50 durometer. Select number and size of pads as required to accept equipment operating weight evenly.

2.04 TYPE 2 MOUNTS (NEOPRENE PAD)

A. Mason Type ND, Mason Type HD, or rails Type RND, double deflection neoprene mounts or hangers with cast-in metal inserts for bolting to equipment.

B. Both surfaces shall be rib molded for skid resistance. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above mountings to compensate for overhang.

2.05 TYPE 3 MOUNTS (UNHOUSED SPRING WITH NEOPRENE)

A. Mason Type SLF, combination spring and neoprene with rib molded base. Spring type isolators shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between baseplate and support.

B. Mountings shall have leveling bolts rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of compressed height of spring at rated load.

2.06 TYPE 4 MOUNTS (RESTRAINED SPRING WITH NEOPRENE)

A. Mason Type SLR, combination spring and neoprene with rib molded base similar to Type 3 above, but shall have housing that includes vertical limit stops to prevent spring extension when weight is removed.

B. Installed and operating heights shall be the same. Maintain minimum clearance of 1/2" around restraining bolts and between housing and spring so as not to interfere with spring action. Limit stops shall be out of contact during normal operations. Use height saving brackets.

2.07 TYPE S BASES (STEEL BASE)

A. Mason Type WF, structural steel bases, rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. Perimeter members shall be beams with minimum depth equal to 1/10 of longest base span between isolators, but not less than 4". Beam depth need not exceed 14" provided that deflection and misalignment is kept within acceptable limits as determined by manufacturer. Employ height saving brackets in all mounting locations to provide base clearance of at least 1" above floor or housekeeping pad.

2.08 TYPE I BASES (INERTIA BASE)

A. Mason Type K, or BMK rectangular or T shaped structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. Base depth need not exceed 12" unless specifically recommended by base manufacturer for mass, rigidity or component alignment. Base depth shall be a minimum of 1/10 of longest base span between isolators, but not less than 6". Forms shall include concrete reinforcement bars welded in place running both ways. Furnish forms with drilled steel members with sleeves welded below holes to receive equipment anchor bolts where anchor bolts fall in concrete locations. Employ height saving brackets in all mounting locations to maintain base clearance of at least 1" above floor or housekeeping pad.

2.09 TYPE 5 HANGERS (SPRING HANGER WITH NEOPRENE)

A. Mason Type 30N, vibration hangers with steel spring and neoprene element in series. Neoprene element shall be molded with rod isolation bushing that passes through hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through 30□ arc before contacting hole and short circuiting spring.

B. Mason Type DNHS may be used where load rating and specified deflection cannot be accommodated by Type 30N.

2.10 TYPE 6 HANGERS (PRECOMPRESSED SPRING HANGER WITH NEOPRENE)

A. Mason Type PC30N, vibration hangers similar to Type 5, but precompressed to rated deflection so as to keep piping or equipment at fixed elevation during installation. Design hangers with release mechanism to free spring after installation complete and hanger is subjected to its full load.

2.11 TYPE 7 HANGERS (SPRING HANGER WITH DEFLECTION INDICATOR)

A. Mason Type HES, steel spring in steel housing including deflection indicator scale. Hangers shall be preset at factory for required load. Select hangers so that actual loads do not exceed rated capacities (lbs).

B. Submittals shall include isolator rated deflection, required deflection and supporting calculation. Calculations shall be made by registered mechanical or civil engineer demonstrating structural adequacy of hanger and that hanger connections to building and pipe are adequate for live and dead loads encountered.

2.12 TYPE 8 HANGERS (SPRING HANGER WITH NEOPRENE)

A. Mason Type 30, W30, or PC30 steel spring located in neoprene cup manufactured with grommet to prevent short-circuiting of hanger rod. Neoprene cup to contain steel washer designed to properly distribute load on neoprene and prevent its extrusion. Spring diameters and hanger box lower hole size to be large enough to permit hanger rod to swing through 30□ arc before contacting hole and short-circuiting spring. Provide hangers with rod attachments or eyebolts on spring end.

2.13 TYPE AG PIPE ANCHORS/GUIDES

A. Mason Type ADA all-directional acoustical pipe anchors and Type VSG guides for vertical piping consisting of telescopic arrangement of 2 sizes of steel tubing separated by minimum 1/2" thickness of heavy duty neoprene and neoprene isolation material. Vertical restraints shall prevent vertical travel in either direction. Allowable loads on isolation materials shall not exceed 500 psi (3447.38 kPa) and design shall be balanced for equal resistance in any direction.

B. Submittals shall include supporting calculations by registered mechanical or civil engineer indicating anchor/guide loads and isolator selection.

2.14 TYPE T THRUST RESTRAINTS

A. Mason Type WB, horizontal thrust restraint consisting of spring element in series with neoprene pad as described for Type 3 mounts with the same deflection as specified for mountings or hangers. Spring element shall be contained within steel frame and designed so it can be preset for thrust at factory and adjusted in field for maximum of 1/4" movement at start and stop. Furnish thrust restraints complete with rods and angle brackets for attachment to both equipment and ductwork or equipment and structure. Attach horizontal restraints at centerline of thrust and symmetrically on either side of unit.

2.15 FLEXIBLE PIPING CONNECTORS

A. Flexible connectors shall be suitable for pressure, temperature and fluid involved, but not less than 215 psig (1482.37 kPa) working pressure at 250°F for 14” and smaller and 150 psi (1034.21 kPa) working pressure at 250□F for 16” and larger.

B. Flexible connectors shall be straight pipe configuration and shall not be used to replace pipe fittings such as elbows.

C. Where metal braided covered flexible connector is utilized, minimum live length of flexible connector shall be as follows.

Nominal Pipe Diameter (in)	Minimum Live Length (in)
2-1/2” and smaller	12”

3” and 4”	18”
5” and larger	24”

D. Water System:

(1) Connection to Rotating Equipment:

(a) Connectors shall consist of Kevlar or Nylon tire cord fabric reinforced with EPDM cover and liner. Solid steel rings or steel wire shall be used within raised face rubber flanged ends to prevent pullout. Furnish connectors with control rods only where recommended by connector manufacturer.

(b) 2" and Smaller: Threaded connections, single sphere design similar to Mason SAFEFLEX SFU.

(c) 2-1/2" and Larger: Floating steel flange connections, two sphere design with ductile iron or plated carbon steel reinforcing rings, similar to Mason SAFEFLEX SFDEJ. Single sphere design similar to Mason SAFEFLEX SFEJ, may be used for 14" and larger.

(2) Connection to Non-rotating Equipment Mounted on Vibration Isolators:

(a) Seamless corrugated bronze or stainless steel flexible connector with braided cover for 2" and smaller with threaded or flanged connections; seamless corrugated stainless steel flexible connector with braided cover for 2-1/2" and larger with flanged connections.

E. Steam and Condensate:

(1) Seamless corrugated stainless steel flexible connector with braided cover for 2" and smaller with threaded or flanged connections; seamless corrugated stainless steel flexible connector with braided cover for 2-1/2" and larger with flanged connections.

F. Compressed Air Systems:

(1) Seamless corrugated bronze flexible connector with bronze wire braided cover for copper piping and seamless corrugated stainless steel flexible connector with braided cover for steel piping. Connector ends shall be threaded, soldered, or flanged to match piping system valve ends.

G. Do not provide flexible piping connectors for compressed air piping.

2.16 PERFORMANCE

A. Select vibration isolation devices to achieve either minimum 95% isolation efficiency or minimum static deflection and mounting requirements listed below, whichever is greater. Minimum static deflections listed below are not nominal but certifiable minimums with actual installed load. Unless otherwise indicated, apply requirements listed for floor mount for roof-mounted equipment.

TYPE OF EQUIPMENT	
REFRIGERATION MACHINES (HEAT RECOVERY CHILLER):	
SCREW	**MOUNT ON AIR SPRINGS SIMILAR TO MASON INDUSTRIES TYPE SLR-MAS OR SLR-MT, OR MARSH MELLOW MOUNTS SIMILAR TO NOVIA TYPE RSM-MM, WITH A MAXIMUM NATURAL FREQUENCY OF 2.6 HZ.**
BOILERS:	**USE TYPE 1 MOUNT WITH MINIMUM DEFLECTION OF 0.25”.**
CHILLED WATER AND HOT WATER PUMPS:	
INLINE – FLOOR SUPPORTED	**MECHANICAL LEVEL: SUPPORT INLINE PUMPS BY PIPE STANDS OR SUPPORT FRAME AS SHOWN. STANDS AND SUPPORTS SHALL BE MOUNTED TO TYPE 3-I INERTIA BASE WITH MINIMUM STATIC DEFLECTION OF 1.5”. PROVIDED SPRING HANGERS FOR CONNECTED PIPING AS SPECIFIED IN THIS SECTION.** **GROUND LEVEL (IMAGING CHILLED WATER PUMPS): PROVIDE TYPE 2 NEOPRENE MOUNTS, SELECTED TO ACHIEVE MINIMUM 0.35” STATIC DEFLECTION UNDER LOAD. PROVIDED SPRING HANGERS FOR CONNECTED PIPING AS SPECIFIED IN THIS SECTION.**
INLINE – CEILING HUNG	**PUMPS GREATER THAN 5 HP SHOULD BE SUSPENDED WITH TYPE 5 HANGERS, SELECTED TO ACHIEVE MINIMUM 1.5” STATIC DEFLECTION UNDER LOAD. PROVIDED SPRING HANGERS FOR CONNECTED PIPING AS SPECIFIED IN THIS SECTION.** **PUMPS 5 HP OR LESS SHOULD BE SUSPENDED WITH TYPE 5 HANGERS, SELECTED TO ACHIEVE MINIMUM 0.75” STATIC DEFLECTION UNDER LOAD. PROVIDED SPRING HANGERS FOR CONNECTED PIPING AS SPECIFIED IN THIS SECTION.**

TYPE OF EQUIPMENT	
PLUMBING WATER TREATMENT SKID AND **DOMESTIC WATER BOOSTER PUMP**	**USE TYPE 2 MOUNT WITH MINIMUM STATIC DEFLECTION OF 0.35".**
LAB AIR COMPRESSOR AND LAB VACUUM PUMP	**USE TYPE 2 MOUNT WITH MINIMUM STATIC DEFLECTION OF 0.35".**
DOMESTIC HOT WATER RECIRCULATION PUMP	**USE TYPE 5 HANGERS WITH MINIMUM STATIC DEFLECTION OF 0.75".**
DISTRIBUTION TRANSFORMERS	**USE TYPE 2 MOUNT WITH MINIMUM STATIC DEFLECTION OF 0.25".**
HYDRONIC EQUIPMENT CONNECTED TO ISOLATED PIPING SYSTEMS (EXPANSION TANKS, STORAGE TANKS, HEAT EXCHANGERS, ETC)	**USE TYPE 2 MOUNTS OR HANGERS WITH MINIMUM DEFLECTION OF 0.25"**
UTILITY SET FANS:	
ROOF MOUNTED	**USE TYPE 4 MOUNT WITH MINIMUM DEFLECTION OF 1.5".**
AHU FAN ARRAYS	
FLOOR MOUNTED	**USE TYPE 3 MOUNT WITH MINIMUM DEFLECTION OF 1.5".**
AIR HANDLING UNITS	**INSTALL THE AHU EXTERIOR CASING ON TYPE 1 NEOPRENE PADS, SELECTED TO ACHIEVE MINIMUM 0.1" STATIC DEFLECTION UNDER LOAD.**
FAN COIL UNITS	**TYPE 5 WITH MINIMUM DEFLECTION OF 0.75".**
UNIT HEATERS	**TYPE 2 WITH MINIMUM DEFLECTION OF 0.25"**
PIPING CONNECTED TO ROTATING OR RECIPRO-EQUIPMENT:	**USE FLEXIBLE PIPING CONNECTIONS, AND TYPE 6 HANGERS FOR DISTANCE OF 100 PIPE DIAMETERS OR 50 FT AWAY FROM EQUIPMENT, WHICHEVER IS GREATER. HANGERS SHALL HAVE MINIMUM DEFLECTION OF 0.75" FOR PIPE SIZES 3" AND SMALLER, 1.5" FOR PIPE SIZES 4" THROUGH 6" AND 2.5" FOR PIPE SIZES 8" AND LARGER. FOR PIPING LESS THAN 2" IN DIAMETER, NEOPRENE OR FELT PAD INSERTED BETWEEN PIPE OR PIPE COVERING AND CLAMP OR HANGER MAY BE USED IN LIEU OF TYPE 6 HANGERS.** **FLEXIBLE PIPING CONNECTION SHALL NOT BE USED FOR UNIT HEATERS AND IN-LINE PUMPS THAT ARE SUPPORTED BY CONNECTED PIPES. TYPE 6 HANGERS WITH 1" MINIMUM DEFLECTION SHALL BE APPLIED WITHIN ONE FOOT OF BOTH SIDES OF IN-LINE PUMP AND FOR DISTANCE OF 100 PIPE DIAMETERS OR 50 FT AWAY FROM FIRST HANGER AT IN-LINE PUMP, WHICHEVER IS GREATER.** **WHERE PIPING IS FLOOR-SUPPORTED, ABOVE REQUIREMENTS SHALL APPLY, BUT USE TYPE 3 MOUNTS INSTEAD OF HANGERS.**
VERTICAL PIPE RISERS:	**USE TYPE 6 HANGERS, TYPE AG ANCHORS AND GUIDES. REFER TO SECTION 20 0529 - PIPING AND EQUIPMENT SUPPORTING DEVICES FOR ADDITIONAL RISER SUPPORT REQUIREMENTS.**

TYPE OF EQUIPMENT	
DUCTWORK IN MECHANICAL EQUIPMENT ROOMS:	**USE TYPE 8 HANGERS WITH 0.75" MINIMUM DEFLECTION FOR DUCTS WITH CROSS SECTIONAL AREA GREATER THAN 2.0 SQ FT AND WHERE AIR VELOCITY IS GREATER THAN 2000 FPM FOR DISTANCE 50 FT FROM FAN.**
MRI QUENCH VENT	**USE TYPE 2 HANGERS FOR ALL SUPPORTS, SELECTED TO ACHIEVE 0.25-INCH MINIMUM STATIC DEFLECTION UNDER LOAD.**

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and adjust vibration isolation devices as specified, as shown on drawings and according to manufacturer's recommendations.

(1) Adjust isolators after piping system is at operating weight.

(2) Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

(3) Adjust active height of spring isolators.

(4) Adjust restraints to permit free movement of equipment within normal mode of operation.

(5) Adjust air-spring leveling mechanism.

B. In no case shall installation short circuit isolation devices.

3.02 INERTIA BASES (TYPE I BASES)

A. Provide required concrete for inertia bases. Refer to Section 20 0000 - General Mechanical Requirements for concrete work.

B. Raise inertia bases to final elevation with temporary blocking prior to making piping connections to pumps or ductwork connections to fans. After connections are complete, install vibration isolators in accordance with manufacturer's installation instructions.

3.03 FLEXIBLE PIPING CONNECTIONS

A. Provide flexible connections for piping connected to rotating or reciprocating equipment, equipment such as coils mounted on vibration isolators, and as indicated on plans and details.

B. Piping connected to coil which is in assembly where fan is separately isolated by vibration isolators and duct flexible connections does not require flexible piping connectors or piping vibration hangers.

C. Piping connected to steam heating coils in floor mounted air handling units where coils are supported without vibration isolation shall have flexible piping connections and piping vibration hangers to prevent thermal stress in piping system from damaging the coils.

D. Install flexible connections on equipment side of shut off valves and horizontal and parallel to equipment shafts where applicable.

E. For non-metallic flexible piping connections, 2-1/2" and larger, use flange type recommended by manufacturer. Flanges for mechanical grooved connections are not allowed.

END OF SECTION 23 05 50

SECTION 23 05 94 - WATER SYSTEMS TEST ADJUST BALANCE

PART 1 GENERAL

1.01 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0993 - Control Sequences

C. Section 23 2118 - Valves (balancing valves)

D. Section 23 2120 - Piping Specialties (flow measure devices)

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

A. This Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for HVAC hydronic systems, such as chillers, pumps, convertors and other processes included in this project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.

C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Procedures shall be in accordance with the latest edition of AABC, NEBB or TABB Standards, ASHRAE - 2015 HVAC Applications Chapter 38, and as detailed herein.

E. Mechanical Contractors who are members of AABC, NEBB or TABB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval. Mechanical Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor who meets these requirements. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor who will submit it for approval.

F. Upon direction of Architect/Engineer or TAB subcontractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer wells. Mechanical Contractor shall be responsible for trimming and balancing pump impellers as necessary to obtain design pump flow rates at the minimum pressure differential.

G. TAB work shall not proceed until all assigned personnel have been approved by Architect/Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

1.04 SUBMITTALS

A. General:

(1) Make submittals in accordance with project submittal procedure.

(2) Reports shall be assembled using bookmarked electronic PDF format. Use pre-printed forms of NEBB, AABC or TABB wherever possible. Assemble report in the following order:

(a) Transmittal letter

(b) Cover sheet with project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer

(c) Index listing major systems

(d) Data organized by system in the following order:

1) Equipment data and measurement summary

2) Equipment measurement data

3) Branch main measurement data

4) Terminal device measurement data arranged by room or zone

B. Quality Assurance Submittal:

(1) Within 30 days of signing contract, Contractor shall submit the following information:

(a) Firm resume

1) AABC, NEBB or TABB active membership certificate

2) Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional

(b) Supervisor resume

(c) Balance technicians resumes

(2) Architect/Engineer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.

C. Planning Report:

(1) Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Architect/Engineer and Owner that proper procedures are being followed. Submit Planning Report after Quality Assurance submittal and 30 days before any fieldwork starts.

D. Initial Test Report:

(1) Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Architect/Engineer and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:

(1) Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.05 REFERENCE STANDARDS

A. Refer to the latest publications of NEBB, AABC, TABB and ASHRAE publications for establishing required procedures.

PART 2 PRODUCTS

2.01 INSTRUMENTATION

A. Provide required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC or TABB Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by Architect/Engineer upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB, AABC or TABB Standards.

PART 3 EXECUTION

3.01 GENERAL

A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

B. Unless otherwise specified, maximum acceptable offset tolerance shall be ± 10% of design flow rates indicated on drawings and schedules.

3.02 PLANNING PHASE

A. Procedure:

(1) Obtain the latest Contract Documents including addenda, construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for pumps, flow measuring devices, and terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:

(1) Planning Report shall contain the following minimum requirements.

(2) Narratives: Furnish written narratives of procedures to be used. Include separate narratives for each pump and liquid fluid handling system. Identify flow-measuring devices to be used at each pump and terminal device. Include different narratives for constant and variable flow systems. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances.

(3) Prebalance Checklist shall include, but not be limited to:

(a) Check for completeness of work

(b) System cleaning

(c) System fill and air venting

(d) Place system into operation

(e) Check expansion tanks and fill pressures

(f) Pump bearings, alignment, starters, vibration isolators, rotation

(g) Setting valves to proper position including shut-off and bypass valves

(h) Set up of controls and control devices

(4) Measuring Instrument List: List of measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:

(a) Manufacturer name and model number

(b) Measurement range

(c) Pressure/temperature limits

(d) Date put into service

(e) Date of last calibration

(f) Certificate from calibration firm

(5) Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument that has not been recalibrated within past year.

(6) Samples: Submit copies of TAB forms to be used.

(7) Branch circuit and terminal measurements and adjustments: Indicate on pre-printed forms all measurements to be taken and adjustments to be made in field. Include branch circuit or terminal identification, system, space served, location, design flow rates (including zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate the initial set points on forms.

3.03 SET-UP PHASE

A. Procedure:

(1) Perform prebalance checkout as per Planning Phase narrative.

B. Initial Test:

(1) Measure pump data and flow rates in "as found" condition after initial valve settings are made.

C. Initial Test Report:

(1) Submit report to Architect/Engineer and Mechanical Contractor indicating measurements made and including notes of items that are not complete or are not within design tolerance.

3.04 FINAL BALANCE PHASE

A. Procedure:

(1) Perform procedures as per Planning Phase narrative. Correct deficiencies and redo procedures as required prior to submitting Final Report.

B. Final Report:

(1) Submit report to Architect/Engineer and to Mechanical Contractor indicating all data, measurements and adjustments as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

C. Final Report Adjustments:

(1) Architect/Engineer reserves the right to check any measurement or adjustment made and to reject any portion of work not within specified tolerance. Contractor shall resubmit all or portions of Final Report as directed by Architect/Engineer.

END OF SECTION 23 05 94

SECTION 23 05 95 - AIR SYSTEMS TEST ADJUST BALANCE

SECTION 23 05 95 – AIR SYSTEMS TEST ADJUST BALANCE

PART 1 GENERAL

2.01 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0993 - Control Sequences

C. Section 23 3314 - Ductwork Specialties

2.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

2.03 DESCRIPTION

A. This Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for air systems, such as air handling units, exhaust fans, air terminal devices, diffusers, grilles and other air moving processes included in this project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.

C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or Testing, Adjusting and Balancing Bureau (TABB). Procedures shall be in accordance with the latest edition of AABC, NEBB or TABB Standards, ASHRAE - 2015 HVAC Application Chapter 38, and as detailed herein.

E. Mechanical Contractors who are members of AABC or NEBB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval. Mechanical Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor who meets these requirements. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor to submit for approval.

F. Upon direction of Architect/Engineer or TAB subcontractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including fan sheaves, motor sheaves and/or drive belts.

G. TAB work shall not proceed until assigned personnel have been approved by Architect/Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

2.04 SUBMITTALS

A. General:

(1) Make submittals in accordance with project submittal procedure.

(2) Reports shall be assembled using bookmarked electronic PDF format. Use preprinted forms of NEBB, AABC or TABB wherever possible. Assemble report in the following order:

(a) Transmittal letter

(b) Cover sheet with Project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer

(c) Index listing major systems

(d) Data organized by system in the following order:

1) Equipment data and measurement summary

2) Equipment measurement data

3) Branch main measurement data

4) Terminal device measurement data arranged by room or zone

B. Quality Assurance Submittal:

(1) Within 30 days of signing contract, Contractor shall submit the following information:

(a) Firm resume

1) AABC or NEBB active membership certificate

2) Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional

(b) Supervisor resume

(c) Balance technician(s) resume

(2) Architect/Engineer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.

C. Planning Report:

(1) Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Architect/Engineer and Owner that proper procedures are being followed. Planning Report shall be submitted after Quality Assurance submittal and 30 days before any fieldwork starts.

D. Initial Test Report:

(1) Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Architect/Engineer and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:

(1) Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

F. LEED Submittal:

(1) Air Balance Report for LEED IEQ Prerequisite 1: Documentation of work performed for ASHRAE 62.1-2007, Section 7.2.2, “Air Balancing”.

2.05 REFERENCE STANDARDS

A. Refer to the latest publications of NEBB, AABC, TABB, ASHRAE, and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) publications for establishing required procedures.

PART 2 PRODUCTS

3.01 INSTRUMENTATION

A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB, AABC or TABB Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by A/E upon request. Calibration and maintenance of instruments to be in accordance with requirements of NEBB, AABC or TABB Standards.

3.02 INSTRUMENT TEST HOLE PLUGS

A. Center-pull plugs similar to CPW Series by Mocap. Plug material shall be low-density polyethylene.

PART 3 EXECUTION

4.01 GENERAL

A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

B. Unless otherwise specified, maximum acceptable offset tolerance is plus or minus 10% of the design flow rates as indicated on drawings and/or as scheduled.

C. For spaces where supply airflow rates and exhaust airflow rates are used to maintain pressure relationships, such as lab spaces, clean rooms, and animal rooms, maximum acceptable supply air offset shall be 0 to +10% of design flow rate. Associated exhaust air flow rate shall be balanced to provide indicated airflow differential between supply air and exhaust air after supply air system has been balanced.

D. For areas such as cleanroom and containment suites where supply airflow rates and exhaust airflow rates are used to maintain specific pressure relationships as defined on pressure relationship drawings, higher airflow rate of either supply or exhaust air shall be balanced to 0 to +10% of design flow rate. Lower airflow rate of either supply or exhaust air shall be balanced to provide indicated space pressure. If pressure relationship suite has more than 3 rooms, room pressures shall all be measured and balanced to common or neutral pressure space.

E. For negative and positive pressure rooms provided with pressure differential monitoring devices, TAB contractor shall initially balance rooms to supply air and exhaust air offsets indicated on drawings. Space pressure monitors shall be set to alarm as indicated below:

Space Description	Alarm Setpoint (in. w.c)	Minimum Initial Pressure Differential (in. w.c)
Negative pressure rooms	-0.01	-0.015

Positive pressure rooms	0.01	0.015

(1) TAB contractor shall confirm and coordinate balance schedule with completion of all partition wall penetrations and door seals prior to completion of balance work.

(2) During initial balancing to the indicated supply and exhaust air offsets, TAB contractor shall record pressure differential as observed at space pressure monitor in TAB reports. Minimum initial pressure differential shall be as indicated in the above table.

(3) If initial offsets do not meet specified minimum pressure differential, TAB contractor shall incrementally increase (50 CFM) exhaust air flow offset from negative pressure rooms until minimum pressure differential is achieved and record final offset and pressure differential in TAB report.

(4) If initial offsets do not meet specified minimum pressure differential, TAB contractor shall incrementally decrease (50 CFM) exhaust air flow offset from positive pressure rooms until minimum pressure differential is achieved and record final offset and pressure differential in TAB report.

(5) Associated exhaust fan speeds shall be adjusted as necessary to meet space pressure differential setpoints.

4.02 PLANNING PHASE

A. Procedure:

(1) Obtain the latest Contract Documents including addenda, applicable construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for fans, flow measuring devices, and all terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:

(1) Planning Report shall contain the following minimum requirements.

(a) Samples: Provide copies of all forms to be used.

(b) General narratives: Furnish written narratives of all procedures used. Include separate narratives for each fan and air handling system. Identify flow-measuring devices to be used at each fan, air terminal device, and air outlet. Narrative shall include statement that every air outlet shall be measured and adjusted. Provide different narratives for constant and variable flow systems. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances.

(c) Air system narratives: Provide narratives for each air system which shall include procedures for measuring static pressures at each component of air handling system to generate a static pressure profile. Measurements shall be made to measure performance of system in all operating modes including economizer mode using 100% outside air where applicable. Differentiate between constant and variable flow systems.

(d) Air terminal narratives: Narratives shall describe procedures for measuring flows and adjusting controls to meet specified minimum and maximum flow rates based on actual field installed conditions.

(e) Branch duct and air outlet measurements: Indicate on preprinted forms all measurements to be taken in field. Include branch duct or air outlet identification, system, space served, location, and design flow rates (include zone and system summaries). Indicate duct or air outlet neck size, make, model number, and design velocities.

(f) Pressure relationship test narrative: Narratives shall describe how to obtain and measure pressure relationships between spaces as listed below.

1) Lab Support Space, Technical Area
2) Laboratory Bench and Table Top
3) Freezer Room
4) Bruker/Microscope
5) Bioenergetics Kitchen and Dining
6) Maker Space/Additive Manufacturing
7) Animal Housing (Mice/Rats/Rabbits)
8) Procedure
9) Chemical Procedure
10) Clean Cage Wash
11) Quarantine Housing
12) Surgery
13) Ante Room/Vestibule/Corridor
14) Feed and Bed Storage

(g) Fume Hood Certification: Narrative shall include procedures as described in Scientific Equipment and Furniture Association (SEFA) Standard SEFA 1-2006. Each hood shall be labeled with:

1) Test date

2) Name of tester
3) Sash position at 100 fpm and 125 fpm
4) Hood Classification

(h) Refer to fume hood specification for sash type of each hood, design exhaust rate and sash design opening size. Design airflows are based on design operating sash opening and 100 fpm face velocity at the sash opening.

(2) Prebalance Checklist - to include, but not limited to:
(a) Check for completeness of work
(b) System cleaning if required
(c) Check fire, smoke and balancing damper positions
(d) Place system into normal operation.
(e) Install test openings where required.
(f) Indicate type of test holes to be used and installation procedure.
(g) Note condition of filters.
(h) Provide temporary blankoffs to simulate design pressure drops of filters.
(i) Chisel holes and duct tape are not allowed.
(j) Wet cooling coils
(k) Fan wheels, blades, bearings, alignment, starters, vibration isolators, and rotation
(l) Drive belt tension and alignment
(m) Setting of automatic dampers to proper position including shutoff and bypass dampers
(n) For hoods and ovens indicate temperature and humidity. Correct for density changes.
(o) Set up of controls and control devices

(3) Measuring Instrument List - list what measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
(a) Manufacturer name and model number
(b) Measurement range
(c) Pressure/temperature limits
(d) Date put into service
(e) Date of last calibration
(f) Include certificate from calibration firm

(4) Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within past year.

4.03 SET-UP PHASE

A. Procedure:
(1) Perform prebalance checkout as per Planning Phase narrative.

B. Initial Test:
(1) Measure fan data and flows in "as found" condition after initial damper settings are made.

C. Initial Test Report:
(1) Submit report to Architect/Engineer and Mechanical Contractor indicating all measurements made and make notes of all items, which are not complete or are not within design tolerance.

4.04 FINAL BALANCE PHASE

A. Procedure:
(1) Perform all procedures as per Planning Phase narrative. Correct all deficiencies and redo procedures as required before submitting Final Report.

B. Final Report:
(1) Submit report to Architect/Engineer and Mechanical Contractor indicating all data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

C. Final Report Adjustments:
(1) Architect/Engineer reserves the right to check any measurement made and to reject any portion of work not within required tolerance of design flow. TAB Contractor shall resubmit all or portions of Final Report as directed by Architect/Engineer.

END OF SECTION 23 05 95

SECTION 23 07 00 - MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 23 05 29 - Mechanical Piping and Equipment Supporting Devices

B. Section 23 05 53 - Mechanical Systems Identification (pipe jacket color chart)

C. Section 23 31 14 - Ductwork

D. Section 23 21 20 - Piping Specialties (for steam trap insulation)

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

A. Provide insulating materials and accessories as required for mechanical systems as specified below.

B. Insulating products delivered to construction site shall be labeled with manufacturer's name and description of materials.

1.04 DEFINITIONS

A. Concealed areas, where indicated in this Section, shall apply to shafts, furred spaces and space above finished ceilings, inaccessible tunnels, and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

B. Unless otherwise indicated, unit of thermal conductivity is BTU in(h ft2'F (W/(m K).

C. Interstitial spaces are considered as concealed areas.

1.05 SUBMITTALS

A. Product Data for each piping system for all pipe sizes, each ductwork system but not limited to, the following:

(1) Manufacturer's name

(2) Schedule of insulating materials

(3) Insulation material and thickness

(4) Jacket

(5) Adhesives

(6) Fastening methods

(7) Fitting materials

(8) Intended use of each material

(9) Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings.

(10) Insulation installation details (manufacturer's installation instruction/details, Contractor's installation details, MICA plates where applicable)

(11) Literature data sheet from sealants and adhesive manufacturers stating VOC compliance with USGBC LEED IEQ 4.1.

(12) Literature data sheet from coatings and mastics (including lagging adhesives) manufacturers stating VOC compliance with USGBC LEED IEQ 4.2.

(13) All other appropriate data.

1.06 DELIVERY, STORAGE AND HANDLING

A. Insulation material shall be delivered to project site in original, unbroken factory packaging labeled with product designation and thickness. Shipment of materials from manufacturer to installation location shall be in weather-tight transportation. Protect insulation materials from moisture and weather during storage and installation. Protect insulation material against long exposure to UV light from sun.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Insulation:

(1) Owens Corning, Johns Manville, Manson, Knauf or CertainTeed similar to product indicated except where product of manufacturers not listed above is specifically identified for special type of insulation.

B. Coatings, Mastics, Sealants and Adhesives:

(1) Foster, Childers, Design Polymerics, Vimasco, Miracle or Pittsburgh Corning

2.02 MATERIALS

A. Products used for or related to air conditioning and ventilating systems shall conform to NFPA 90A possessing flame spread index of not over 25 and smoke developed index no higher than 50.

B. Unless otherwise indicated, all products, material itself or on composite basis, shall have flame spread index not more than 25 and smoke developed index not more than 50, when tested in accordance with ASTM E84 or UL 723.

C. Pipe insulation installed outdoors may have smoke developed index not exceeding 450.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in manufacturing process.

E. Insulation applied on stainless steel shall meet requirements of ASTM C795 and NRC 1.36.

2.03 INSULATION

A. Insulation materials shall be fire retardant, moisture, and mildew resistant, vermin proof, and suitable to receive jackets, adhesives, and coatings as indicated.

B. Glass fiber insulation shall be of inert inorganic material, non-corrosive to mechanical surfaces.

C. Insulating cement shall be Quick-Cote by PK Insulation MFG Co. or Ryder GP, with dry density of no more than 38 lb/ft3 (603 kg/m3) thermal conductivity of 0.96 at 400°F (0.138 at 204°C) mean temperature, and service temperature to 1200°F (650°C).

D. Filling and finishing cement shall be Super-Stik by PK Insulation MFG Co., or Ryder MW, with dry density of no more than 24 lb/ft3 (384 kg/m3), thermal conductivity of 0.74 at 500°F (0.107 at 260°C) mean temperature, and service temperature to 1900°F (1040°C).

E. Type A Insulation (Flexible Elastomeric):

(1) Flexible, closed-cell, elastomeric cellular insulation.

(a) ASTM Standard: ASTM C534/C534M, Type I (tube form) or Type II (sheet form), Grade I

(b) Thermal Conductivity: Maximum 0.28 at 75°F (0.04 at 24°C) mean temperature

(c) Water Vapor Permeability: Maximum 0.08 perm-inch (0.12 ng/s m Pa)

(d) Water Absorption: Maximum 0.2 % by volume

(e) Service Temperature: -297 to 220°F (-183 to 104°C)

(2) Manufacturers/Products:

(a) Armacell, AP Armaflex or AP Armaflex FS

(b) Aeroflex, Aerocel

(c) K-Flex, Insul-Tube

F. Type C Insulation (Ceramic Fiber Blanket):

(1) High temperature ceramic fiber blanket insulation.

(a) Density: Minimum nominal 8 lb/ft3 (128 kg/m3)

(b) Thermal Conductivity: Maximum 0.83 at 1100°F (0.12 at 600°C) mean temperature

(c) Service Temperature: Continuous 1832°F (1000°C)

(2) Manufacturers/Products:

(a) Morgan Thermal Ceramics, Superwool Plus.

G. Type F Insulation (Flexible Fiberglass Blanket):

(1) Flexible fiberglass blanket insulation, faced with specified jacket.

(a) ASTM Standard: ASTM C1290

(b) Density: Minimum 1.0 lb/ft3 (12 kg/m3)

(c) Thermal Conductivity: Out-of-package (uncompressed) conductivity shall not exceed Maximum 0.27 btu-in/(hr-ft2-°F) at 75°F (0.04 at 24°C) mean temperature.

(d) Service Temperature: Maximum 250°F (121°C).

(2) Manufacturers/Products:

(a) Johns Manville, Microlite EQ FSK

(b) Owens Corning, SOFTR Duct Wrap FRK

(c) Knauf, Performance Plus Duct Wrap

H. Type FR Insulation (Fire Resistive Duct Wrap):

(1) High temperature inorganic flexible fiber blanket encapsulated in fiberglass foil facing shall be suitable for ventilation duct wrap. Wrap shall be single layer of 1-1/2” (40 mm) thick, fire resistive rating of 2 hr.

(a) ISO 6944-1, Fire Resistance Tests - Ventilation Ducts

(b) ASTM E136, Non-combustibility

(c) Density: 6 lb/ft3 (96 kg/m3)

(d) Thermal Resistance: (R-value per ASTM C518): 7.2 per layer at 70°F (1.26 m°C/W at 21°C).
(e) Service Temperature: Minimum 1832°F (1000°C)

(2) Manufacturers/Products:
(a) Thermal Ceramics, Fire Master Fast Wrap XL
(b) 3M, Fire Barrier Duct Wrap 615+
(c) Unifrax: FyreWrap Elite 1.5 Duct Insulation

I. Type G Insulation (Cellular Glass):

(1) 100% cellular glass cells with no organic material, noncombustible.
(a) ASTM Standard: ASTM C552, Type I (block) or Type II (pipe), Grade 6
(b) Density: Minimum nominal 7.18 lb/ft3 (115 kg/m3)
(c) Thermal Conductivity: Maximum 0.31 at 75°F (0.045 at 24°C) mean temperature
(d) Compressive Strength: Minimum 90 psi (620 kPa)
(e) Water Vapor Permeability: 0.00 perm-"
(f) Water Absorption: Maximum 0.2% by volume
(g) Service Temperature: -450 - 900°F (268 - 480°C)

(2) Manufacturers/Products:
(a) Owens Corning, Foamglas

J. Type H Insulation (Calcium Silicate Block or Pipe):

(1) Hydrous calcium silicate block and pipe insulation with non-asbestos fibrous reinforcement.
(a) ASTM Standard: ASTM C533, Type I
(b) Density: Minimum dry 13 lb/ft3 (208 kg/m3)
(c) Thermal Conductivity: Maximum 0.49 at 400°F (0.072 at 204°C)
(d) Compressive Strength: Minimum 100 psi (690 kPa) at 5% compression
(e) Service Temperature: 80 to 1200°F (26 to 650°C)

(2) Manufacturers/Products:
(a) Industrial Insulation Group (IIG), Thermo-12 Gold

K. Type KG Insulation (Kitchen Grease Duct Wrap):

(1) High temperature flexible fiber blanket encapsulated in fiberglass foil facing shall be suitable for kitchen grease duct wrap. Wrap shall be two layers, each 1-1/2” (40 mm) thick, rated as 2 hr shaft alternative.
(a) ASTM Standard: ASTM E2336 and related ICC ESR (2 hr grease duct enclosure)
(b) Codes/Standards: ICC (IMC), IAPMO (UMC), NFPA 96.
(c) Density: Nominal 6 lb/ft3 (96 kg/m3)
(d) Service Temperature: Continuous 1832°F (1000°C).

(2) Manufacturers/Products:
(a) Thermal Ceramics, FireMaster FastWrap XL
(b) 3M, Fire Barrier Duct Wrap 615+
(c) Unifrax, FyreWrap Elite 1.5 Duct Insulation

(3) Duct access doors shall be furnished by duct wrap manufacturer as part of duct wrap system. Access doors shall pass ASTM E2336 test standard.

L. Type M Insulation (Mineral Fiber):

(1) Mineral fiber preformed pipe insulation faced with specified jacket.
(a) ASTM C547, Type II
(b) Density: Minimum nominal 8 lb/ft3 (128 kg/m3)
1) Thermal Conductivity: Maximum 0.29 at 200°F (0.040 at 93°C) and 0.40 at 400°F (0.058 at 204°C)
(c) Water Vapor Absorption: Maximum 1% by weight
(d) Service Temperature: To 1200°F (650°C)

(2) Manufacturers/Products:
(a) Roxul, ProRox PS 960
(b) IIG, MinWool-1200 Pipe

M. Type PP Insulation (Phenolic):

(1) Rigid cellular phenolic insulation faced with specified jacket.
(a) ASTM Standard: ASTM C1126, Type III
(b) Density: Minimum 2.5 lb/ft3 (40 kg/m3)

(c) Thermal Conductivity: Maximum 0.18 at 75°F (0.026 at 24°C) mean temperature
(d) Compressive Strength: Minimum 30 psi (206 kPa)
(e) Water Vapor Permeability: 2.14 perm-" (3.10 ng/s m Pa)
(f) Water Absorption: Maximum 0.9% by volume
(g) Service Temperature: -290°F (-179°C) to 250°F (121°C)

(2) Manufacturers/Products:
(a) ITW, Trymer Supercel Phenolic
(b) Resolco, Insul-phen
(c) Polyguard, PolyPhen

N. Type R Insulation (Rigid Mineral Fiber Pipe Insulation):
(1) Mineral fiber (fiberglass) preformed pipe insulation faced with specified jacket.
(a) ASTM Standard: ASTM C547, Type I
(b) Density: Minimum nominal 3 lb/ft3 (48 kg/m3)
1) Thermal Conductivity: Maximum 0.23 at 75°F (0.034 at 24°C) and 0.29 at 200°F (0.040 at 93°C)
2) 0.29 at 200°F (0.040 at 93°C) mean temperature
(c) Service Temperature: To 850°F (454°C)
(2) Manufacturers/Products:
(a) Johns Manville, Micro-Lok HP
(b) Owens Corning, ASJ Max Fiberglas Pipe Insulation
(c) Knauf, Earthwool 1000° Pipe Insulation

O. Type R Insulation (Rigid Mineral Fiber Board Insulation):
(1) Mineral fiber (fiberglass) duct and equipment insulation faced with specified jacket.
(a) ASTM Standard: ASTM C612, Type IA and IB
(b) Density: Minimum nominal 3 lb/ft3 (48 kg/m3)
(c) Thermal Conductivity: Maximum 0.23 at 75°F (0.034 at 24°C) mean temperature
(d) Service Temperature: To 450°F (232°C)
(2) Manufacturers/Products:
(a) Johns Manville, 800 Series Spin-Glas, Type 814
(b) Owens Corning, Fiberglas Fiberglass 700 Series, Type 703
(c) Knauf, Earthwool Insulation Board

P. Type RR Insulation (Rigid Mineral Fiber Board Insulation):
(1) Mineral fiber (fiberglass) duct and equipment insulation faced with specified jacket.
(a) ASTM Standard: ASTM C612, Type IA and IB
(b) Density: Minimum nominal 6 lb/ft3 (96 kg/m3)
(c) Thermal Conductivity: Maximum 0.23 at 75°F (0.034 at 24°C) mean temperature
(d) Service Temperature: To 450°F (232°C)
(2) Manufacturers/Products:
(a) Johns Manville, 800 Series Spin-Glas, Type 817
(b) Owens Corning, Fiberglas Fiberglass 700 Series, Type 705
(c) Knauf, Earthwool Insulation Board

Q. Type S Insulation (Rigid Polystyrene):
(1) Rigid closed cell, extruded polystyrene (XPS), insulation faced with specified jacket.
(a) ASTM Standard: ASTM C578, Type XIII
(b) Density: Minimum nominal 1.6 lb/ft3 (26 kg/m3)
(c) Thermal Conductivity: Maximum 0.26 at 75°F (0.037 at 24°C) mean temperature
(d) Compressive Strength: Minimum 20 psi (138 kPa)
(e) Water Vapor Permeability: 1.5 perm-" (2.2 ng/s m Pa)
(f) Water Absorption: Maximum 1% by volume
(g) Service Temperature: -297°F (-183°C) to 165°F (74°C)
(h) Flame Spread Index/Smoke Developed Index: Maximum 25/165
(2) Manufacturers/Products:
(a) Dow Chemical, Styrofoam XPS Pipe Insulation Billet

(b) ITW, XPS PIB

R. Type T Insulation (Mineral Fiber Fireproofing):

(1) Mineral fiber board insulation.

(a) ASTM Standard: ASTM C612, Type IVa

(b) Density: Minimum nominal 8 lb/ft3 (128 kg/m3)

(c) Thermal Conductivity: Maximum 0.23 at 75°F (0.033 at 24°C) mean temperature

(d) Service Temperature: To 1200°F (650°C).

(e) Flame Spread Index/Smoke Developed Index: Maximum 25/0

(2) Manufacturers/Products:

(a) Owens Corning Thermafiber, FireSpan

(b) Rockwool, Roxul Safe

(c) Fibrex, FBX Industrial Board Insulation

S. Type AG Insulation (Flexible Aerogel):

(1) Flexible aerogel blanket insulation.

(a) ASTM Standard: ASTM C1728, Type III

(b) Density: Minimum 12 lb/ft3 (192 kg/m3)

(c) Thermal Conductivity: Maximum 0.19 at 392°F (0.028 at 200°C) mean temperature

(d) Water Absorption: Maximum 5% by weight

(e) Service Temperature:1200°F (To 650°C)

(2) Manufacturers/Products:

(a) Aspen Aerogels, Pyrogel XTE

(b) Armaflex, ArmaGel HT

2.04 JACKETS

A. Jacket puncture resistances shall be based on ASTM D781 test methods. Vapor barrier permeance ratings shall be based on ASTM E96/E96M Procedure A.

B. Type A-1 Jacket (Aluminum Roll Jacketing):

(1) Factory fabricated 0.016" (0.41 mm) thick, ASTM B209/B209M, Type 3003 or 3105, stucco embossed aluminum jacket with integrally bonded moisture barrier/retarder consisting of 3 layers of polymer films with total thickness of 3 mil (0.075 mm).

(2) Fitting covers shall be factory fabricated from not lighter than thick, Type 3003 or 1100 aluminum. For large pipes, where factory fabricated fitting covers are not available, Contractor shall fabricate fitting covers from like sheet materials.

(3) Manufacturers/Products:

(a) Johns Manville, Aluminum Jacketing

(b) RPR Products, Insul-Mate

C. Type A-2 Jacket (Aluminum Roll Jacketing – High Temperature Application)

(1) Factory fabricated 0.016” (0.41 mm) thick, ASTM B209/B209M, Type 3003 or 3105, stucco embossed aluminum jacket. Due to potential for high temperature exposure, jacket shall be absent of additional moisture barrier/retarder of any kind.

(2) Fitting covers shall be factory fabricated from not lighter than thick, Type 3003 or 1100 aluminum. For large pipes, where factory fabricated fitting covers are not available, Contractor shall fabricate fitting covers from like sheet materials.

D. Type D-1 Jacket:

(1) Heavy-duty, fire retardant material with glass fiber reinforcing. Jackets shall have neat, white Kraft finish suitable for painting, with beach puncture resistance of 50 units minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm (1.15 ng/s m2 Pa).

(2) Manufacturers/Products:

(a) Owens Corning, ASJ Max

(b) Johns Manville, ASJ-4535

(c) Knauf, ASJ+

E. Type D-2 Jacket:

(1) Glass fiber reinforced foil Kraft laminate with permeance not exceeding 0.02 perm (1.15 ng/s m2 Pa) and beach puncture resistance 25 units minimum.

(2) Manufacturers/Products:

(a) Owens Corning, FRK

(b) Johns Manville, FSK

(c) Knauf, FSK

F. Type D-3 Jacket:

(1) Self-adhering, multiple laminated waterproofing material with reflective aluminum foil, high density polymer films and minimum 40 mil (1 mm) rubberized asphalt waterproofing compound.

(2) Venture Clad 1577 CW, Alumaguard Lite or Foster Vaporfas 62-05

(a) Jackets shall be minimum 5 ply laminated, weather proofing material with acrylic adhesive capable of installation with no additional mechanical attachments, 0.00 water vapor permeance rating per ASTM E96/E96M, mold inhibitors incorporated and UV stable.

(b) Jackets shall have _____ finish.

(3) Manufacturers/Products:

(a) MFM Building Products Corp., FlexClad

(b) Polyguard, Alumaguard

G. Type E-2 Jacket:

(1) Heat sealable, multi-ply laminate consisting of layer of asphalt, glass fiber reinforcement, second layer of asphalt, aluminum foil layer, third layer of asphalt, and polyester outer film. Minimum total thickness shall be 125 mils (3.175 mm).

(2) Manufacturers/Products:

(a) Owens Corning, Pittwrap HS

H. Type E-3 Jacket:

(1) Self-sealing, non-metallic sheet consisting of special bituminous resin reinforced with woven glass fabric and 1 mil (0.025 mm) thick aluminum film. Minimum total thickness shall be 70 mils (1.8 mm).

(2) Manufacturers/Products:

(a) Owens Corning, Pittwrap SS

I. Type P-1 Jackets:

(1) Heavy-duty, fire retardant material with glass fiber reinforcing and self-sealing lap. Jacket shall have neat, white Kraft finish suitable for painting, with burst strength of 1.5 Joules (50 beach units) minimum and tensile strength 45 lbs/in (7.9 N/mm) minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm (1.15 ng/s m2 Pa).

(2) Manufacturers/Products:

(a) Owens Corning, ASJ-SSL

(b) Johns Manville, ASJ

(c) Knauf, ASJ+

J. Type P-2 Jackets:

(1) Jackets shall be minimum 5 ply laminated, weather proofing material with acrylic adhesive capable of installation with no additional mechanical attachments, 0.00 water vapor permeance rating per ASTM E96/E96M, mold inhibitors incorporated and UV stable.

(2) Jackets shall have _____ finish.

(3) Manufacturers/Products:

(a) 3M, VentureClad

(b) Polyguard, Alumaguard Lite

K. Type SS-1 Jacket (Protective Insulation Shield):

(1) Factory fabricated 1 mil (0.025 mm) thick, ASTM A240/A240M, Type 304 stainless steel, 2B mill finish jacket with integrally bonded moisture barrier/retarder consisting of 3 layers of polymer films with total thickness of 3 mil (0.075 mm).

(2) Fitting covers shall be factory fabricated from not lighter than 0.016" (.40 mm) thick, ____, stainless steel. For large pipes, where factory fabricated fitting covers are not available, Contractor shall fabricate fitting covers from like sheet materials.

(3) Manufacturers/Products:

(a) Johns Manville, Stainless Steel Jacket

(b) RPR Products, Insul-Mate Stainless Steel

L. Type SS-2 Jacket (Stainless Steel Roll Jacketing – High Temperature Application)

(1) Factory fabricated 0.01” (0.25 mm) thick, ASTM A240/A240M, Type 304 stainless steel, 2B mill finish jacket. Due to potential for high temperature exposure, jacket shall be absent of additional moisture barrier/retarder of any kind.

(2) Fitting covers shall be factory fabricated from not lighter than 0.016" (.40 mm) thick ____, stainless steel. For large pipe where factory fabricated fitting covers are not available, Contractor shall fabricate fitting covers from like sheet materials.

(3) Manufacturers/Products:

(a) Johns Manville, Stainless Steel Jacketing

(b) RPR Products, Insul-Mate Stainless Steel

M. Type S-1 Jacket:

(1) Saran Vapor Retarder Film with self-sealing lap (SSL), ASTM C755 and ASTM C1136, 6 mil (0.15 mm) thickness, permeance not more than 0.01 perms (0.574 ng/s m2 Pa).

(2) Elbows, fittings, valves, and butt joints shall be wrapped with vapor retarder tape, 2 mil (0.05 mm) thickness, permeance not more than 0.03 perms (1.72 ng/s m2 Pa). Butt joints shall be wrapped with single layer and elbows/fittings/valves with 2 layers of tape.

(3) Provide PVC jacket (Type V-1) over vapor retarder tapes for exposed elbows, fittings, and valves.

(4) Manufacturers/Products:

(a) Johns Manville, Saranex 560 CX

N. Type V-1 Jacket:

(1) Fire retardant and UV resistant PVC in minimum _____ mil (_____ mm) thickness consisting of preformed fitting covers, preformed end terminations, and sheet material for straight runs of pipe. Jacketing system shall be suitable for indoor and outdoor application in temperature range of -35°F (-37°C) to 150°F (66°C). Material when installed according to manufacturer's instructions shall provide complete vapor barrier and readily cleanable surface while meeting Federal CGMP requirements.

(2) Manufacturers/Products:

(a) Johns Manville, Zeston

(b) Speedline, Smoke Safe

(c) Proto, LoSmoke

(3) PVC jacket color _____.

2.05 ADHESIVES, MASTIC, COATINGS, SEALANTS, AND REINFORCING MATERIALS

A. Adhesives and sealants shall comply with the South Coast Air Quality Management District SCAQMD 1168; VOC limits shall comply with Indoor Environmental Quality Section, Credit IEQ-4.1.

B. Coatings and mastics shall comply with VOC limits set forth by Green Seal BS-11 and comply with the South Coast Air Quality Management District SCAQMD 1113; VOC limits shall comply with Indoor Environmental Quality Section, Credit IEQ-4.2.

C. Products shall be compatible with surfaces and materials on which they are applied and shall be suitable for use at operating temperatures of systems to which they are applied.

D. Products shall be fire retardant, moisture resistant and mildew resistant and vermin proof.

E. Vapor Barrier Mastic: Below ambient insulation. Water vapor permeance shall be less than 0.08 perms at 45 mils dry film thickness per ASTM F1249.

(1) Foster 30-33

(2) Childers CP-33

(3) Vimasco 749

F. Weather Barrier Breather Mastic: Above ambient insulation. Permeance shall be greater than 1.0 perms at 1/16" (1.59 mm) dry film thickness per ASTM E96/E96M.

(1) Foster 46-50 Weatherite

(2) Childers CP-10/CP-11 Vi Cryl

(3) Vimasco WC-5

G. Lagging Adhesive/Coatings: Indoors applications used in conjunction with canvas/glass cloth.

(1) Foster 30-36

(2) Childers CP-50 AMV1

(3) Vimasco 713

H. Metal jacketing sealant for aluminum jacketing:

(1) Foster 95-44 Elastolar

(2) Childers CP-76 Chil Byl

(3) Pittsburgh Corning 727

I. Insulation joint sealant for Type P, Type PP, and Type G insulation:

(1) Foster 95-50 Flextra
(2) Childers CP-76 Chil Byl
(3) Pittsburgh Corning CW Sealant

J. Glass fiber fabric reinforcing shall be 10 x 10 mesh similar to Childers Chil Glas #10 or Foster Mast A Fab.

K. Wire mesh reinforcing shall be 22 ga (0.7 mm), 1" (25 mm) galvanized.

L. Insulation cement shall be ANSI/ASTM C195, hydraulic setting mineral wool.

M. Finishing cement shall be ASTM C449.

N. Butt joint and longitudinal joint adhesive for Type A insulation shall be Armaflex 520, Rubatex 373, Childers CP-82 or Foster 85-75.

O. Weather-resistant protective finish for Type A insulation shall be equal to Armstrong WB Armaflex finish or Foster 30-65 elastomeric coating.

2.06 METAL BANDS AND WIRES

A. Aluminum bands shall be 0.5 x 0.20" (13 mm x 0.51 mm) up to 48" (1220 mm) diameter and 0.75 x 0.020" (19 mm x 0.51 mm) over 48" (1220 mm) diameter.

B. Stainless steel bands shall be 0.5 x 0.015" or 0.75 x 0.015" (13 mm x 0.38 mm or 19 mm x 0.38 mm).

C. Stainless steel wires shall be 16 ga (1.50 mm).

2.07 INSULATION FASTENERS

A. Insulation fasteners shall be cup head weld pins, galvanized low carbon steel, minimum 12 ga (0.105”) (2.5 mm)) pins.

B. Washer edge shall be beveled.

C. Fasteners shall be stainless steel for stainless steel ductwork application.

D. Insulation fasteners using adhesive are not allowed.

2.08 REMOVABLE INSULATING BLANKETS

A. Custom designed removable, reusable, flexible, blanket thermal insulation system.

B. Acceptable Manufacturers: Thermal Energy Products, Inc., Advanced Thermal Corp., Temptec, Remco Technology, Inc., or approved equal.

C. Removable insulation system shall be custom designed for each individual item to provide close contour fit. Overlapping seams and gaps are not acceptable.

D. Removable insulation shall be designed to overlap adjoining pipe insulation by minimum of 2" (50 mm).

E. Insulation: Minimum 2" (50 mm) thick, 2.4 lb/ft3 (38.4 kg/m3) density, 1000°F (540°C) continuous service temperature thermal insulating wool; Owens Corning Fiberglass or equal.

F. Interior and Exterior Fabric: Minimum weight 0.59 kg/m² (17.5 oz/sq yd) silicone rubber coated fiberglass cloth.

G. Securement: Blanket seams shall be closed with buckle and strap assembly (D ring closure).

H. Identification/Tagging: Label each removable insulation device with plastic or 304 stainless steel tag with raised letters. Tag as directed by Owner.

2.09 ACOUSTICAL BARRIER MATERIALS

A. Acoustical barrier material shall be combination of absorber and barrier, similar to Sound Seal Model B-10 LAG/QFA-3. Absorber/Barrier material shall have acoustic ratings of STC-29.

B. Minimum sound transmission loss at each octave band shall be as follows:

Sound Transmission Loss (dB)					
Octave Band Center Frequency (Hz)					
125	250	500	1000	2000	4000
18	18	23	30	39	46

PART 3 - EXECUTION

3.01 APPLICATION

A. Provide insulation and jackets with minimum insulation thickness as indicated in the following schedule. The schedule applies to both exposed and concealed applications unless noted otherwise:

Piping System							
		Minimum Insulation Thickness According to Pipe Size					
Service	Jacket Type	Insulation Type	3/4" (19 mm) and	1" - 1-1/4" (25 mm to	1-1/2" - 3" (40 mm to	4" - 6" (100 mm to 150	8" (200 mm) and

			Smaller	32 mm)	80 mm)	mm)	Larger
Heating Hot Water 105-140°F (40-60°C)	P-1	R	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)
Heating Hot Water 141-200°F (60-93°C)	P-1	R	1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)	2" (50 mm)	2" (50 mm)
Heated Glycol 141-200°F (60-93°C)	P-1	R	1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)	2" (50 mm)	2" (50 mm)
Heating Hot Water 201-250°F (94-121°C)	P-1	R	2-1/2" (65 mm)	2-1/2" (65 mm)	2-1/2" (65 mm)	3" (80 mm)	3" (80 mm)
Chilled Water 51-60°F (10-15°C)	P-1	R	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)
Chilled Water 40-60°F (4-15°C)	P-1	R	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)
Chilled Water 40-60°F (4-15°C)	---	A	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)
Chilled Water 40-60°F (4-15°C)	S-1	_____	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)
Chilled Water 40-60°F (4-15°C)	S-1	PP	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)
Chilled Water (Glycol) 30-40°F (-1-4°C)	---	A	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)
Chilled Water (Inside AHU housing)	V-1	PP	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)
Chilled Water (Interior) 40-60°F (4-15°C)	P-1	G	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)	2" (50 mm)
Chilled Water (Exterior) 40-60°F (4-15°C)	P-2	P	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)
Chilled Water (Exterior) 40-60°F (4-15°C)	P-2	S	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)	2" (50 mm)
Chilled Water (Underground - direct buried)	E-3	G	1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)	2" (50 mm)	2-1/2" (65 mm)
Condenser Water (Interior) 50°F (10°C) and lower or used for water side economizer)	S-1	PP	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)
Condenser Water (Interior) [50°F] ([10°C]) and lower or used for water side economizer)	---	A	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)
Refrigerant Suction Lines and Hot Gas By-pass Line if Used (Interior)	---	A	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)
Refrigerant Suction Lines and Hot Gas By-pass Line if Used (Exterior)	P-2	A	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)
Cooling Coil Condensate Drain	---	A	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)
Low Pressure Steam and Condensate 201-250°F (94-121°C)	P-1	R	2-1/2" (65 mm)	2-1/2" (65 mm)	2-1/2" (65 mm)	3" (80 mm)	3" (80 mm)
High Pressure Steam and Condensate 251-350°F (122-176°C)	P-1	R	3" (80 mm)	4" (100 mm)	4-1/2" (115 mm)	4-1/2" (115 mm)	4-1/2" (115 mm)
(Two layers of insulation shall be provided)							
High Pressure Steam and Condensate 351-450°F	P-1	R	4-1/2" (115 mm)	5" (125 mm)	5" (125 mm)	5" (125 mm)	5" (125 mm)

(177-232°C)							
(Two layers of insulation shall be provided) (A-2 jacket shall be provided over P-1 jacket for exposed piping)							
High Pressure Steam and Condensate (Operating Temp. 450°F (232°C)	P-1	M	4-1/2" (115 mm)	5" (125 mm)	5" (125 mm)	5" (125 mm)	5" (125 mm)
(Two layers of insulation shall be provided) (A-2 jacket shall be provided over P-1 jacket for exposed piping)							
Condensate Pump Discharge 141-200°F (60-121°C)	P-1	R	1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)	2" (50 mm)	2" (50 mm)
Steam and Condensate	A-1	G	3" (80 mm)	4" (100 mm)	4" (100 mm)	5" (130 mm)	5" (130 mm)
Steam and Condensate (Underground - direct buried)	E-2	G	3" (80 mm)	4" (100 mm)	4" (100 mm)	5" (130 mm)	5" (130 mm)
Boiler Feed 201-250°F (94-121°C)	P-1	R	2-1/2" (65 mm)	2-1/2" (65 mm)	2-1/2" (65 mm)	3" (80 mm)	3" (80 mm)
Boiler Blow Down	P-1	R	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)
Heated Fuel Oil	P-1	R	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)
Snow Melting (Except piping encased in concrete)	P-1	R	1" (25 mm)	1" (25 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)	1-1/2" (40 mm)
Engine Generator Remote Radiator	P-1	R	1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)	2" (50 mm)	2" (50 mm)
Piping Between Separation Chamber and Manifolds of Steam Jacketed Humidifiers	P-1	R	2-1/2" (65 mm)	2-1/2" (65 mm)	2-1/2" (65 mm)	3" (80 mm)	3" (80 mm)
Steam Safety Valve Vent Piping located within 8" (2.4 m) above floor	P-1	R	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)
Steam Safety Valve Vent Piping	P-1	R	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)
Non-Potable Cold Water	P-1	R	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)
Non-Potable ColdWater	---	A	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)	3/4" (19 mm)
Piping Provided with Heat Tracing	P-1	R	1" (25 mm)	1-1/2" (40 mm)	2" (50 mm)	2" (50 mm)	2" (50 mm)
Insulation thickness shall be the greater thickness specified for piping system or thickness specified above.							
MRI Quench Vent	For first 10 ft (3 m) provide two layers of 1" (25 mm) Type A insulation, all seams and joints staggered. Apply minimum 0.002" (0.05 mm) aluminum foil with complete adhesive coverage between first layer and second layer. Provide single layer of 2" (50 mm) Type A insulation for remainder of vent pipe.						
RO Water (pumped)	-	A	1/2" (13 mm)	1/2" (13 mm)	1/2" (13 mm)	1/2" (13 mm)	1/2" (13 mm)

Insulated Exterior Piping	Unless otherwise indicated, provide protective insulation shield (Type A-1 jacket) in addition to pipe insulation and jacket specified in this schedule.
Insulated Piping Subject to Abuse as Indicated on Drawings	Provide Type H insulation for hot piping and Type PP insulation for cold piping with V-1 jacket in lieu of specified insulation/jacket with same insulation thickness.

Ductwork/Equipment & Systems			
Service	Jacket Type	Insulation Type	Insulation Thickness
OA Ducts Exposed	D-1 or D-2	R	2" (50 mm)
OA Ducts Concealed	D-2	R	2" (50 mm)

Mixed Air (Outside Air & Return Air Ducts & Plenum)	D-1	R	1-1/2" (40 mm)
Supply Ducts Exposed	D-1	R	1-1/2" (40 mm)
Supply Ducts Concealed	D-2	F	2" (50 mm)
OA Intake Pipes (Medical air, lab air intake, etc.)	---	A	1" (25 mm)
Exhaust or Relief Ducts from 12" upstream of Control or BD Damper to Outside Wall or Roof	D-1	R	1-1/2" (40 mm)
Return and Relief Ducts in Equipment Rooms	D-1	R	1-1/2" (40 mm)
Return Ducts in _____	D-2	F	2" (50 mm)
Supply Ducts Exterior	D-3	S	____
Supply Air Diffuser Plenums or Back-pans (concealed)	D-2	F	1-1/2" (40 mm)
Active Chilled Beam Primary Air Plenums	D-2	F	1-1/2" (40 mm)
Return Ducts Exterior	D-3	S	_____
Exhaust Ducts Exterior	D-3	S	3" (75 mm)
Exhaust Ducts Serving Cold Rooms	---	A	1" (25 mm)
Exhaust Ducts Downstream from Heat Recovery Units - Exposed	D-1	R	1" (25 mm)
Exhaust Ducts Downstream from Heat Recovery Units - Concealed	D-2	F	2" (50 mm)
Fume Exhaust Ducts Exterior up to Exhaust Fan Inlet.	D-3	RR	2" (50 mm)
Kitchen Grease Exhaust Ducts	---	KG	(Refer to Part 2)
Ductwork Covered with 2 h Rated Wrap	---	FR	(Refer to Part 2)
Heat Recovery Units	D-1	R	1" (25 mm)
Breechings	A-1	H	3" (80 mm)
Breechings	P-1	R	2" (50 mm)
Flue Gas Recirculation Ducts for Boilers	A-1	H	4" (100 mm)
Engine Generator Set Exhaust Pipe (up to 1200°F (650°C))	A-1	H	4" (100 mm)
Engine Generator Set Muffler (up to 1200°F (650°C))	A-1	H	4" (100 mm)
Engine Exhaust Pipe (over 1200°F (650°C))	A-2	Air Gap (1st layer) 304 SS Liner (2nd layer) C (3rd layer) M (4th layer)	1" (25 mm) (1st layer) 24 gauge (2nd layer) 2" (50 mm) (3rd layer) 3" (80 mm) (4th layer)
Active Chilled Beam Plenums	D-2	F	2" (50 mm)
Supply Air Diffuser Plenums/Back pa ns	D-2	F	2" (50 mm)
Weight-Supporting Insulation Inserts for Trapeze Hangers		G, H, P or PP	To Match System
Air Separators & Water Filters (Hot Water)	P-1	R	2" (50 mm)
Air Separators & Water Filters (Chilled Water)	---	A	1" (25 mm)
Heat Exchangers (Shell and Tube Type)	P-1	R	2-1/2" (65 mm)

Heat Exchangers (Plate and Frame Type)	---	A	1" (25 mm)
Condensate Receivers	P-1	R	2" (50 mm)
Pressure operated condensate pumps (Pump manufacturer may furnish removable insulation blanket as an option.)	P-1	R	2" (50 mm)
Flash Tanks	P-1	R	2" (50 mm)
Blowdown Separator	P-1	R	2" (50 mm)
Chilled Water Storage Tank	---	A	1" (25 mm)
Storage Tanks	---	A	1" (25 mm)
Chiller Evaporator Shell	---	A	1" (25 mm)
Water Cooled Condenser Shell	---	A	1" (25 mm)
Chilled Water Pump Heads (Removable)	(Refer to specification)	A	1" (25 mm)
Chiller Water Boxes (Removable)	---	A	1" (25 mm)
Chilled Water Expansion Tanks	---	A	3/4" (19 mm)
Humidifier Separator	P-1	R	2" (50 mm)

B. Type F insulation with Type D-2 jacket may be used in lieu of Type R insulation with Type D-1 jacket for ductwork located 6 ft (1.8 m) or higher above floor in mechanical equipment rooms. Horizontal ducts that are not completely 6 ft (1.8 m) above floor shall be insulated with Type R insulation as specified for its entirety.

3.02 INSTALLATION - GENERAL

A. All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards published by MICA (Midwest Insulation Contractors Association) and manufacturer's installation instructions, except as modified in this Section of specifications.

B. Install products with smooth and even surfaces. Use full-length factory-furnished material where possible. Do not use scrap pieces.

C. Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed. Do not insulate any section of system that must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects prior to end of guarantee period shall be accomplished at no expense to Owner.

D. Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required, and to allow for expansion.

E. Where possible longitudinal joints in jackets shall face toward wall or ceiling.

F. Apply insulation to each pipe or duct individually. Common insulation applied to adjacent pipes or ducts will not be accepted.

G. Unless otherwise indicated, pipe and duct insulation shall be continuous through walls and floors.

H. Where multiple layers of insulation are used, stagger and secure each layer with metal bands.

I. Where penetrations occur through fire-rated walls, partitions, or floors, provide fire-stopping system as specified in Section 23 00 00 - General Mechanical Requirements and Section 07 84 00 - Firestopping.

J. Insulate the following systems for complete vapor barrier protection:

(1) Chilled Water
(2) Refrigerant
(3) Cooling coil condensate drain
(4) Non-Potable Cold Water
(5) Insulated ductwork
(6) Piping and/or equipment with surface temperature below 60°F (16°C)
(7) Geothermal Water

K. Apply Type A insulation for insulation and jackets requiring vapor barrier protection where specified insulations are cut for mounting sensors, control devices, parts of valves, devices or components which extend out from specified insulation to prevent condensation.

3.03 PIPING, VALVE AND FITTING INSULATION

A. Apply insulation to pipe, unions, flanges, fittings, valves and piping specialties with butt joints and longitudinal seams closed tightly. Valve insulation shall cover entire valve body including bonnets and packing nuts.

B. Laps on factory-applied jackets shall be 2" (50 mm) minimum width firmly cemented with lap adhesive or shall be pressure sealing type lap.

C. Cover joints with factory furnished tape 3" (80 mm) minimum width) to match jacket. Cement firmly with lap adhesive. On systems requiring a vapor barrier (ASJ), vaporseal all longitudinal and butt joints ASJ/Saran seams with 4" (100 mm)wide coat of vapor barrier mastic or 3" (80 mm) minimum tape.

D. Where staples are used, they shall be on 6" (150 mm) maximum centers. When used for systems requiring vapor barrier, cover lap and staples with finish coat of vapor barrier mastic or 3" (80 mm) minimum tape.

E. For finishing of insulated pipe fittings and valves where surface temperature of insulation is not higher than 125°F (51°C), use one piece PVC fitting covers, minimum thickness of 20 mil (0.05 mm), Fitting cover shall be Johns Manville Zeston 2000 PVC, PROTO Fitting Covers, or similar by other manufacturers listed. Where fitting and valve insulation requires vapor barrier, seal joints of PVC covers with vapor barrier adhesives. Insulation type, R-value and density of insulation used at fittings shall match insulation of adjacent piping. Install insulation at pipe fittings and valves completely prior to applying PVC covers.

(1) For Type R (Rigid glass fiber) pipe insulation, PVC fitting covers with flexible mineral fiber blanket insulation inserts are acceptable, except those located in mechanical rooms within 6 ft (1.8 m) above floor. For fitting covers located in mechanical room within 6 ft (1.8 m) above floor, insulation inserts shall be pre-molded rigid fiber glass type wrapped around elbows.

F. Stove pipe style insulation on elbows (Detail A on Plate 2-200 of MICA 8th Edition) is not allowed. It may be used for closed cell elastomeric insulation.

G. Where terminations of pipe insulation are required, insulation shall have tapered ends, built up and finished as specified for fittings.

H. For pipes 1" (25 mm) and smaller, install specified pipe insulation and jacket continuous through hanger or support locations. Install insulation protection shields to protect insulation from compressing.

I. For pipes 1-1/2" (40 mm) and larger, where manufactured pre-insulated pipe supports are used at hanger or support locations, extend insulation to insulated pipe supports. Where vapor barrier is required, this Contractor shall be responsible for continuity of vapor barrier at insulated pipe supports 3" (80 mm) wide vapor barrier tape on hot and cold systems at pipe supports.

J. For pre-insulated pipe supports and insulation protection shields, refer to Section 23 05 29 - Mechanical Piping and Equipment Supporting Devices.

K. For Contractor-fabricated anchors, secure insulation directly to pipe surface and extend insulation up anchor for distance of 4 times insulation thickness. For pre-insulated anchors, cover entire surface of anchors with Type A insulation. Where applicable, take special care to assure vapor seal at anchor.

L. Where mechanical grooved pipe connections are used in piping system, insulate couplings as specified for pipe.

M. Piping, fittings, and valves not to be insulated:

(1) Heating hot water piping inside fin tube radiation enclosures

(2) Control valves and balancing valves for heating terminal devices

(3) Valves and steam traps furnished with removable insulation/jacket

3.04 EQUIPMENT INSULATION

A. For equipment requiring _____ insulation such as breechings, stacks, exhaust pipes and mufflers, apply insulation to equipment and secure with stainless steel bands with tightly butted joints as recommended by manufacturer. Where multiple layers of insulation are required, stagger and secure each layer with stainless steel bands.

B. Install removable insulation where access is required for cleaning, repair, and inspection. Construct removable insulation with Type A insulation for cold equipment and Type R insulation with V-1 jacket for hot equipment. Do not apply bonding adhesive to equipment surface.

C. Provide removable insulating blankets on expansion joints.

D. Do not insulate over equipment nameplates or ASME stamps. Bevel and seal insulation at these locations.

E. Water chiller insulation shall include insulation of evaporator shell, water boxes and other miscellaneous piping and/or equipment as directed by equipment supplier and scheduled above. Verify chillers are fully charged with refrigerant before insulating.

F. Chilled Water Pump Insulation Box

(1) Provide removable insulating boxes where shown on Drawings and where access is required for cleaning, repair, and inspection, including pump heads and strainers.

(2) Construct removable insulating boxes with split metal enclosures using minimum 24 ga galvanized sheet metal lined with insulation as scheduled above. Adhesive shall be as specified above.

(3) Do not apply bonding adhesive to equipment surface.

(4) Finish interior surface of insulating box to allow removal without damage. Provide fastener, supports and membranes.

G. Equipment not to be insulated:

(1) Equipment furnished with factory insulation.

3.05 DUCTWORK AND COMPONENTS

A. Apply duct insulation evenly over duct surface. Unless otherwise indicated, insulation and jacket shall run continuously between duct and duct supports. Maintain insulation thickness specified over duct reinforcing members.

B. For support points of ducts supported by trapeze hangers, place weight-supporting insulation at bottom of duct over trapeze. Weight supporting insulation inserts shall be minimum 6" (150 mm) wide and cover entire bottom of duct. Insulation insert shall have same thickness as insulation specified. Size inserts based on compression strength and weight being supported.

C. Insulation may be installed outside of support for rectangular or oval ducts having width 60" (1500 mm) or smaller or round ducts 24" (600 mm) or smaller, and supported with strap hangers, provided that vapor barrier integrity is maintained at strap penetration.

D. For support points of round ducts 16" (400 mm) diameter and larger, place weight-supporting insulation between duct and strap or trapeze. Weight-supporting insulation shall be minimum 6" (150 mm) long with same thickness as insulation specified and shall be Type G, H, P or PP insulation. Size inserts based on compression strength and weight being supported.

E. Securing glass fiber insulation (Type F, R, and RR) for rectangular or oval ductwork.

(1) Horizontal ductwork:

(a) Secure to bottom of duct where duct width is 24" (600 mm) diameter or greater.

(b) Secure to sides of duct where duct side is 24" (600 mm) diameter or greater.

(2) Vertical ductwork:

(a) Secure to all sides where duct width is 18" (450 mm) diameter or greater.

(3) Install fasteners as required to secure, but not over 18" (450 mm) on center and within 3" (80 mm) of butt joint or edge.

(4) Fastener shall be weld pin mechanical type.

F. Fastening insulation anchors to ductwork with adhesives is not allowed. Where weld pin fasteners are used, install them without damage to interior galvanized surface. Where weld pin fasteners cannot be used, use other type of fasteners such as metal bands.

G. Where ductwork is specified to be insulated, entire system including components with external surfaces equivalent to duct exterior (filter housings, mixing air chambers, air measuring stations, reheat coils, life safety dampers, sound attenuators, etc.) shall be insulated and integrity of vapor barrier shall be continuous. For life safety dampers in ductwork requiring insulation, install insulation and jacket to wall and apply vapor barrier sealant to prevent condensation. Coordinate inspection requirements with local Authority Having Jurisdiction before concealing life safety dampers.

H. Where ductwork is specified to be internally lined, duct system components which are not lined (filter housings, mixing chambers, air measuring devices, reheat coils, sound attenuators, etc.), shall be externally insulated and vapor barrier jacket shall be sealed to duct. External insulation shall extend a minimum of ____ in each direction from component.

I. Provide insulation over back pan or plenum of supply air diffusers, registers, or grilles primary air plenums of active chilled beams, and unlined boots after termination point of flexible ducts or rigid duct insulation to prevent sweating.

J. Where vapor barrier jackets are specified, pins and staples if used shall be jacketed over with matching material using 4" (100 mm) tape. Vaporseal insulation seams, punctures, and tears with two 4" (100 mm) wide tape.

K. Insulation without factory jacket shall be cut and mitered to suit surface. Build up voids, seams and joints with insulating cement, cover with glass fabric as specified herein and finish to smooth surface.

L. D-1 jackets:

(1) Butt together joints and seams firmly, cover with glass fiber fabric 4" (100 mm) minimum width. Where operating fluid is below dewpoint of space, finish with 2 coats of vapor barrier mastic.

M. D-2 jackets:

(1) Butt together joints and seams firmly and cover with 4" (100 mm) wide FSK tape.

N. D-3 jackets:

(1) Install jacket in strict accordance with manufacturer's installation requirements.

(2) For rectangular ducts, overlap bottom half jacket and top half jacket at each side of duct at least 4" (100 mm) (bottom inside top outside at overlap).

(3) For round ducts, wrap duct insulation continuously with spiral shaped overlapping. Overlap at least 4" (100 mm).

(4) Use welded stickpins for Type D-3 jacketing wider than 24" (600 mm) in width alongside and bottom surfaces of ducts. Retainers of stick pins shall be covered with Type D-3 patch, minimum ____ square, once retainer cup is in place on stick pin.

O. Acoustical Barrier Materials:

(1) Provide 2" (50 mm) thick Type R insulation with Type D-1 jacket as inner layer. Over insulation install acoustical barrier materials as outer layer in accordance with manufacturer's installation instruction.

(2) For ductwork specified with Type F insulation, replace it with insulation specified above.

(3) Refer to plans for ductwork requiring acoustical barrier materials.

P. Ductwork not to be insulated:

(1) Internally lined ductwork.

(2) Ductwork components with factory installed insulation.

(3) Exposed supply and return ductwork in _____.

3.06 PROTECTIVE INSULATION SHIELD (A-1 JACKET) FOR PIPE JACKETS EXTERIOR TO BUILDING

A. Unless otherwise indicated, install shields (A-1 jacket) around insulated pipe and fittings exterior to building. Seal water and vapor tight at terminations.

B. Longitudinal overlap shall be at least 2" (50 mm) wide with vapor barrier sealant.

C. Secure jacketing with 3/4" (19 mm) wide .015" (.38 mm) stainless steel or 3/4" (19 mm) wide .020" (.51 mm) aluminum bands and wing seals on maximum 18" (450 mm) centers.

3.07 TYPE FR INSULATION (FIRE RESISTIVE DUCT WRAP)

A. Install Fire Resistive Duct Wrap system in accordance with manufacturer's instructions and referenced Standards.

B. Where duct is specified to have Type FR wrap, and other insulation is indicated in Ductwork/Equipment System Schedule in this Section, other insulation does not need to be provided in addition to Type FR wrap.

3.08 TYPE KG INSULATION (KITCHEN GREASE DUCT WRAP)

A. Install Fire Resistive Duct Wrap system in accordance with manufacturer's instructions and referenced Standards.

B. Where duct is specified to have Type KG wrap, and other insulation is indicated in Ductwork/Equipment System Schedule in this Section, other insulation does not need to be provided in addition to or Type KG wrap.

3.09 TYPE G INSULATION (CELLULAR GLASS)

A. Install cellular glass insulation system in strict accordance with manufacturer's installation instructions.

B. Chilled Water Piping (Interior):

(1) Butter joints of insulation with Pittseal 727 or 444N Sealant. Apply insulation to pipe and fittings with joints tightly fitted and sealed full depth with joint sealant. Secure each length of insulation with 1" (25 mm) wide filament tape and stainless steel wire over tape. Apply insulation with joints fitted to eliminate voids. Eliminate voids by refitting or replacing insulation. Do not fill voids with joint sealer.

(2) Finish with specified jacket, joints and laps sealed with fire rated adhesive. Finish elbows and fittings with white PC-79 polyester fabric coated with Pittcote 404.

C. Chilled Water Piping (Underground):

(1) Apply insulation to pipe and fittings with joints tightly fitted. Hold each section of insulation in place with minimum 2 stainless steel wires.

(2) Apply insulation with joints fitted to eliminate voids. Eliminate voids by refitting or replacing insulation. Do not fill voids with joint sealer.

(3) Finish underground insulation with Type E-3 jacket and install in accordance with Pittsburgh Corning Bulletin FI-213, "Foamglas Insulation Systems for Underground Direct Burial Applications" and Product Data Sheets, FI-234, and FI-155, "Pittwrap SS Primer".

D. Steam and Steam Condensate Piping (with Type A-1 jackets):

(1) Apply insulation to piping with all joints dry and tightly fitted without voids. Do not use glue on joints.

(2) Secure insulation to piping with 1" (25 mm) wide, high tensile strength, fiber reinforced strapping tape similar to Scotch Brand Filament Tape and stainless steel wire over tape. Apply tape on equal spacing such that there are 2 rounds of tape per insulation section. Overlap tape minimum 50%.

(3) Apply aluminum jackets over insulation.

(a) Seal water and vapor tight at terminations.

(b) Longitudinal overlap shall be at least 1/8" (3 mm) wide bead with metal jacketing sealant.

(c) Secure jacketing with 3/4" (19 mm) wide .015" (.38 mm) stainless steel or 3/4" (19 mm) wide .020" (.51 mm) aluminum bands and wing seals on maximum 18" (450 mm). Provide minimum of 2 bands per section.

E. Steam and Steam Condensate Piping (Underground Direct Buried)

(1) Install insulation and jackets in accordance with Pittsburgh Corning Bulletin FI-213, Foamglas Insulation Systems for Underground Direct Burial Applications, and other appropriate Pittsburgh Corning product data sheets.

3.10 TYPE P AND PP INSULATION (POLYISOCYANURATE)

A. Install insulation with specified insulation jacket in accordance with manufacturer's installation recommendations. Insulation shall be tightly butted and free of voids and gaps at joints. Use 3" (80 mm)wide tape at butt joints with minimum 1.25 times circumference wrapping. Apply insulation joint sealant in longitudinal and butt joints.

B. Install pre-fabricated tight fitting insulation pieces on fittings, elbows, tees and valves.

C. Insulation at fittings and valves shall be the same thickness as on pipe section.

D. Replace Type P insulation and jacket with Type R insulation of same thickness with Type P-1 jacket at penetration of fire rated walls and floor slabs where fire stopping system is required.

3.11 TYPE S INSULATION (POLYSTYRENE)

A. Pipe:

(1) Use sectional insulation (semi-circular form) for pipe sizes 10" (250 mm) and smaller. Use segmental or sectional insulation for pipe sizes above 10" (250 mm).

(2) Plain sectional insulation shall be applied so that end joints are broken by making one-half of first section 18" (450 mm) long and leaving other half 36" (915 mm) in length. Longitudinal joints shall be on top and bottom of pipe. Apply insulation with sealer such as Foster 30-45 Foam-seal or Childers CP-70 Chil Joint on joints of single layer and outer layer insulation with band placed approximately 80 mm or 3 or 4-1/2" (80 or 115 mm) (see band schedule) back from end joints. Do not cement insulation to pipe. Omit joint sealer from inner layer of double layer insulation.

(3) Plain insulation lagging (blocks) for segmental insulation may be factory fabricated or beveled lagging assembled on job. Lags shall fit pipe snugly and maximum width of each lag shall be such as to leave not more than 1/8" (3 mm) void between pipe and joints of segments. Joints shall be broken by, starting with alternating 18" (450 mm) and 36" (915 mm) lags. Apply sealer and bands same as specified for plain sectional insulation.

(4) Apply pipe insulation in double layer construction with joints staggered (2 layers at 1" (25 mm) thick each).

B. Fittings, Valves and Flanges:

(1) Insulation at fittings shall not be of less thickness than insulation on adjacent piping. Fitting insulation (covers) shall be held together and applied with sealer. Insulation on welded fittings shall fit snugly to fitting contour and shall be applied in same manner and with same materials as specified for pipe.

(2) Apply fitting insulation with sealer on joints and band insulation in place using not fewer than 2 bands on threaded fittings and 4 bands on flanged fitting.

(3) Insulate threaded fittings before straight pipe is covered. Insulate flanged fittings after straight pipe is covered.

C. Band Material:

(1) Secure single layer or outer layer insulation with stainless steel bands, 6" (150 mm) spacing for insulated outside diameter under 12" (300 mm) and 9" (230 mm) spacing for 12" (300 mm) and over.

(2) Secure inner layer insulation with stainless steel bands 9" (230 mm) spacing.

(3) Tighten bands with mechanical tightening tool and secure with 304 stainless steel wing type seals.

D. Vapor Barrier and Jacket:

(1) Finish plain pipe insulation, fittings, valves, and flanges with vapor barrier mastic.

(2) After thoroughly dry, apply service jacket (Type P-1) and insulation shield jacket (Type A-1).

3.12 ENGINE EXHAUST PIPE INSULATION (OVER 650°C (1200°F)

A. Install engine exhaust pipe (4-layer system) in accordance with the following and as detailed on drawings.

B. 1st Layer:

(1) Provide insulation spacer (stand-offs), tack-welded to exhaust pipe, to create specified air space and support for liner (2nd layer). Insulation spacer material shall be of same material as exhaust pipe and shall be minimum of 1/8" (3 mm) thick. Refer to details on drawings for quantity and location of insulation spacers.

C. 2nd Layer:

(1) Liner shall be mechanically fastened to insulation spacers with stainless steel tap screws or bolts.

D. Insulation Support Tabs:

(1) Provide insulation support tabs fastened through liner and into insulation spacers for support of 3rd layer and 4th layer of insulation system.

(2) Support tabs shall be _____ and shall be segments of structural angle or fabricated bent plates in angle configuration, minimum 1/4" (6 mm) thick, with one leg being 1/2" (13 mm) short of outer jacket. The other leg shall be 2" (50 mm). Support tabs shall not come in contact with outer jacket. Provide support tab at each insulation spacer around circumference of pipe at not more than 60" (1500 mm) apart on vertical pipes. Refer to details on drawings.

E. 3rd Layer:

(1) Where multiple layers are required, stagger insulation joints and seams. Insulation shall rest on insulation support tabs and shall be secured in place with stainless steel bands.

F. 4th Layer:

(1) Where multiple layers are required, stagger insulation joints and seams. Insulation shall rest on insulation support tabs and shall be secured in place with stainless steel bands.

G. Outer Jacket:

(1) Finish system with specified outer jacket.

END OF SECTION 23 07 00

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.01 DESCRIPTION

A. Commissioning of HVAC is the process of ensuring that the HVAC System is installed and performs interactively according to the basis of design criteria and meets the building's operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up, and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the HVAC System from installation to complete dynamic operation and optimization.

B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Agent (CxA). Primary elements of Commissioning during the construction, acceptance, and warranty phases of the project include:

(1) Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.

(2) Demonstrate functional operational performance of equipment and systems in the commissioning program.

(3) Verify Operations and Maintenance (O&M) documentation submitted is complete. Provide required documentation and information to the General Contractor to allow compilation of Building Systems Manuals in accordance with Section 01 78 23 - Building System Manuals (O&M).

(4) Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.

(5) Verify systems are interacting and performing optimally in accordance with the system sequence of operations.

(6) Furnish labor and material to accomplish HVAC system commissioning and systems testing as specified herein and other related sections.

1.02 RELATED SECTIONS

A. Section 01 79 13 - Demonstration and Training

B. Section 01 78 23 - Building System Manuals (O&M)

C. Section 01 91 13 - General Commissioning Requirements

D. Section 01 91 14 - Functional Testing Requirements

1.03 SUBMITTALS

A. Refer to Section 01 91 13 - General Commissioning Requirementsfor commissioning submittal requirements. Provide copies of commissioning submittal requirements to the Commissioning Agent, in addition to the copies required by the Owner and Design Professional.

1.04 COORDINATION

A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 - General Commissioning Requirements for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.

C. Datalogging equipment or software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.01 COMMISSIONING

A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13 - General Commissioning Requirements.

B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting Contractor Pre-Testing. Both of these documents are required prior to the CxA scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.

C. Construction Checlists for each type of equipment and system shall be provided to the installation contractors by the CxA via the web-based commissioning application for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.

D. For equipment and system components requiring a manufacturer's representative for Construction Checklists and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the CxA.

E. Functional Testing Procedures for each type of equipment and system shall be provided to the installation contractors by the CxA for use by the contractor in documenting the performance of the Contractor Pre-Testing. Refer to Section 01 91 14 - Functional Testing Requirementsfor further information.

F. Completed Start-up checklists and performance test documentation for all pieces of equipment shall be submitted by contractors to the CxA through the General Contractor prior to the scheduling of the final Functional Performance Testing that is witnessed by the CxA.

3.02 TRAINING

A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of 01 79 13 - Demonstration and Training and 01 79 13A - Demonstration and Training Sample Agenda.

3.03 OPERATIONS AND MAINTENANCE DATA

A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications

3.04 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing

(1) Refer to Sections 01 91 13 - General Commissioning Requirementsand 01 91 14 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment systems.

END OF SECTION 23 08 00

SECTION 23 09 01 - CONTROL SYSTEMS INTEGRATION

SECTION 23 09 01 – CONTROL SYSTEMS INTEGRATION

PART 1 GENERAL

2.01 RELATED WORK

A. Section 20 0513 - Motors
B. Section 20 0553 - Mechanical Systems Identification
C. Section 23 0550 - Vibration Isolation
D. Section 23 0902 - Control Valves and Dampers
E. Section 23 0903 - Control Instrumentation
F. Section 23 0923 - Direct Digital Controllers and Networks
G. Section 23 0993 - Control Sequences
H. Section 23 2118 - Valves
I. Section 23 3600 - Air Terminal Devices
J. Section 23 3614 - Laboratory Temperature and Airflow Control System
K. Section 26 0000 - General Electrical Requirements
L. Section 26 0519 - Conductors and Cables
M. Section 26 0533 - Raceway and Fittings
N. Section 27 1500 - Communications Horizontal Cabling
O. Control Sequences: Refer to Drawings

2.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.
B. ASHRAE FUNDAMENTALS IP - (2013) Fundamentals Handbook, I-P Edition
C. ASHRAE 135 - (2016) BACnet - A Data Communication Protocol for Building Automation and Control Networks (ANSI Approved)

2.03 DEFINITIONS

A. The following abbreviations, acronyms, and definitions may be used in addition to those found elsewhere in Contract Documents.
   (1) Actuator: Control device to provide motion of valve or damper in response to control signal.
   (2) AI: Analog Input
   (3) AO: Analog Output
   (4) Analog: Continuously variable state over stated range of values
   (5) Auto-Tune: Software routine used to adjust tuning parameters based on historical data.
   (6) BAS: Building Automation System
   (7) BMS Building Management System
   (8) DDC: Direct Digital Control
   (9) DDCP: Direct Digital Control Panel
   (10) Discrete: Binary or digital state
   (11) DI: Discrete Input (Sometimes referred to as Binary Input BI)
   (12) DO: Discrete Output (Sometimes referred to as Binary Output BO)
   (13) EMCS: Energy Management and Control System (Typically interchangeable with BAS or BMS)
   (14) E/P: Voltage to pneumatic transducer (Often solenoid valve is referred to as an E/P transducer)
   (15) FA Field Adjustable
   (16) FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
   (17) FLP Fail Last Position
   (18) FMS: Facility Management System linking two or more BAS
   (19) FO: Fail Open position of control device or actuator. Device moves to open position on loss of control signal or energy source.
   (20) I/P: Current to pneumatic transducer

(21) Instrument: Device used for sensing input parameters or used for actuation.

(22) Modulating: Movement of control device through an entire range of values proportional to an infinitely variable input value.

(23) Motorized: Control device with actuator

(24) NC: Normally Closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.

(25) NO: Normally Open position of switch after control signal is removed or normally open position of manually operated valves or dampers.

(26) Node: DDCP, operator workstation, or other control device connected to communications network.

(27) Operator: Same as actuator for motorized devices. Also refers to an individual who physically "operates" facility.

(28) PC: Personal Computer

(29) Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each share its database values with other devices connected to network.

(30) P: Proportional control, control mode with continuous linear relationship between observed input signal and final controlled output element.

(31) PI: Proportional - Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controlled variable (reset control).

(32) PID: Proportional - Integral - Derivative control, control mode with continuous correction of final controlled output element versus input signal based on proportional error, its time history (reset), and rate at which its changing (derivative).

(33) Point: Analog or discrete instrument with addressable database value.

(34) Self-Tune: Same as Auto-Tune

(35) Solenoid: Electric two-position actuator. (See E/P.)

(36) TCC: Temperature Control Contractor (Same as Control Contractor)

(37) TCP: Temperature Control Panel

2.04 ACCEPTABLE CONTROL CONTRACTORS

A. Control Contractor shall have full-service office within 100 miles (160.93 kilometers) of project site. Full-service office is defined as being home office of applications engineers, supervisors, and field technicians, having complete parts inventory, and having required test and diagnostic equipment. Control Contractors shall be factory authorized agent or dealer of controllers and control hardware as manufactured by:

(1) Johnson Controls, Inc by Harrison Energy Partner.

(2) Siemens Building Technologies by Powers of Arkansas

B. Bids will be accepted only from prequalified Control Contractor per "Instruction to Bidders".

2.05 SYSTEMS DESCRIPTION

A. System shall be electric and/or electronic.

B. Control system shall be Direct Digital Control (DDC).

C. Damper and valve actuators shall be electronic type, unless otherwise noted.

D. Control system shall be 100% DDC unless otherwise indicated.

E. New BAS shall seamlessly integrate with existing site Niagra front end server. Existing web server shall be able to access and read all input, output and calculated points and issue commands to all output points in new BAS by means of a standard web browser. Contractor shall provide necessary hardware and software components to accomplish this interface.

F. Provide modular designed stand-alone controllers capable of future BAS architecture with peer-to-peer and/or low/medium speed communication networks. Upgrade to full BAS architecture shall not require removal of existing controllers, sensors, actuators, etc.

G. BAS network architecture shall be based on an Open implementation of BACnet using ASHRAE 135-2016 exclusively as the communications protocol for communication between DDC Hardware devices, including BAS Web Server, to allow multi-vendor interoperability.

H. Building Automation System (BAS) shall control building's HVAC components and provide interface with Lighting Control System.

I. Provide BAS architecture consisting of communication network, controllers and instrumentation. BAS shall be fully expandable with addition of hardware and/or software. Expansion shall not require removal of existing controllers, sensors, actuators, or communication networks.

J. System shall support operator workstations as specified and shall be capable of additional workstations, limited only by systems maximum node capacity.

K. System intelligence shall be such that operator workstation(s) can be used for programming controls, performing analysis on filed data, generating maintenance and operation reports and providing permanent storage for programs and data.

L. Workstation PCs and printers will be furnished by Owner.

M. Safety devices shall function in both auto and hand modes on starter, and on VFD in auto, hand or bypass modes.

(1) Dampers interlocked with fans shall operate in both auto and hand modes to prevent dead-head of fans.

(2) Valves interlocked with pumps shall operate in both auto and hand modes of operation to prevent dead-head of pump.

(3) All safeties shall be hardwired through starter/VFD safety circuit to prevent unsafe operation when in either auto or hand modes.

2.06 SCOPE OF WORK

A. Provide all labor and materials for complete fully functioning control systems in accordance with Contract Documents included in this Section plus:

(1) Section 23 0902 - Control Valves and Dampers

(2) Section 23 0903 - Control Instrumentation

(3) Section 23 0923 - Direct Digital Controllers and Networks

(4) Section 23 0993 - Control Sequences

B. Engineering services shall be performed by Factory Trained Engineers. System shall be installed either by trained mechanics directly employed by Control Contractor or by subcontractors who are under direct supervision of Control Contractor's representative. Engineer reserves right to exclude Project Managers, Engineers, Field Supervisors, or Technicians whose past experience is not sufficient to meet needs of Project.

C. Control Contractor’s Project Managers, Engineers and Digital System Programmers shall have previously performed in capacity that qualifies them to successfully engineer system of scope and magnitude similar to this Project.

D. Submit qualification of Project Managers, Engineers, Programmers, Field Supervisors, and Technicians to be assigned to this Project within 30 days after contract award. Use Qualification Form attached at end of this Section.

E. Labor shall include, but not be limited to:

(1) Engineering services to size unscheduled valves and dampers based on design criteria specified in Section 23 0902 - Control Valves and Dampers, and confirm sizing of scheduled valves and dampers.

(2) Engineering services to produce requested submittals and working construction drawings and record drawings as specified here within.

(3) Engineering services for required software programming.

(4) Engineering services for graphics programming specified.

(5) Engineering services for mapping control points from Laboratory Temperature and Airflow Control System (Section 23 3614), if provided for the project.

(6) Engineering services for BAS Ethernet network design.

(7) Project management services as single point contact to coordinate construction related activities.

(8) Field mechanics for installation of pneumatic tubing and related control devices.

(9) Field mechanics for installation of control wiring and related control devices.

(10) Field technicians to startup, calibrate, adjust, and tune control loops.

(11) Field technicians to perform system checkout and testing, and to complete required reports.

(12) Field supervisor during controls installation and startup.

(13) Field technicians to assist Mechanical Contractor and Testing and Balancing (TAB) Contractor in adjusting controls and determining setpoints related to TAB work.

(14) Field representatives and/or classroom instructors to provide Owner training as specified.

F. Control Contractor shall be responsible for complete installation of control devices (except as noted), wiring, and pneumatic terminations at controller locations to accomplish control sequences specified in project manual or on drawings. Control Contractor is required to provide power for air terminal controllers and other field mounted devices that require 24 VAC, 60 Hertz and shall be powered from 120 to 24 VAC transformer panels provided by Control Contractor. Control Contractor shall also be responsible for additional instrumentation described in point schedules found in Contract Documents, which may not be directly related to specified control sequences.

(1) Control contractor shall provide unique tag numbers for all devices under this specification and reference those tag numbers in control sequences and control diagrams.

(2) If Owner has tagging convention, Control contractor shall utilize it. If no tagging convention exists, Control contractor shall provide one for all devices under this specification.

G. Mechanical Contractor shall provide wells, taps, and other mechanical interfaces required for control equipment mounting into piping systems. Mechanical Contractor shall install in-line mounted devices, such as valves, dampers, flow meters, static pressure probes, etc., furnished by Control Contractor. Control Contractor shall be responsible for installation of other control devices, such as actuators, linkages, sensors, air terminal controllers, flow transducers, remote mounted control devices, control panels, control transformers, etc.

H. Electrical work required as integral part of control work is responsibility of Control Contractor. Control Contractor is responsible for providing final power connections, including conduit, wire, and/or disconnect switches, to control devices from appropriate electrical distribution panels.

(1) Electrical Contractor will provide circuit breakers required to provide electrical power to controllers.

(2) 120 to 24 VAC transformer panels shall be provided by Control Contractor and mounted adjacent to controller panels or in Electrical Rooms, Telecommunications Rooms and/or (IDF/EIDF) rooms, or as indicated on plans and powered from dedicated electrical circuit.

(3) Should any change in number of controllers or addition of other electrical equipment after Contracts are awarded, Control Contractor shall immediately notify Electrical Contractor of change. Additional costs due to these changes shall be responsibility of Control Contractor.

(4) Coordinate with Electrical Contractor for additional power requirements.

I. Provide temporary Ethernet network for communications between Ethernet-based controllers and BAS servers (Web & Data Historian) until building IT network is available for use by BAS. Temporary Ethernet network and all other communications required for BAS shall be installed as required for specified operation of mechanical equipment to allow check out and commissioning of equipment in timely manner.

J. Additional BAS data drops (from telecommunication room patch panel to field jacks/patch panels) that are not accounted for in contract documents can be provided by Control Contractor in one of two ways:

(1) Option 1:

(a) Control Contractor shall sub-contract at control contractor’s expense the project’s Structured Cabling Contractor to install additional data drops.

(2) Option 2:

(a) Control Contractor can provide their own data drops but must exactly match all cabling and hardware installed by Structured Cabling Contractor as indicated in the following spec sections:

1) 27 000 – General Communication Requirements
2) 27 0528.33 – Raceway and Boxes for Communication System
3) 27 1000 – Structured Cabling
4) 27 1300 – Communications Backbone Cabling
5) 27 1500 – Communications Horizontal Cabling
6) 27 1600 – Communications Connecting Cords Devices and Adapters

(3) If Control Contactor chooses Option 2, submit to EOR a separate control submittal including all material and proposed locations for data jacks for approval prior to installation.

(4) Coordinate final Telecommunications room patch panel connections with network installation Contractor.

K. Control Contractor shall be responsible for maintaining master IP address list for all BAS devices throughout project to be handed over to Owner upon completion.

L. Materials shall be as specified unless approved through procedures for product substitution specified in Division 01. Control Contractor shall provide components not specifically indicated or specified, but necessary to make system function within the intent of specification.

M. If during the installation period any of the factory equipment or material provided in the system is found to be defective in material or workmanship, it shall be replaced or repaired by Contractor at no additional cost to the Owner within 24 hours from the time the problem was reported/discovered.

N. Any part/device or equipment installed as part of this contract found to be malfunctioning or defective during the warranty period shall be replaced by Contractor within 24 hours from the time the problem was reported.

O. Electrical products shall be listed and labeled by UL and comply with NEMA Standards.

P. All controls and wiring used for smoke control/life safety shall be UL 864 UUKL rated.

Q. Provide weather protection cover or weatherproof control devices where required for control devices located outdoors.

R. Provide tamper resistant screws and fasteners for equipment located in accessible and/or public areas.

S. Contractor is responsible for integration of the following independent systems into BAS:

(1) Electrical Metering:

(a) Electrical Metering provider will provide Modbus TCP connection(s) for interfacing to BAS. Control contractor responsible for a BAS solution to communicate data directly or through a gateway to all suppliers listed in Division 26 for Electrical Metering. Control contractor and Electrical Metering provider responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to control diagrams, Section 26 2413 Switchboards and Section 26 2713 Electrical Metering for programming and monitoring requirements.

(2) Fire Alarm System (FAS) Monitoring:

(a) FAS provider will provide contact termination points and/or addressable relays for connection to BAS for Smoke Control and Equipment Shutdown. Contractor shall supply cabling, conduit, and hardware necessary to make connections from BAS to FAS. Contractor and FAS provider are responsible for coordination of testing point connections between systems, and joint commissioning of systems. Contractor to refer to Control Diagrams, DDC Point Schedules and Control Sequences for programming and monitoring requirements.

(3) Lighting Control System (LCS):

(a) LCS provider will provide appropriate network termination points for connection to BAS. Contractor shall supply cabling, conduit, and gateway (if necessary) to make an interface connection from BAS to LCS point of connection. Contractor is responsible for a BAS solution to communicate data directly or through a gateway to all suppliers listed in Division 26 for LCS bidders. Contractor and LCS provider are responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Contractor to refer to Control Diagrams, DDC Point Schedules, and Division 26 for programming and monitoring requirements.

(4) Variable Frequency Drives (VFD):

(a) VFD provider will provide a termination point for a single point communication connection to the BAS utilizing BACnet MS/TP protocol. Contractor shall provide cabling and conduit to make an interface connection from the BAS to the VFD. Contractor and VFD provider responsible for translation of network protocols, testing of communications between systems, and joint commissioning of systems. Contractor to refer to Control Diagrams, DDC Point Schedules, and Section 20 0514 Variable Frequency Drive (VFD) System for programming and monitoring requirements.

2.07 SUBMITTALS

A. Technical Proposal:

(1) Submit, directly to Engineer on bid day, 3 copies of technical proposal. Technical proposal shall include written and/or graphic representation of proposed BAS architecture including quantity and types of controllers to be used at each location. Show or describe routing of communication networks. Include product data sheets for proposed controllers and sensors. Provide complete, detailed description of software packages to be used. Use pre-printed shop drawing materials with technical details in lieu of sales literature whenever they are available.

(2) Submit resumes of subcontractors to be used for project. List projects of similar size and scope. List shall include name and location of project, dollar value of control contract, date completed, and references. References shall include name and phone number of contact person.

B. Extended Service Agreement:

(1) Control manufacturer shall, upon completion of warranty period, make available to Owner annual service agreement covering all labor and material required to effectively maintain control system after warranty period. Owner reserves the right to accept or reject any such offers and to cancel on-going agreements with 30-day written notice.

(2) During extended service period, Contractor shall maintain Operation and Maintenance manuals to reflect all changes made to BAS.

C. Shop Drawings:

(1) Submit manufacturer's printed product data sheets for control devices and materials listed in bill of material in Control Contractor's control drawings. Datasheets shall be submitted electronically in pdf format with programmed bookmarks. When a manufacturer’s data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Data sheets shall include sufficient technical data to describe instrument parameters required as specified.

(a) All submitted PDF documents shall have electronic bookmarks setup to quickly and easily locate documents and submitted information. Bookmarks shall be set up as follows:

1) Shop Drawings:

1. Each major system (AHUs, Heating systems, Cooling systems, etc.) shall have a master bookmark programmed with all documentation for the system grouped in order under a single bookmark for that system. Subgroups under the main bookmark should be divided in a minimum of: flow diagram/bill of material, wiring detail, control sequence, point list.

2. Each minor system (Air Terminals, FCUs, Plumbing systems, Electrical systems etc..) shall have a master bookmark programmed for the type of system with bookmarks under the master for each type of minor system. All documentation for the system shall be grouped in order under a single bookmark for equipment type but subgroups for flow diagrams, control sequences, point list etc. are not required.

2) Device Data Sheets:

1. Device Data Sheets for all equipment specified in 23 0902, 23 0903, and 23 0923 shall have bookmarks organized in alpha numerical order by part number. Part numbers can and should be grouped by major category such as Valves, Dampers, Temperature sensors, Actuators, etc.

3) Hyperlinks:

1. Hyperlinks can be used to enhance the bookmark tools but are not an acceptable substitute for electronic bookmarks.
2. If hyperlinks are used, they should be clearly identifiable as a hyperlink but using a different color text similar to how MS Office documents identify hyperlinks.

(2) Submit data concerning type of signal wiring and installation methods including raceway types and grounding methods.

(a) Submit voltage drop calculations for all low voltage DDC circuits. Voltage drop to include number of devices and wiring run lengths, calculated voltage available at each device.

(3) Submit control drawings in pdf format with bookmarks provided for each system and table of contents with links to each page. Control drawings shall include, but are not limited to, the following:

(a) Overall system/network architecture drawings: Provide block diagram showing relationship of each controller, control panel, or other network devices relative to each other. Label room location of each device. Number and indicate model number of each device. Indicate network types.

(b) Control Drawings: Including graphic representation of systems with major in-line components to properly locate all control devices. Identify controlled devices with their software designation on drawings, including unique valve and damper tag numbers.

(c) Detailed wiring and piping diagrams showing point-to-point hookup details of transducers, relays, outputs, inputs and subsystem components. Label pneumatic lines and control wires with field ID numbers/colors.

(d) Bill of material identifying actual product model number used for each control device for each schematic control drawing.

1) Bill of material shall be included on flow diagrams for each system and on panel layouts showing panel components.

(e) Drawings showing proposed locations of sensors and flow meters in ductwork and piping systems.

(f) Sequence of operation: Provide written narrative describing each control sequence indicating method of control. Identify sensors, controllers, and actuators used with references to tag number of controlled device. Include set points of each control loop.

(g) BACnet Compliance Documentation: The Protocol Implementation Conformance Statement for each component.

(4) Control Instrumentation (23 0903) and Direct Digital Controllers and Networks (23 0923) submittals can be submitted as separate submittals from control shop drawings but must be submitted simultaneously with control shop drawings.

(5) Submit a sample graphic page for each type.

D. Completion Checklist:

(1) Submit with shop drawings, detailed completion checklist including written procedures for adjusting and calibrating each type of instrument and sensor. Engineer reserves the right to request modifications to any procedure, which is incomplete or not adequate to prove system performance.

(2) Checklist shall include references to the following additional requirements:

(a) Instruments and sensors shall be calibrated by comparison to known device, which is traceable to National Institute of Standards and Testing.

(b) Each point shall be checked for calibration, connection to correct control loop, and proper setting of limit and alarm values.

(c) Transducers and other output devices shall be properly zeroed and calibrated at both minimum and maximum output. Document settings for discrete instruments and set points for analog instruments shall include minimum and maximum positions for safe operating conditions where applicable (max. pump speed or max. frequency of fan drive, etc.).

(d) Control loops shall be tuned to maintain controlled process variable at set point through seasonal conditions without operator intervention. Provide multiple sets of tuning parameters if necessary. Controller shall automatically use tuning parameters appropriate to existing ambient conditions. Maintain record on completion checklist, of control loops that require tuning at alternate times of year. Instruct technicians to supply default parameters that can approximate stable control until actual load conditions allow proper tuning of control loops.

(e) Performance tests of analog control loops shall be performed by changing set points and verifying that sequences can come into stable control within reasonable time period appropriate for each sequence. Simulate load changes for pressure and flow control loops.

(f) Performance tests of discrete control loops shall be performed by adjusting set point and verifying sequence action.

(g) Alarms, including network failures, shall be tested for each controller and device connected to network. Ensure that alarms are properly acknowledged at operator's workstation.

(h) Schedules for each system/device shall be verified.

(i) Graphics shall be verified for functionality including password protection, floor plan displays, system displays, alarm messaging, historical trends, report generation and HVAC schedules.

(j) BAS Ethernet network testing and benchmarking documentation showing network performance from switch to switch.

(k) Testing of BAS to ensure cyber security. Coordinate testing requirements with Owner.

E. Control Contractor and Mechanical Contractor shall walk proposed static pressure sensor and flow meter locations and mark up drawings for review and approval by Owner and Engineer prior to installation.

2.08 WARRANTY

A. Warranty period shall begin as authorized by the Owner's representative in writing. Authorization will not be given before the following conditions are met:

(1) All verified completion checklists provided to Owner.

(2) Completion of all punch list items.

(3) Conduction of a preliminary training session for personnel. The training shall consist of an orientation session at the job site to familiarize the personnel with the location and type of controlled equipment and controls on the project, a discussion of the control sequences, and a review of the control drawings.

(4) Completion and distribution of the as-built control drawings, including correction of all items noted by Owner and Engineer after review of the documents.

B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. A telephone number where the service supervisor can be reached at all times shall be provided. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.

D. This warranty shall apply equally to both hardware and software.

E. Service personnel shall be qualified to accomplish work promptly and satisfactorily. Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

F. Scheduled Inspections:

(1) Two inspections shall be performed prior to warranty expiration and all work required shall be performed. Inspections shall be scheduled 6 months after Owner acceptance and one month prior to end of warranty period.

(2) These inspections shall include:

(a) Visual checks and operational tests of equipment.

(b) Clean control system equipment including interior and exterior surfaces.

(c) Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all digital inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital inputs and outputs during the second inspection.

(d) Run system software diagnostics and correct diagnosed problems.

(e) Resolve any previous outstanding problems.

(f) Install software upgrades, patches and fixes. Contractor to provide verification to facility personnel that all upgrades, patches and fixes to be installed have been tested in accordance with site testing and deployment procedures.

G. Scheduled work shall be performed during regular working hours, Monday through Friday, excluding holidays.

H. Dated records and logs shall be kept of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain initial analog span and zero calibration values and digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

I. Each service call request shall be recorded as received and shall include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. A record of the work performed shall be submitted within 5 days after work is accomplished.

J. Recommendations for system modification shall be submitted in writing. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected.

K. During the warranty period, the Contractor shall maintain a backup of all software installed in the system. The backup shall be updated monthly or whenever the Contractor makes a change to the software. A reload of backup software into the system shall be performed by the Contractor immediately upon notification by the Owner. The reload shall be free of charge.

L. At the end of the warranty period, the Contractor shall provide updated copies of the latest versions of all project record documentation as described in Paragraph 1.10, Record Documents. This includes final updated drawings, software documentation, and electronic media backups that include all changes that have been made to the system during the warranty period.

2.09 COORDINATION WITH TAB CONTRACTOR

A. Control Contractor shall allow sufficient time to provide assistance and instruction to TAB Contractor in proper use and setting of control components such as, Operator Workstation computers, static pressure controllers, "K" Factors for VAV boxes, or any other devices that may need set points changes so that TAB work can be performed.

B. Provide required hardware and software related to control system to TAB Contractor to allow testing of systems and continued operation.

2.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 - General Requirements.

B. Operation and Maintenance manuals shall provide descriptions of maintenance on all system components, including sensors and controlled devices. Descriptions shall include:

(1) Product manuals for the key software tasks.
  (a) Operating the system
  (b) Administering the system
  (c) Engineering the Operator workstation
  (d) Application programming
  (e) Engineering the network
  (f) Setting up the web server
  (g) Report creation
  (h) Graphics creation
  (i) Data backup & Archiving

(2) List of recommended maintenance tasks associated with the system, controllers, instruments, operator workstations, data servers, web servers, and web clients.
  (a) Define the task.
  (b) Recommend a frequency for the task.
  (c) Reference the product manual that includes instructions on executing the task.

(3) Licenses, guarantees, and warranty documents for equipment and systems.

(4) System architecture diagram for components within the building annotated with specific location information.

(5) As-built drawing for each control panel

(6) As-built wiring design diagram for each control panel

(7) As-built system flow diagram for each system

(8) Sequence of control for each system

(9) Binding map for the building
  (a) A list of the device to device data flow. This shall not include the flow of data from devices to the presentation system.
  (b) Include:
    1) Description of the variable
    2) Sending device
    3) Receiving device

(10) Product data sheet for each component
(11) Troubleshooting guide
(12) Repair parts list
(13) Calibration instructions
(14) Control Contractor's completion checklist
(15) Manufacturer representative's name, address, and phone number
(16) Refer to SUBMITTALS, Shop Drawings above for electronic bookmark requirements for electronically submitted Operation and Maintenance manuals.

2.11 RECORD DRAWINGS

A. Refer to Division 01 - General Requirements.
B. Submit revised shop drawings indicating changes made during Project.
(1) Refer to SUBMITTALS, Shop Drawings above for electronic bookmark requirements for electronically submitted record drawings
C. Record drawing submittals shall be inclusive of BAS as installed and commissioned.
D. Update control diagrams to include tuning parameters and set points applicable to systems depicted as of date of system completion. This information shall be incorporated with sequence of operation for each system.
E. Include floor plans showing location of control panels and routing of BAS network cabling.
F. BACnet systems and devices:
(1) Submit finished device addressing documentation.
(2) Submit finished hardcopy of device binding database.
G. Provide passwords, if used, for back-up and restore functions for each controller.
H. Software (as installed and commissioned)
(1) All software submittals shall be provided in a format suitable for restoration of the programming and configuration of respective digital controllers, servers, workstations and peripheral devices, etc. provided as part of the BAS.
(2) Submit a copy of all software installed on the servers and workstations.
(3) Submit all licensing information for all software installed on the servers and workstations.
(4) Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
(5) Submit all licensing information for all of the software used to execute the project.
(6) All software revisions shall be as installed at the time of the system acceptance.
I. Firmware Files (as installed and commissioned)
(1) All firmware files shall be provided in a format suitable for restoration of the programming and configuration of respective digital controllers, servers, workstations and peripheral devices, etc. provided in the BAS.
(2) Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
(3) Submit control listing of firmware version for all firmware that is permanently burned on a chip at the factory.
(4) Submit a copy of all application files that were created during the execution of the project.
(5) Submit a copy of all graphic page files created during the execution of the project.
(6) Submit a copy of all secondary graphic files such as bitmaps, jpegs, etc. that were used in the creation of the graphic pages.

2.12 OWNERSHIP OF PROPRIETARY MATERIAL

A. Owner shall retain all rights to software for this project.
B. Owner shall sign a copy of the manufacturer’s standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer’s license agreement, but shall protect the manufacturer’s rights to disclosure of Trade Secrets contained within such software.
C. Licensing agreement shall not preclude the use of the software by individuals under contract to the Owner for commissioning, servicing, or altering the system in the future. Use of the software by individuals under contract to the Owner shall be restricted to use on the Owner’s computers and only for the purpose of commissioning, servicing, or altering the installed system.
D. All project developed software, files and documentation shall become the property of Owner. These include but are not limited to:

(1) Server and Workstation software
(2) Application Programming Tools
(3) Configuration Tools
(4) Addressing Tools
(5) Application Files
(6) Configuration Files
(7) Graphic Files
(8) Report Files
(9) Graphic Symbol Libraries
(10) All Documentation.

PART 2 PRODUCTS

3.01 CONTROL WIRING

A. Control wiring shall be in accordance with National Electrical Code and Local Electrical Codes. Final connection points at devices and panels shall be made either at terminal blocks integral to device or at separate terminal blocks mounted inside of control panel enclosures. Use of wire nuts and crimped connections are not allowed for terminating control wiring unless approved by Engineer.

B. Refer to Division 26 for specification requirements for conduits and conductors, except as noted.

C. Terminal Blocks:

(1) Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

D. Signal and Power Conductors (24 V and Under):

(1) Wires smaller than #18 AWG shall not be used, except for manufacturer supplied instrument specific wire, or where otherwise specified. Use 2-wire stranded twisted/shielded pair 24 VDC for analog and discrete input and 24 VAC/VDC output devices. For 3-lead RTD signal wiring, use #18 AWG stranded, tinned copper twisted/shielded 3-conductor. Provide isolated instrument grounding system as per manufacturer's recommendations.

(2) Conductors not concealed in raceway shall have UL Listed plenum rated Teflon or low-smoke PVC jacket and insulation. Conductors not concealed in raceway used in high temperature applications or harsh environments shall have UL Listed plenum rated Teflon jacket and insulation.

(3) Provide 250 ohm, 5 watt, 0.1% tolerance dropping resistors in 4 - 20 mA circuits as required to generate 1 to 5 volt signals in 24 VDC powered instrument loops.

(4) 24 VAC Power Conductors shall be #18 AWG 2 wire twisted pair or larger. Provide Metal Oxide Varistors (MOVs) on 24 VAC/VDC discrete outputs connected to inductive loads to reduce noise levels (i.e., solenoid valves, motor contactors, relays, damper/valve electric actuators, etc.).

(5) Stranded twisted/shielded control conductors are required with shields to be terminated within variable frequency Drive enclosures to reduce effects of noise from VFD. Follow VFD manufacturer's installation instructions for wiring control conductors to VFD.

E. Communication Cable:

(1) Cable not concealed in raceway shall have UL Listed plenum rated insulation.

(2) Floor Level Network Communication Cable (Twisted Pair): Use control system manufacturer's standard communications cable or #22 AWG to #24 AWG twisted, shielded pairs, coaxial cable, or fiber optics for communications between remote controllers/devices

(3) Interior LAN Horizontal Communication Cable:

(a) Refer to specification 27 1500 - Communications Horizontal Cabling for the following requirements:

1) LAN cable requirements
2) LAN cable color
3) Termination requirements
4) Cable length and slack requirements

F. Transient Voltage Surge Suppression Devices:

(1) Devices shall be designed for 120 V power conditioning devices for electronic equipment. Devices shall be designed, manufactured, tested, and installed in compliance with ANSI/IEEE C62.41 and C62.45, Federal Information Processing Standards Publication 94 (FIPS PUB 94), NEMA, NFPA 70, 75, and 78, and UL 1449 and 1283. Devices shall be labeled for UL 1449.

(2) Clamping voltage for 120 V power systems shall be 400 V.

(3) Provide visual indicator of when surge device has been used.

G. Uninterruptible Power Supply

(1) Manufacturers: MGE UPS Systems, Eaton Powerware, Liebert PowerSure or approved equal

(2) Provide UPS for backup power for Operator Workstations, Building Level Controllers, Floor Level Controllers and field panels required for control of emergency/standby powered equipment, UPS shall maintain control upon loss of normal power and until emergency/standby power supply is brought on line.

(3) Select UPS for minimum of 5 minutes backup time for load connected. This will allow emergency/standby power sources to come on line and provide backup power to emergency/standby powered equipment.

(4) Upon sensing loss of normal power, transfer time shall be 8 milliseconds maximum.

(5) Operating Parameters:

(a) Operating Temperature: 32°F to 104°F

(b) Relative Humidity: 0 to 95% rh, non-condensing

(c) Recharge Time: 8 hours, typical

(6) UPS shall have self-diagnostic capability with DO to BAS to allow remote monitoring/alarming of UPS trouble or alarm conditions.

H. Uninterruptible Power Supply (Servers):

(1) Manufacturers: MGE UPS Systems, Eaton Powerware, Liebert PowerSure or approved equal

(2) Provide rack mounted dual/double conversion UPS for backup power for each rack-mounted Server. UPS shall maintain power to Server upon loss of normal power and until emergency power supply is brought on line.

(3) Select UPS for minimum of 20 minutes backup time for load connected. This will allow emergency power sources to come on line.

(4) UPS shall be provided with power management software and communication cable for interfacing with respective Server.

(5) Upon sensing loss of normal power, transfer time shall be 8 milliseconds maximum.

(6) Operating Parameters:

(a) Operating Temperature: 0 to 40°C

(b) Relative Humidity: 0 to 95% rh, non-condensing

(c) Recharge Time: 8 hours, typical

3.02 LOCAL CONTROL PANELS

A. Control panels shall meet the following minimum requirements:

(1) Outdoors: Control panels located outdoors shall comply with NEMA 3R or 4X requirements.

(2) Mechanical Rooms: Control panels located in mechanical or electrical rooms shall comply with NEMA 4 requirements.

(3) Other Locations: Control panels in other locations, including but not limited to occupied spaces, above ceilings, and plenum returns shall comply with NEMA 1 requirement.

B. Local control panels shall be constructed of steel or extruded aluminum with hinged door and keyed lock, with baked enamel finish of manufacturer's standard color.

C. Provide panels of adequate size to accommodate instruments for future expansion of approximately 25% beyond space required for this scope of work.

3.03 NETWORK HARDWARE

A. Ethernet Switches, Routers, and Bridges:

(1) Network hardware shall be provided and configured to form a campus-wide Fast Ethernet (a combination of 100BASE-TX and 100BASE-BX, -FX, and –SX or higher).

(2) Ethernet devices shall be IEEE Std 802.3 which shall function as the center of a distributed-star architecture and shall be "learning" type with spanning tree algorithms per IEEE Std 802.1D. All devices shall have a non-blocking architecture.

(3) The switch shall support the connected media types and shall have a minimum of 150% the required ports and no fewer than 4 ports. One port shall be switch selectable as an uplink port.

(4) Network hardware shall be compatible with the copper and fiber optic cabling installed by the Division 27 contractor. Refer to specifications 27 1300 and 27 1500 for media types.

(5) Switch located in BAS server rack shall be managed type and shall have a minimum of two fiber optic ports.

(6) Switch shall include N.O./N.C. alarm contact for monitoring by BAS.

B. Network Components:

(1) Network components (Racks, enclosures, patch panels, etc.) shall comply with respective sections of specification 27 1100 – Communications Equipment Room Fittings.

PART 3 EXECUTION

4.01 GENERAL

A. Install control equipment and wiring in neat and workmanlike manner.

B. Coordinate timely delivery of materials and supervise activities of other trade contractors to install devices such as immersion wells, pressure tappings, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, valves, dampers, and other such items furnished by Control Contractor, which are to be installed by Mechanical Contractor.

C. Install control devices in accessible location.

D. All BAS associated 120 VAC power wiring (including all input and output power supplies) shall originate from clearly-marked, BAS-dedicated circuit breakers. All input/output transducers shall be powered from the same circuit that supplies power to the associated BAS controller. All BAS equipment shall be fused in accordance with manufacturer's recommendations.

E. 120 VAC power shall not be allowed inside BAS controller panels. All 120 VAC to 24 VAC transformers and 120 VAC to 24 VDC power supplies shall be located in enclosures adjacent to the control panel being served. Terminal unit controls shall be served by consolidated 24 VAC transformer panels.

F. BAS controllers shall be labeled with the source of electrical power including panel number, circuit breaker number, and room number where electric panel is located.

G. Devices containing mercury are not allowed.

H. Coordinate mounting height and location of control devices so that NEC workspace clearances are maintained.

I. During construction, Contractor shall take necessary precautions to ensure all panels, wiring, instrumentation, etc. are kept clean and dry. Upon Project completion, control panels shall be clean of wire nuts, trash, and wire stripping. All excess material is to be turned over to Owner BAS group.

J. BAS floor level network to room/equipment controllers shall be confined to the same floor the respective building level controller is located on.

(1) In applications where the floor level network must transition between floors, the transition shall be located in a clearly marked junction box on each floor of appropriate size to accommodate a screw terminal strip. Network cabling shall be labeled to indicate the previous connection prior to entering the junction box with the terminal strip. Terminal strip shall be used as a transition point from one floor to the next. Terminal strip shall be large enough to accommodate transitions to and from the floors below and above if floor transitioning is required.

K. Labels and tags shall be keyed to unique identifiers shown on As-Built drawings. Enclosures and DDC Hardware and controllers shall be labeled. Sensors, valves and actuators shall be tagged. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Duct static pressure taps shall be tagged at location of pressure tap. Tags shall be plastic or metal and shall be mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures shall be engraved plastic and mechanically attached to enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but shall not be hand written.

4.02 CONTROL WIRING

A. Provide electrical wiring required for complete functional control systems, including power circuit to control panels, both line and low voltage, in accordance with applicable local codes, and latest version of National Electrical Code and NFPA. Refer to Paragraph 1.6.H. for definition of scope of Work.

(1) Voltage drops for all low voltage circuits shall be calculated prior to installing low voltage circuits. Voltage drop calculations shall be made available to Engineer on demand.

B. Control panels serving equipment fed by emergency/standby power shall also be served by emergency/standby power. Equipment fed by emergency/standby power is so indicated on mechanical equipment schedules and electrical motor schedules. Control panels shall be powered by local UPS (Uninterruptible Power Supply) to ensure continued control of equipment powered by site standby power sources when primary power source is lost. Devices such as Operator Workstations, Floor Level and Building Level Controllers, Application Specific Controllers and fume hood controls shall be provided with UPS power.

C. Where multiple controllers reside in a single control panel, provide a separate disconnect (or fuse) for each controller.

D. Install control wiring in metal conduit or raceway system. Refer to Division 26 - Electrical for additional requirements.

E. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 26 0000 – General Electrical Requirements.

F. Color-code each junction box cover plate as to signal type using 1/2" self-adhesive color dot or enamel spray paint. Use green for low voltage signal wiring, blue for pneumatic tubing, and yellow for line voltage wiring used for signal wiring or dedicated power wiring.

G. Tag each wire termination at control panels, junction boxes, and remote control devices with unique wire ID number.

H. Low voltage wiring concealed above accessible ceilings does not require raceway. Cables not in raceway shall be routed along building structure lines using Bridal Rings, J-hooks or other mounting methods as approved by Engineer. Use of wire-ties for attaching cabling to duct brackets, piping or structure is not acceptable. Diagonal routing is not allowed. Label each cable not in raceway with unique wire ID number every 50 feet (1524 cm)

I. Run direct current instrument conductors separately from alternating current conductors. Where allowed by NEC wiring classification, AC-DC route crossings shall be at 90 degrees. Install special sensor to transmitter cables in accordance with manufacturer's installation drawings or in compliance with manufacturer's instructions. Extra precautions shall be taken when pulling and shortening these "vendor furnished" cables. Any extra length on these cables shall be neatly coiled into minimum 3" diameter coils and installed into junction box.

J. All wiring terminating in a control panel/enclosure shall be landed on terminal strips, with one wire per terminal. All I/O points on a DDC/BAS controller shall be wired to panel-side of terminal strip, including all spare I/O points.

K. All communication/power/signal wiring terminating in a control panel/enclosure/junction box shall be provided with a minimum of 3” – 6” extra wiring length. Extra cable shall be loosely folded/looped and stored neatly in wireways or cable tray/headers above control panel.

L. Follow Control Contractor’s Company standard cabling color codes.

M. Electric Signal Cables:

(1) Analog electric signal cables from electronic transmitters to controllers/receivers and from controllers to other analog devices shall be continuously shielded to reduce effects of EMI on control signals residing on those cables. Electric signal cables to discrete devices typically do not require shielding, but for better noise immunity use twisted/shielded pairs.

(2) Shields shall be grounded at power source end only and floated at other end. Pay particular attention to floating shields through termination points, maintaining only one single grounding point, and insulating from ground at other points.

(3) Provide 250 ohm, 5 watt, 0.1% tolerance, dropping resistors as required to generate 1 - 5 VDC signals or 500 ohm, 5 watt, 0.1% tolerance, dropping resistors as required to generate 2 - 10 VDC signals from 4 - 20 mA control loop powered by 24 VDC power supply.

N. BAS Network Communication Cable:

(1) Install special cable connectors in accordance with BAS manufacturer's recommendations.

(2) Typically, #22 AWG, but no smaller than #24 AWG, twisted pairs, twisted shielded pairs, coaxial cable, fiber optics or manufacturer's standard cabling for communications between remote control devices and BAS controllers.

(3) BAS Network communication cable shall not be spliced.

(4) Provide isolated instrument grounding system as necessary per manufacturer's recommendations.

4.03 LOCAL CONTROL PANELS

A. Provide local control panel for each system where more than one control device requires field mounting, (air handling units, exhaust fans, miscellaneous control systems including pump controls, heat exchanger controls, etc.). Single devices may be mounted on piping, wall or ductwork. Install local control panel where indicated on drawings or suitable location adjacent to system served.

B. Mount panels on wall with suitable brackets or on self-supporting stand. Mount top of panels no higher than 6 ft above floor. Install panels so front cover door can swing fully open without interference.

C. Label local control panels with respective unique ID numbers in accordance with Section 20 0553 - Mechanical Systems Identification.

D. All control panels located in accessible areas be provided with keyed locks. Locks shall utilize a single master key. Provide 2 spare key sets to Owner.

E. Panel Layout:

(1) Locate controllers in lower half of panel first and upper half second.

(2) Locate terminal strips either horizontally in upper half of back panel or vertically. Do not locate terminal strips below 2'-0" or above 6' above finished floor.

(3) Provide separate enclosure for 120 VAC power transformer and circuitry.

(4) Enclose wire and cable in wireways or bundle w/ wire ties and secure to back-panel. This does not apply to wire exiting wireways to terminal strips or panel mounted devices.

(5) Space controllers according to manufacturer's requirements with 3" minimum between controllers and other devices on panel and 6" between controller front and door mounted devices. Ensure adequate space is allowed for device heat dissipation.

(6) Do not place controller or control devices on enclosure sides.

(7) Do not use any control panel as wire or cable pass-through to adjacent panel.

4.04 BAS ETHERNET NETWORK TESTING AND BENCHMARKING

A. Test and document connectivity, latency, and integrity of network from each switch to each BAS controller and BAS server switch and from switch-to-switch.

(1) Latency between any ports shall be equal to or less than 1 millisecond.

(2) Packet loss shall be less than 0.5% between any ports when tested with frame sizes between 64 and 1518 frames for duration of 60 seconds.

B. Test and document all telecommunication protection/security techniques employed on system including access control into BAS Ethernet network from other building networks and access control to other building networks from BAS Ethernet network. Coordinate testing procedures with Owner.

4.05 ADJUSTMENT AND COMPLETION CHECKLIST

A. After completion of installation, follow checklist procedure defined in checklist submittal to adjust and calibrate thermostats, control valves, control actuators, controllers, sensors, and other equipment provided in this Contract. Include signed and dated, completed checklist in Operation and Maintenance Manuals.

B. Upon completion of Work but before final acceptance of systems, Engineer or Owner's representative will verify performance of control loops. Control Contractor shall immediately remedy any deficiencies found. Corrective measures may include modification or addition of equipment and devices, control strategies and/or software program. Corrective modifications made by Control Contractor during warranty period shall be incorporated and updated in Operation and Maintenance Manuals.

C. After final acceptance of system, Contractor shall work with Owner to remove all existing user names and passwords for all software and hardware used on project and create new user names and passwords as required.

4.06 OWNER TRAINING

A. Provide minimum of 40 hours of on-site training to Owner's representatives. Conduct training sessions during normal business hours after system start-up and acceptance by Owner. Scheduling of training session(s) will be established by Owner. Portions of training may be performed before system is completely operational, but no sooner than one month before system is planned to be fully operational. Final training session shall be held after systems are complete including all graphics programming.

B. Course content shall include, but not be limited to, the following topics:

(1) Explanation of control sequences. Include which sensors are used and how output device operates.

(2) Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.

(3) Walk-through of Project to identify controller locations and general routing of network cabling.

(4) Review of operation and maintenance of hardware devices. Include schedule for routine maintenance.

(5) Review of operation of operator's workstation; include hardware (PC's, printers, etc.).

(6) Review of operator's workstation software using specific examples of operating hardware.

(7) Review of portable operator's workstation software using specific examples of operating hardware.

(8) Any additional item(s) specifically requested by Owner.

C. Provide listing of regularly scheduled factory classroom training sessions concerning advanced topics covering proper operation and maintenance of control systems, sensing, monitoring and control equipment. Additional classes travel and lodging will be arranged and paid by Owner.

D. Provide minimum of 16 hours of additional on-site training to Owner's Representatives, 6 months after initial training is completed.

E. Scheduling of training session(s) will be established by Owner.

END OF SECTION 23 09 01

END OF SECTION 23 09 01

SECTION 23 09 02 - CONTROL VALVES AND DAMPERS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0993 - Control Sequences

C. Section 23 2118 - Valves

D. Section 23 3314 - Ductwork Specialties

E. Section 23 3600 - Air Terminal Devices

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.]

1.03 GENERAL

A. Devices containing mercury are not allowed.

1.04 SUBMITTALS

A. Product data sheets shall include construction materials and assembly methods, maximum design parameters (temperature, pressure, velocity, etc.), and performance data for full range of actuator stroke. Product data sheets shall include charts, graphics or similar items used in making selections, including damper to duct area ratio and free area ratio. Damper product data sheets shall indicate certified leakage rates for given pressure differentials.

(1) Device data sheets shall be submitted with electronic bookmarks as specified in Section 23 0901 - Control Systems Integration. Refer to PART 1 – GENERAL, subsection SUBMITTALS.

B. Submit valve schedules with shop drawings, indicating unique tag numbers for each device, equipment item or system served, device model numbers, sizes, shut-off head required, actuator air pressure or force required to meet shut-off head, torque requirements for rotary valves, flow coefficients (Cv) for 10% and 100% valve stem travel, actual flow requirements based on equipment shop drawings, calculation of actual pressure drops, actuator model number, actuator torque capacities and pilot positioner locations.

C. Valve and damper Shop Drawing submittals will not be processed unless supporting data and sizing calculations are included.

D. Submit damper schedules with Shop Drawings, indicating unique tag numbers for each device, equipment or system served, device model numbers, duct sizes, damper sizes, flow rates, pressure differentials, calculation of actual damper pressure drops, approach velocities, leakage rates, torque requirements, actuator model number, actuator torque capacities and pilot positioner locations.

E. Select dampers to meet their intended service with respect to maximum approach velocities and maximum pressure differential. Damper materials shall match duct construction materials of systems in which they are installed (galvanized steel, aluminum, 304 or 316 stainless steel, etc.).

F. Aluminum dampers may be used in galvanized steel ductwork.

1.05 VALVE SELECTION AND SIZING

A. General:

(1) Select control valves to meet their intended service without cavitation. Provide cavitation calculations for modulating globe control valves over 250°F and all modulating butterfly valves over 60°F.

(2) Select control valves and actuators for 100% shut-off against system maximum differential pressure.

(3) Valve body ratings indicated in Part 2 are minimum required. Valve body, trim and packing selected shall be designed to withstand maximum pressure and temperature encountered in system.

(4) Submit engineering calculations for sizing modulating control valves unless valves are scheduled. Control valves serving terminal devices may be sized based on flow ranges for each pump system.

(5) Shut-off and 2-position valves shall be full pipe size.

(6) Calculations for sizing modulating valves shall be based on actual characteristics of equipment and system in which valves are installed. Valve calculations shall include information such as pump head or available pressure.

(7) Control Contractor is responsible for obtaining adequate system information necessary for sizing.

B. Instrumentation Valves:

(1) Unless otherwise noted, instrumentation shut-off valves for isolation of gauges, switches, transmitters, etc., shall be as follows:

(a) Water systems: globe-type valves

(b) Ductwork, air handling unit or air terminal device penetrations: ball or plug-type valves

(c) Liquid line sampling valves: multiple turn, metering-type valves.

C. Water Valves:

(1) Select modulating control valves to provide 3-5 psi (34.47 kPa) pressure drop at design flow rate with differential pressure less than 20 psi (137.90 kPa), and pressure drop equal to 25% of total pressure drop with differential pressure equal to or greater than 20 psi.

(2) Select control valves based upon pressure drop calculations and Cv values at 100% stroke.

(3) Size 3-way mixing or diverting valves not directly associated with pump subcircuit for 3-5 psi (34.47 kPa) pressure drop.

(4) Subcircuit is defined as branch supply and return piping to terminal device, including valve, coil, control valve, and balancing valve.

1.06 DAMPER SELECTION AND SIZING

A. Submit engineering calculations for sizing unscheduled modulating control dampers.

B. Calculations for sizing dampers shall be based on actual characteristics of ductwork system being installed. Opposed blade dampers shall be sized for minimum of 10% of duct system pressure drop. Parallel blade dampers shall be sized for minimum of 30% of duct system pressure drop. Duct section is defined as ductwork containing flow control damper starting with inlet or branch tee and ending with outlet or branch tee. Calculate actual duct pressure drops for each duct section containing modulating damper using latest version of ASHRAE Handbook of Fundamentals. If control systems fixes pressure drop, use those pressure setpoints. Use balance damper to provide additional pressure drop as required for obtaining linear damper response.

C. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

D. Two position dampers to be sized as close as possible to duct size, but in no case is damper size to be less than duct area.

E. Submit leakage and flow characteristic data for control dampers along with shop drawings. Leakage ratings shall be based on AMCA Standard 500 and dampers shall bear AMCA Air Leakage Seals.

PART 2 PRODUCTS

2.01 CONTROL VALVES

A. General:

(1) If control valves are not scheduled, refer to Part 1 of this Section for sizing criteria.

(2) Use 2 or 3 port normally open globe type control valves with equal percentage contoured throttling plugs for steam and water applications, except as otherwise noted. Characterized ball valves may be used for water applications.

(3) Butterfly valves may be used for water system control valves 5" and larger provided that valves meet pressure and temperature requirements. High performance butterfly valves shall be used for modulating applications. General purpose butterfly valves may be used for 2 position control.

B. Globe Valves (Commercial Grade):

(1) Manufacturers: Belimo, Honeywell, Johnson Controls, Siemens Building Technologies, or TAC

(2) Valves shall be bronze or brass body, threaded ends for steel piping, solder ends for copper piping, 150 psi (1034.21 kPa) rating for 2" and smaller; iron body, bronze mounted, flanged, 125 psi (861.84 kPa) rating for 2-1/2" and larger.

(3) Two-way valves shall have equal percentage flow characteristics; three-way valves shall have modified equal percentage characteristics with linear flow from B-to-AB.

(4) Valves shall have stainless steel stems, spring-loaded Teflon packing, with replaceable stem/plug and packing kits.

C. Characterized Ball Valves:

(1) Belimo, Valve Solutions Inc., Bray Controls, Neles Controls or approved equal

(2) Provide two-way or three-way modulating control valves as required.

(3) Valves shall be ball-type valves with V-notch, segmented ball or characterizing disks for equal percentage flow response. Characterizing disks shall be securely fastened by a keyed ring or other securing device to prevent the disk from movement during operation.

(4) Valves shall be forged brass body, NPT threaded ends, 150 psi (1034.21 kPa) rating for 2" and smaller. Valve bodies 2-1/2" and larger shall be carbon steel or cast iron.

(5) Valves shall be furnished with stainless steel ball and stem with fiberglass reinforced Teflon (RTFE) seats and Viton, EPDM or RTFE O-rings and seals.

(6) Actuators shall be either mechanical spring return type or electronic fail-safe for valves requiring fail position; floating control, or fail last position type for areas such as animal rooms, offices or conference rooms. Mechanical spring return shall drive the controlled device to an end position upon loss of power. Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors. The electronic fail-safe shall be adjustable in 10 degree increments with a 2-second operational delay.

(7) Actuators for major equipment such as air handling units, heating hot water or chilled water shall be fail-in-place, fail open, or fail closed depending upon service requirements. Size actuators to achieve system shutoff pressures.

(8) Terminal control valves near the end of the reheat supply lines on each floor shall be 3-way diverting type valves to provide minimum flow through the supply mains.

D. General Purpose Butterfly Valves:

(1) Refer to Section 23 2118 - Valves. Refer to Damper and Valve Actuators in this Section for valve actuators.

E. High Performance Butterfly Valves:

(1) Manufacturers: Belimo, DeZurik, Xomox, Jamesbury, Posi-Seal, Bray/McCannalok or Fisher

(2) Carbon steel body, lugged style, ANSI Class 150, adjustable PTFE packing, PTFE seat with suitable metal back-up ring, upper and lower shaft thrust bearings, 316 stainless steel one piece shaft and 316 stainless steel disc with offset shaft/disc design.

(3) Normal and dead end (without downstream flanging) pressure rating shall be 275 psi (1896.06 kPa).

(4) Provide electric/electronic actuator and positioner. Provide limit switches as required.

(5) Valves and actuators shall be manufactured by valve manufacturer. Valve assembly including actuator, positioner and limit switches if used shall be assembled by valve manufacturer.

(6) Use high performance type for modulating control. Be sure to size and schedule control valves and check for cavitation.

F. Two-Position Ball Valves (Isolation Valves):

(1) Belimo, Valve Solutions Inc., Bray Controls, Neles Controls or approved equal

(2) Valves shall be forged brass body, NPT threaded ends, 150 psi (1034.21 kPa) rating for 2” and smaller. Valve bodies 2-1/2” and larger shall be carbon steel or cast iron.

(3) Valves shall be furnished with stainless steel ball and stem with fiberglass reinforced Teflon (RTFE) seats and Viton, EPDM or RTFE O-rings and seals.

(4) Actuators shall be either mechanical spring return type or electronic fail-safe for valves requiring fail position; floating control, or fail last position type for areas such as animal rooms, offices or conference rooms. Mechanical spring return shall drive the controlled device to an end position upon loss of power. Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors. The electronic fail-safe shall be adjustable in 10 degree increments with a 2-second operational delay.

(5) Actuators for major equipment such as air handling units, heating hot water or chilled water shall be fail-in-place, fail open, or fail closed depending upon service requirements. Size actuators to achieve system shutoff pressures.

G. Solenoid Valves:

(1) Manufacturers: Asco, TAC, Honeywell, Johnson Controls, Siemens Building Technologies, Moore Industries, or Schrader Bellows

(2) Valves shall be brass or bronze body. Select valves to match required temperatures and pressures, and to have materials that are compatible with intended working fluids.

(3) Line voltage actuators shall be Class "H" (high temperature), listed by UL or CSA.

H. Terminal Control Valves With Characterizing Disks (Reheat or Chilled Water):

(1) Belimo, Johnson Controls, Siemens Building Technologies, Honeywell, TAC or approved equal

(2) Provide two-way or three-way modulating control valves as required.

(3) Valves shall be ball-type valves with characterizing disks for equal percentage flow response. Characterizing disks shall be securely fastened by a keyed ring to prevent the disk from movement.

(4) Valves shall be forged bass body with nickel plating, NPT threaded ends, 150 psig (1034.21 kPa) rating for 2" and smaller.

(5) Valves shall be furnished with stainless steel ball and stem, and fiberglass reinforced Teflon seats and seals.

(6) Terminal control valves near the end of the reheat supply lines on each floor shall be 3-way diverting type valves to provide minimum flow through the supply mains.

(7) Actuators shall be either mechanical spring return type or electronic fail-safe for valves requiring fail position, floating control with fail last position type for areas such as animal rooms, offices or conference rooms. Mechanical spring return shall drive the controlled device to an end position upon loss of power. Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors.

(8) Manufacturer shall warranty components for period of 5 yrs from date of production, with first 2 yrs unconditional.

I. Terminal Control Valves – Globe Type:

(1) Manufacturers: Siemens Building Technologies, Johnson Controls, Honeywell, Invensys Building Systems, Belimo or approved equal.

(2) Valves shall be globe type forged brass or bronze with threaded body connections. Valves shall be provided with stainless steel stems and trim. Packing shall be Ethylene Propylene Rubber or Teflon.

(3) Provide 3-way mixing control valves at the last 2 reheat coils at the end of each supply main on each floor to provide minimum flow path.

(4) Unless otherwise noted, provide fail open or closed position pneumatic or electric actuators as identified in control documents and shown on project drawings.

2.02 CONTROL DAMPERS

A. General:

(1) If control damper sizes are not shown or scheduled, refer to Part 1 of this Section for sizing criteria.

(2) Unless otherwise indicated, modulating control dampers shall be opposed blade or parallel blade type and 2-position (open/close) dampers shall be parallel blade type.

(3) Blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.

(4) AMCA Leakage Classification of Control Dampers

CLASS	**STATIC PRESSURE INCHES WATER COLUMN**			
	1	**4**	**8**	**12**
	LEAKAGE RATE CFM/FT2			
IA	**3**	**N/A**	**N/A**	**N/A**
I	**4**	**8**	**11**	**14**
II	**10**	**20**	**28**	**35**
III	**40**	**80**	**112**	**140**

B. Standard Modulating and Two-Position Dampers:

(1) Manufacturers and acceptable model numbers:

(a) Johnson Controls VD-1630 (airfoil type)

(b) Honeywell D2

(c) Ruskin CD50/CD60

(d) Air Balance AC-525/526

(e) Greenheck VCD-43/VCD-33

(2) Damper frames shall be minimum of 16 ga galvanized steel or 14 ga extruded aluminum. Blades shall be minimum of 16 ga galvanized steel or 14 ga aluminum. Blades shall have maximum blade width of 8" with steel trunnions mounted in bronze sleeve, nylon or ball bearings.

(3) Furnish dampers with blade seals and stainless steel side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity, but not less than temperature range of -40° to 200°F, pressure differential of 6” WC, and approach velocity of 4000 fpm based on 4 ft damper section width.

(4) Leakage rate shall meet AMCA Leakage Class IA or I.

(5) Testing and ratings shall be per AMCA Standard 500-D.

C. Insulated Blade Dampers (Outdoor Air Dampers and Relief/Exhaust Air Dampers):

(1) Manufacturers: Tamco Series 9000 BF, Ruskin CDTI50

(2) Ultra-low leak thermally insulated steel airfoil blade design with flexible silicone side seals and blade gaskets. Damper leakage rates in closed position shall not exceed 6 cfm/square foot at 4” WG differential pressure.

(3) Extruded aluminum 6063T6 damper frame shall not be less than 0.080” in thickness. Damper frame shall be 4” deep x 1", with duct mounting flanges on both sides of frame. Damper frame shall have a 2" mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners. Welded frames shall not be acceptable.

(4) Blades shall be maximum 6.4" deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 0.063”. Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55 (tested to AAMA 1502.7 Test Method). All blades shall be symmetrically pivoted.

(5) Blade seals shall be extruded EPDM, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.

(6) Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.

(7) Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around a 7/16" aluminum hexagon blade pivot pin), rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable.

(8) Hexagonal control shaft shall be 7/16". It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be zinc-plated steel.

(9) Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage and a Celcon bearing between moving parts to reduce wear and increase longevity. Linkage that consists of metal rubbing metal will not be approved.

(10) Dampers shall be designed for operation in temperatures ranging from -40°C-40°F to 212°F.

(11) Dampers shall be AMCA rated for Leakage Class 1A at 1" w.g. static pressure differential. Standard air leakage data to be certified under AMCA Certified Ratings Program.

(12) Dampers shall be custom made to required size, with blade stops not exceeding 1-1/4" in height. Blade stop shall be a continuous and integral part of the head/sill. Welded and caulked blade stops shall not be acceptable.

(13) Dampers shall be opposed blade action or parallel blade action as indicated on plans.

2.03 SMOKE DAMPERS

A. Refer to Section 23 3314 - Ductwork Specialties, for Smoke Damper Specification.

2.04 DAMPER AND VALVE ACTUATORS

A. General:

(1) Actuators shall have an electronic cut off or other means to provide burnout protection if stalled.

(2) Actuators shall have a visible position indicator and provide position feedback to the controller as shown.

(3) Provide manual hand wheel actuator or hand crank in addition to electric valve actuator to allow manual override.

(4) Actuators located outside shall be provided with internal heaters.

(5) Actuators located outdoors should operate in the ambient temperature range of -40°F to 120°F.

(6) Actuators installed outdoors shall be NEMA 4X or IP66 rated or shall be provided with weatherproof NEMA 4X stainless steel enclosures (Belimo ZS-300 or equal) that have removable covers that have clasps or machine screws (no sheet metal screws) and that do not require removing fasteners from the ductwork.

B. Analog Electronic:

(1) Manufacturers: Belimo, Honeywell, Johnson Controls, Siemens Building Technologies or TAC

(2) Actuators shall be electric motor/gear drives that respond proportionally to analog voltage or current input, or digital floating control signals.

(a) Analog control actuators shall be used for all modulating applications.

(3) Stroke time for major equipment shall be 90 seconds or less for 90° rotation. Stroke time for terminal equipment shall be compatible with associated local controller, but no more than 6 minutes.

(4) Provide spring return or electronic fail-safe feature for fail open or closed positions, as required by control documents, for critical applications such as outside, return, or exhaust dampers, heating and cooling coils on major air handling units, humidifiers, heat exchangers, flow control for major equipment items such as chillers, cooling towers, boilers, etc. Fail-last-position actuators do not have spring return feature.

(5) Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops.

(6) Provide position feedback on all modulating actuators, excluding terminal units.

(7) Actuators for terminal heating/cooling equipment do not require spring return feature.

C. Discrete Two-Position Electric:

(1) Manufacturers: Belimo, Honeywell, Johnson Controls, Siemens Building Technologies or TAC

(2) Actuators shall be electric motor/gear drives for two-position control. Stroke time shall be 90 seconds or less for 90° rotation.

(3) Provide spring return or electronic fail-safe feature for fail open or closed positions as required by control documents. Fail-last-position actuators do not have spring return feature.

PART 3 EXECUTION

3.01 CONTROL VALVES

A. Furnish control valves as shown on drawings and/or as required to perform control sequences specified.

B. Control valves furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Increaser and decreaser fittings required to facilitate valve installations shall be provided by Mechanical Contractor.

D. Install control valve with visual indicators in such a manner that the visual indicator is visible to individual standing at floor level.

3.02 CONTROL DAMPERS

A. Furnish control dampers as shown on drawings and/or as required to perform control sequences specified, except those furnished with other equipment.

B. Control dampers furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Blank-off plates or transitions required to facilitate dampers shall be provided by Mechanical Contractor.

3.03 SMOKE DAMPERS

A. Refer to Section 23 3314 - Ductwork Specialties

B. Furnish smoke dampers as shown on drawings.

C. Smoke dampers furnished by Control Contractor will be installed by Mechanical Contractor.

3.04 ACTUATORS

A. Provide actuator for each automatic damper or valve with sufficient capacity to operate damper or valve under all conditions. Select actuators to provide tight shut-off against maximum system temperatures and pressure encountered. Each actuator shall be full-modulating or two-position type as required or specified, and shall be provided with spring-return for fail open or fail closed position for fire, freeze, moisture, occupant safety, equipment protection, heating or cooling system protection on power interruption as indicated and/or as required. Smoke dampers and steam valves serving pressure rated heat exchangers or convertors shall fail-closed.

B. Valve and damper operating speeds shall be selected so that actuators will remain in step with controllers without hunting, regardless of load variations. Actuators acting in sequence with other actuators shall have adjustment of control sequence as required by operating characteristics of system.

C. Provide proper linkage and brackets for mounting and attaching actuators to devices. Design mounting and/or support to provide no more than 5% hysteresis in either direction (actual movement of valve stem or damper shaft versus ideal movement) due to deflection of actuator mounting.

D. Provide single actuator on damper section not exceeding torque capacity of actuator.

E. Multiple damper sections where used shall be connected together via jackshaft or other coupling device, not by internal pinned connections at blade shafts of individual damper sections. Where multiple damper sections are connected together via jackshaft or other coupling device, damper actuator shall be mounted directly to jackshaft or other coupling device for operating damper sections. For instances where damper actuator cannot be mounted to jackshaft or other coupling device, damper actuator shall be provided for each damper section.

(1) Mounting multiple actuators to common damper jackshaft or valve stem to meet torque requirements is not allowed.

F. Calibrate position feedback potentiometers, where specified, with range and gain factors as required for proper operation per manufacturer's recommendations.

G. Integral actuator end switches or feedback potentiometers shall not be used. Provide separate end switches/feedback potentiometers that provide actual damper/valve position.

(1) Integral actuator end switches or feedback potentiometers can be used if damper or valve shaft is keyed or directly affixed to the actuator such that the shaft cannot slip and provide false position. U-clamp type actuator mounting always requires separate end switches/feedback potentiometers.

H. Actuators installed outdoors shall be NEMA 4X or IP66 rated or shall be provided with weatherproof NEMA 4X stainless steel enclosures (Belimo ZS-300 or equal) that have removable covers that have clasps or machine screws (no sheet metal screws) and that do not require removing fasteners from the ductwork.

END OF SECTION 23 09 02

SECTION 23 09 03 - CONTROL INSTRUMENTATION

SECTION 23 09 03 – CONTROL INSTRUMENTATION

PART 1 GENERAL

2.01 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0993 - Control Sequences

C. Section 23 2120 - Piping Specialties

2.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.]

2.03 SUBMITTALS

A. Device data sheets shall be submitted with electronic bookmarks as specified in Section 23 0901 - Control Systems Integration. Refer to PART 1 – GENERAL, subsection SUBMITTALS.

B. Device data sheets shall be submitted simultaneously with Control Systems Integration submittal. Refer to submittals section in 23 0901.

C. Thermostat/Room Temperature Sensor Schedules:

(1) Submit thermostat/room temperature sensor schedule with shop drawings. Thermostat/room temperature sensor schedule shall have detailed listing of which type is used for each room, including data concerning service and model numbers, sizes, cover types, and engineering data sheets for each control device.

D. Warranty

(1) Provide 1 year warranty on all materials and labor.

(2) Warranty requirements shall include furnishing and installing software upgrades issued by the manufacturer during the 1 year warranty period.

2.04 FCC COMPLIANCE

A. Digital equipment furnished under this Contract shall be tested and made to comply with limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environments. Literature shall so note and equipment shall be so labeled.

PART 2 PRODUCTS

3.01 GENERAL

A. Instruments of same type shall be by same manufacturer, for instance, pressure transmitters, gauge, absolute, and differential pressure shall be of same manufacturer.

B. Pressure and temperature ratings of devices indicated in Part 2 - of this Section are minimum required. Devices shall be designed to withstand maximum pressures and temperatures encountered in respective systems.

C. No devices containing mercury will be allowed under this Specification.

D. All instrumentation located outdoors shall be NEMA 4X rated.

3.02 GENERAL INSTRUMENTATION

A. Pressure Gauges:

(1) Refer to Section 23 2120 - Piping Specialties

B. Thermometers (Dial-Type):

(1) Refer to Section 23 2120 - Piping Specialties

C. Analog Electronic Instrument Indicators:

(1) Electronic indicators, used for displaying sensor and/or output values as measured by current or voltage, shall be panel mount type and at least 2" square. Output may be either analog needle type or digital with 1/2" high LED or backlit LCD displays.

(2) Electronic indicators shall be marked in appropriate units (degrees, psi, % rh, gpm, cfm, etc.) and with appropriate range of values. Panel mounted indicators shall have minimum accuracy of 1% of scale range. Digital units shall be scaled to show 3 digits plus 1 decimal point.

3.03 DISCRETE ELECTRIC INSTRUMENTATION

A. General:

(1) Electrical devices, switches, and relays shall be UL listed and of type meeting current and voltage characteristics of project. Terminal connections shall be made at terminal blocks inside of NEMA 1 enclosures unless otherwise specified. Outdoor units shall be NEMA 4 with concealed adjustment.

(2) Ratings of normally open and normally closed contacts shall be adequate for applied load (minimum 5 amps at 240 Volts).

(3) Accuracy of devices shall be ± 1% of scale with adjustable offset unless otherwise specified.

B. Temperature Low Limit Switches (Freezestats):

(1) Electric 2 position type with temperature sensing element and manual reset. Controls shall be capable of opening circuit if any 1 foot (30.48 cm) length of sensing element is subject to temperature below setting.

(2) Sensing element shall not be less than one lineal foot per square foot of coil surface areas. Unless otherwise indicated, calibrate temperature switch setpoint to 38°F.

(3) Specifications:

(a) Range Cutout 35 to 45 F

(b) Differential 12 F

C. Relays:

(1) Manufacturers: IDEC, Potter Brumfield, Square D, or Allen Bradley

(2) Equal to IDEC Type RH2B-U, miniature 8 blade pilot relay with DPDT silver cadmium oxide contacts rated at 10A, 30 VDC, or 120 VAC. Coil shall match control circuit characteristics. DDC outputs shall be 24 VDC with maximum current burden of 50 milliamps. Rectangular base socket mount with blade type plug-in terminals and polycarbonate dust cover.

(3) Provide DIN rail mountable (Snap type) mounting sockets equal to IDEC SH2B-05.

D. Enclosed Relay (Relay-in-a-Box):

(1) Manufacturers: Veris Industries, Functional devices, Inc. or approved equal

(2) 1 or 2 SPDT relays in NEMA 1 or better enclosure. Coil shall be selected for control circuit characteristics.

(3) Contacts rated at 10A, 28 VDC or 120 VAC. Conduit nipple is 1/2" NPT. Maximum coil current burden 50 milliamps.

E. Pressure Differential Switches (Air Systems):

(1) Manufacturers: Cleveland Controls, Dwyer, Honeywell, Johnson Controls/Penn, Siemens Building Technologies, or TAC

(2) Adjustable set point, differential pressure type. Select switches for accuracy, ranges (20 to 80% of operating range) and dead-band to match process conditions, electrical requirements and to implement intended functions.

(3) Pressure differential switches for air systems shall have pressure rating of at least 10" WC.

(4) Pressure switches shall be automatically reset or manually reset. Refer to 23 0993 – Control Sequences for the specified type.

(5) Pressure indicating differential switches for air systems shall be equal to Dwyer Series 3000 photohelic gauge.

(a) Maximum Temperature Rating: 180°F

(b) Repeatability: ± 1%

(6) Provide pitot tubes on tubing ends that penetrate housings or ductwork.

F. Position Switches (End Switches):

(1) Manufacturers: Allen Bradley, Johnson Controls/Penn, Honeywell, Ruskin, Greystone Energy Systems, Reed National Air Products, NAMCO, Omron or Westlock

(2) Provide damper position switches, as required to meet specified sequence. Rotary switches shall be cam action, lever, or proximity type. Provide damper brackets and connecting rods for connecting position switch actuation levers to damper blades or jackshafts.

(3) "Tip Switches" or other position switches that contain mercury shall not be used for damper end switch applications.

G. E-P Switches (Solenoid Valves):

(1) Manufacturers: Asco, Johnson Controls, Siemens Building Technologies, TAC, or MAC Valves

(2) E-P switches shall provide control air for operation of fan isolation dampers, smoke or smoke/fire dampers, or other On/Off dampers. Line voltage actuators shall be Class "H" (high temperature) and listed by UL or CSA.

(a) Valve Body: Brass or bronze

(b) Valve Type: 2-way or 3-way

(c) Operating Voltage: 24 VDC, 24 VAC, 120 VAC or as specified

(d) Operating Temperature: 32 to 104°F

(e) Operating Pressure: Greater than maximum supply pressure

(f) Pipe Size: 1/4" NPT

(g) Enclosure Rating: NEMA 4 (locally mounted), NEMA 1 (Panel Mounted)

(h) Conduit Connection: 1/2"

H. Current Switches -

(1) Manufacturers: Veris Industries, N-K Technologies, Setra or approved equal

(2) These shall be induction type sensors clamped over single-phase conductor of AC electrical power and shall consist of solid-state sensors with self-calibrating threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.

(a) Output: Solid state relay or relay contacts

(b) Trip Setpoint: Self-calibrating through microprocessor

(c) Operating Temperature: 32 to 131°F

(d) Response Time: < 0.5 seconds

I. Indicator Lights:

(1) Manufacturers: Allen Bradley, GE, Square-D, or Idec

(2) 1/4" minimum size or 1-1/4" maximum size, push-to-test type. Use green for normal, yellow for warning (low/high values), and red for alarm or fail (low-low or high-high conditions). AC or DC type with voltage matched to control circuit without transformers.

J. Drain Pan Moisture Detector:

(1) Manufacturers: Kele and Associates, DiversiTech or approved alternate.

(2) Moisture detector is small, electronic control relay for detecting rising water levels, within drain pans or other containments. Moisture detector shall alarm when water levels reach 0.43” to prevent damage from overflow of drain pans. Relay shall reset when water levels decrease to 0.31” and relay re-energizes.

(3) Relay is normally energized upon powering up and no water is present. When water level reaches the trip point the relay de-energizes for alarming in BAS.

(4) Moisture Detector Relay Module (Model LD1-24):

(a) Supply Voltage: 24 VAC, 60 Hz

(b) Power Consumption: 1 W

(c) Cable length: 18”

(d) Relays Contacts:

1) Type: SPDT

2) Rating: 2.5A at 24 VDC; 5.0A at 120 VAC

(e) Enclosure Rating: Hermetically Sealed

(f) Dimensions: 0.87” H x 2.0” W x 1.25” L

3.04 PNEUMATIC INSTRUMENTATION

A. Multi-Probe Air System Static and Air Flow Sensing Elements:

(1) Manufacturers: Tek-Air Systems, Ultratech or Air Monitor Corporation

(2) Multi-probe type static and/or total pressure sensing station consisting of minimum 16 ga galvanized steel casing with flanged connection and multiple metallic sensors with automatic averaging manifold. Arrange sensors to perform equal area traverse of duct cross section.

(a) Maximum temperature: 250°F

(b) Airflow resistance: less than or equal to 0.25" WC at 4000 fpm

(c) Accuracy: ± 2% of full scale within velocity range from 700 to 4000 fpm

(3) Provide aluminum honeycomb cell air straightener devices for unit installed in supply or filtered air streams.

B. Fan Inlet Airflow Traverse Probe:

(1) Air Monitor Corporation, Tek-Air, Ultratech or approved equal

(2) These shall be averaging differential pressure type flow elements mounted in inlet cone of fan capable of continuously measuring air volume of fan.

(3) Inlet flow element shall consist of:

(a) Sensing tube with two internal chambers. One shall sense upstream pressure (velocity pressure) and one shall sense downstream pressure (static pressure).

(b) These chambers shall have ports of quantity and size to accurately sense flow rate in fan inlet size into which these are specified to be installed.

(c) Sensing tube shall have form so shaped as to minimize measurement inaccuracies.

(4) Sensing assemblies shall be provided with suitable supports to prevent damage to these assemblies at maximum flow-rate.

(a) Accuracy: Error ??? ± 3.0% of actual flow

(b) Materials: Standard extruded aluminum with anodized finish. Optional 316 stainless steel, PVC, Kynar and other materials.

(c) Mounting Hardware: Galvanized Steel

(d) Approved Fan Inlet Installations: Centrifugal Fan

(e) Plug Fan

(f) Ducted Vane Axial Fan

(g) Vane Axial Fan with Bellmouth

C. Single-Probe Air System Static Sensing Elements:

(1) Sensors shall be similar to Dwyer Model A-301 or Tek-Air Model T-5PP7620 with angled tips and 1/4" metal tubing connections.

D. Space Static Pressure Sensor:

(1) Manufacturers: Air Monitor Corporation, Accutrol (Tek-Air), Thermo Electron Corporation, or approved equal.

(2) Space static pressure probe shall be brushed aluminum with anodized finish or stainless steel with polished or painted finish selected by Architect.

(3) Shielded static air probe shall be similar to Air Monitor Corporation Model S.A.P./R for flush ceiling mounting, complete with multiple sensing ports, pressure impulse suppression chamber, air flow shielding, and 1/8" FPT take-off fitting. Sensor shall be capable of sensing static pressure within 1% of actual pressure value while being subjected to maximum air flow of 100 fpm from radial source.

E. Outdoor Static Pressure Sensor:

(1) Manufacturers: Air Monitor Corporation, Ultratech Industries or approved equal

(2) Static outside air probe (SOAP) constructed of stainless steel with 2" diameter FPT connection. SOAP shall be capable of sensing outside atmospheric air pressure to within 2% of actual value when subject to radial wind velocities up to 40 miles per hour with approach angles up to 30 degrees to horizontal.

F. Differential Air Pressure Indicator:

(1) Dwyer model 2000 Series magnehelic gauge for surface or panel mounting. 4" dial readout, die cast aluminum housing. Case and aluminum parts Iridite-dipped. Exterior finish to be baked dark grey hammerloid. Hi/lo 1/8" pressure taps. Provide adapters to match tubing type.

(a) Accuracy: ± 2% of full scale.

(b) Ambient Temperature Range: 20 to 140°F

(c) Rated Total Pressure: -20" Hg to 15 psig (103.42 kPa)

(d) Range: 0-2 times normal setpoint. (Use 0-0.25" WC for building

(e) and space pressure indication.)

G. Plastic Tubing:

(1) Fire resistant virgin polyethylene, meeting stress-crack test ASTM D1693. Individual tube polyethylene or multi-tube instrument tubing bundle shall be classified as flame retardant under UL 94. Polyethylene material shall be rated as self-extinguishing when tested in accordance with ASTM D635.

3.05 ANALOG ELECTRONIC INSTRUMENTATION

A. Space Temperature Sensors:

(1) Sensors shall be platinum RTD type, with the following minimum performance:

(a) Temperature Coefficient of Resistivity (TCR): 0.00385 ohm/ohm/□C

(b) Accuracy: ± .54°F + (0.005 X T) (Class B)

(c) Accuracy: ± .27°F + (0.005 X T) (Class A)

(d) Conformance: DIN-IEC 751

(e) Operating Range: 32 to 122°F, 0 to 99% rh

(2) Thermistors will be acceptable in lieu of RTD provided thermistor carries 5 year guarantee that device will maintain its accuracy within tolerance of ± 0.36°F between 32°F and 150°F, and 0.5°F between -20°F and 212°F.

(3) Unless otherwise stated, space sensor cover shall be manufacturer's standard plastic cover.

B. Duct Mounted or Insertion Temperature Sensors:

(1) Platinum RTD type, with the following minimum performance:

(a) Temperature Coefficient: 0.00385 ohm/ohm/°C

(b) Accuracy: ± .54°F + (0.005 X T) (Class B)

(c) Accuracy: ± .27°F + (0.005 X T) (Class A)

(d) Conformance: DIN-IEC 751

(e) Operating Range: -50 to 170°F, 0 to 99% RH

(2) Sensors mounted in pipes:

(a) Install insertions sensors in stainless steel (carbon or stainless steel pipe) or brass (copper pipe) thermowells. Process coupling to be 3/8" or 1/2" NPT. Extension shall exceed insulation thickness by 1". Thermowell shall project into middle third of the process fluid when installed.

(b) Sheath diameter shall not exceed 5/16". Length shall be such that sheath, containing sensor, projects into middle third of the process fluid when installed.

(c) Connection head to be NEMA 4, cast iron, with screw on cap. Provide internal screw terminations for RTD and wire connection. Conduit connection shall be 1/2" NPT.

(3) Outside air sensors shall be weatherproof of noncorrosive construction and protected with solar shield. Mount outside air sensors on north side of building or in area intake wells for air handling systems to avoid thermal effects from direct sunlight.

(4) Sensors mounted in air streams, such as air handling units, supply ducts, exhaust ducts or return ducts, shall be averaging type. Averaging type sensor to be installed in ducts larger than 24" x 24" or greater than 576 in2. Mount averaging sensor across duct area in a "Z" pattern using mounting clips specific for averaging temperature sensor probes.

(5) Thermistors will be acceptable in lieu of RTD provided thermistor carries 5 year guarantee that the device will maintain its accuracy within a tolerance of ± 0.36°F between 32°F and 150°F, and 0.5°F between -20°F and 212°F.

C. Direct Insertion Temperature Sensors:

(1) Sensor assembly shall be direct insertion, suitable for use with water systems, 150 lb class, minimum rating.

(2) Sensor shall be platinum wound RTD, with the following minimum performance:

(a) Temperature Coefficient: 0.00385 ohm/ohm/°C

(b) Accuracy: ± .54°F + (0.005 X T) (Class B)

(c) Accuracy: ± .27°F + (0.005 X T) (Class A)

(d) Conformance: DIN-IEC 751

(e) Operating Range: -50 to 170°F, 0 to 99% RH

(3) Sheath diameter shall not exceed 5/16". Length shall be such that sheath, containing sensor, projects into middle third of process fluid when installed. Material to be 304 or 316 stainless steel (carbon or stainless steel pipe) or brass (copper pipe). Process coupling to be 3/8" or 1/2" NPT.

(4) Connection head to be NEMA 4, cast iron, with screw on cap. Provide internal termination for RTD and wire connection. Conduit connection shall be 1/2" NPT.

(5) Provide hot tap assembly and extension. Material to be 304 or 316 stainless steel. Support hot tap at minimum of 2 points to eliminate vibration. Extension shall exceed insulation thickness by 1".

D. RTD Temperature Sensor/Transmitters:

(1) Manufacturers: Rosemount, Burns, Minco Products, Weed or Pyromation

(2) Transmitters shall provide 2 wire, 4-20 mA current output signal proportional to specified temperature span of transmitter and compatible with DDC equipment.

(a) These shall be 100 Ohm platinum RTD type temperature instruments for process immersion or air duct mounting

(b) Operating Temperature: -20 to +180°F

(c) Power Supply Voltage: 13 to 35 VDC unregulated

(d) Accuracy or Output Error: 0.1% of span of sensor and transmitter combination

(e) Temperature Coefficient: 0.00385 ohm/ohm/°C

(f) Thermowells: By same manufacturer as Sensor/Transmitter or approved alternate.

E. Duct Mounted Humidity Sensors/Transmitters:

(1) Manufacturers: General Eastern, Automation Components Inc., Versis Industries, Setra, Minco, Rotronic or Vaisala

(2) Probe type, temperature compensated, resistive bulk polymer or thin film capacitive type. Sensor/transmitter shall have the following minimum performance.

(a) Accuracy: ± 2% rh at 25°C over 20-95% rh including hysteresis, linearity and repeatability

(b) Temperature Effect: Less than 0.06% per °F at baseline of 68°F.

(c) Sensitivity: 0.1% rh

(d) Repeatability: 0.5% rh

(e) Hysteresis: Less than 1%

(f) Long Term Stability: Less than 1% drift per year

(g) Adjustment: ± 20% rh zero, non-interactive

(h) ± 10% rh span, non-interactive

(i) Operating Range: 0-99% rh, non-condensing, sensor

(j) 0-95% rh, non-condensing, electronics

(k) Output: 4-20 mA, 0-100% linear, proportional

(l) Power: 12-36 VDC

T = TEMPERATURE OF INTEREST

A. Ducted Air System Static Pressure and Differential Pressure (Velocity) Transmitters:
   (1) Manufacturers: GE Modus, Setra, Belimo, Ashcroft XLDP or approved equal
   (2) Provide transducers/transmitters to convert velocity pressure differential or static duct pressure relative to sensor location into electronic signal.
   (3) Unit shall be capable of transmitting linear 4 - 20 mA DC output signal proportional to differential (total minus static or static minus ambient) pressure input signals with the following minimum performance and application criteria:
      (a) Span: Not greater than twice duct static or velocity pressure at maximum flow rate, or more than 16 times velocity pressure at minimum flow rate.
      (b) Accuracy: ± 1.0% of span or ± 1.0% of full scale
      (c) Dead Band: Less than 0.5% of output
      (d) Hysteresis: Within 0.5% of span or within 0.5% of full scale
      (e) Linearity: Within 1.0% of span or within 0.5% of full scale
      (f) Repeatability: Within 0.5% of output
      (g) Response: Less than 1 second for full span input
      (h) Stability: ± 0.5% of span/year
   (4) Transmitters that require “auto-zeroing” in frequencies less than every 6 months are not acceptable.
   (5) Return and exhaust air system static pressure transducers/transmitters shall be furnished with protective integral air filters on pressure sensing lines from static pressure sensing stations and with static air probes to prevent migration of moisture and particulate matter into transducers. If inputs to pressure transducers/transmitters are dead-ended, integral air filters are not required. Supply air system sensors do not require integral air filters.

B. Space Pressure Monitoring System:
   (1) Manufacturers: Tek-Air Systems, TSI, Siemens Building Technologies, Setra, or approved equal
   (2) Provide directional pressure monitoring system for clean rooms, isolation rooms. Biosafety research labs and hospital rooms. System shall include ultra-low differential pressure transmitter including thermal mass airflow sensor, two space pressure probes, room display for visual monitoring of space pressurization and LCD readout of space differential pressure.
   (3) Space pressure monitoring system shall have the following characteristics:
      (a) Accuracy: ± 2% of set range.
      (b) Pressure Range: 0.100 to -0.100” WC, full scale range, adjustable to ± 0.001, ± 0.005, to 0.010 or 0.10” WC.
      (c) Analog Resolution: 0.0001” WC.
      (d) Digital Resolution: ± 0.00005” WC.
      (e) Output: 4-20 mA DC, self-powered, 5000 ohm load max.
      (f) Power Supply: 24 VAC =/- 4 VAC, <10 VA.
      (g) Communications: RS-485, RS-232, BACnet, Ethernet or LonWorks.

C. Magnetic Flowmeter/Transmitter:
   (1) Manufacturers: Krohne, Siemens, Cadillac, Fisher Rosemount, Invensys Foxboro or Yokogawa
   (2) Electromagnetic induction type with linear response proportional to flow rate. Selected span shall be not greater than twice design flow range. Select units for 10:1 turndown. Note: some meters have limited straight pipe lengths available (before or after meter). Select model for zero pipe lengths in these instances. See mechanical floor plans.
   (3) Unit shall be complete with 150 lb raised face flanged flowtube, PTFE, EPDM neoprene or PFA liner, magnetic coils, self-cleaning 316 stainless steel or Hastelloy C4 electrode, and 4-20 mA transmitter/power supply housed in NEMA 4 enclosure. Transmitter shall be fully field configurable microprocessor based unit.
      (a) Minimum Accuracy: ± 0.5% of Span including hysteresis
      (b) Repeatability: ± 0.1% of reading
      (c) Operating Temperature: 0 to 51°C(0-125°F)
      (d) Power Requirements: 120 VAC / 60 Hz
   (4) Flow meters installed in non-metallic or lined pipe shall be provided with grounding rings per Manufacturer recommendations.
   (5) Transmitter shall be integral mounted on flow meter if meter is below 6 ft from finished floor.
   (6) Provide remote mounted indicator/transmitter when meter is above 6 ft from finished floor. Indicator to be 1/2" LCD or back lit LED type.

D. In-Line Turbine Flowmeter (only use if shown on Control Diagrams)

(1) Manufacturers: Brooks, EMCO, FTI Flow Technology, ABB Instrumentation, Aaliant
(2) These shall be volumetric flow measuring and transmitting flow meters that produce output signals directly proportional to rate-of-flow process being measured.
(3) Accuracy: Error ± 0.5% in linear range
(4) Repeatability: Error ± 0.5%
(5) Min Rangeability (Turndown): 10 to 1
(6) Material of Construction:
  (a) Body: Stainless Steel
  (b) Turbine: Stainless Steel turbine with tungsten carbide bearings
(7) Process Connection:
  (a) Up to 2” line size: NPT
  (b) 2” to 6”: Wafer
  (c) 8”: ANSI Class #150 Raised Face Flange
(8) Output Option 1: 4-20 mA isolated current loop
(9) Outpu Option 2t: Frequency
(10) Calibration Shift and Ambient Effects:
  (a) Position: Transmitter shall operate in any position.
  (b) Vibration: Transmitter shall not be affected by industry normal piping
  (c) vibration when operating within its normal range.
  (d) Ambient Temperature: Transmitter shall not be in error more than 1.0 % of span over
  (e) change in ambient temperature of 100°F.

E. Vortex Flowmeter/Transmitter:
(1) Manufacturers: Invensys Foxboro, Siemens, Yokogawa, Fisher Rosemount, ABB, or EMCO PhD Series
(2) Piezoelectric type with bluff body, separate downstream sensor, and 316 stainless steel wetted parts and NEMA 4 enclosure.
(3) Selected span shall be not greater than twice design flow range. Select units for 10:1 turndown.
  (a) Temperature Range: 0-400°F
  (b) Accuracy:
    1) Liquid: ± 1.0% of calibrated range
    2) Gas and Steam: ± 1.5% of calibrated range
  (c) Power Supply: 14 - 30 VDC unregulated
  (d) Output: 4 - 20 mA DC current
  (e) Connection: ANSI Class 150 SS Raised Face Flange.
(4) Transmitter shall be integral mounted on flow meter if meter is below 6 ft from finished floor.
(5) Provide remote mounted indicator/transmitter if meter is above 6 ft from finished floor. Indicator shall be 1/2" LCD or back lit LED type.

F. Thermal Dispersion Air Flow Measurement Sensor/Transmitter:
(1) Manufacturers: Ebtron or approved equal
(2) Duct Mounted Flow Sensor:
  (a) Multi-probe type thermal dispersion flow sensing station consisting of aluminum probe assembly with flanged connection and multiple hermetically sealed sensors in glass-filled polypropylene housing. Arrangement of sensors along probe assembly factory set to perform equal area traverse of duct cross section.
  (b) Flow Sensor:
    1) Accuracy: ± 2% of reading
    2) Repeatability: ± 0.25% of reading
    3) Materials: Probe – Aluminum
      1. Sensor Housing – Glass-Filled Polypropylene
      2. Mounting Brackets - 204 SS
    4) Calibrated Range: 0 – 5,000 fpm
  (c) Temperature Sensor:
    1) Accuracy: ± 0.15%
    2) Sensor Temperature Range: -20°F to 160°F (0 –1,500 fpm); 30°F to 160°F (>1,500 fpm)
    3) Humidity Range: 0 – 99%, non-condensing

4) Probe Size Range: 8” to 120”

(d) Transmitter:

1) Power Requirements: 24 VAC (22.5 to 29 VAC), 8 VA max.
2) Enclosure: Aluminum Housing
3) Outputs: 4 to 20 mADC
4) Output Resolution: 0.025% of selected range
   1. Output 1: Airflow (0 – 5,000 fpm)
   2. Output 2: Temperature (-20°F to 160°F)
5) Ambient Temperature: -20°F to 120°F

G. Thermal Dispersion Natural Gas Flow Meter

(1) Acceptable Manufacturers: Fluid Components International, Kurz Instruments, Magnetrol, Sage Metering, or Sierra Instruments

(2) Insertion Flow Sensor:

(a) Thermal dispersion type flow sensing element consisting of all welded 316 stainless steel probe assembly with male compression fitting.

(b) Element shall be designed to sense flow of natural gas with specific gravity of 0.60.

(c) Flow sensor and body:

1) Minimum Accuracy: ±1% of Reading
2) Repeatability: ±1% of Reading
3) Pressure Rating: 150-300 psig (2068.43 kPa)
4) Process Temperature Range: -40 to 257°F

(3) Transmitter:

(a) Power Requirement: 15 VDC, 24, VDC, or 120 VAC, 60 Hz

(b) Enclosure: Epoxy Coated Aluminum

(c) Enclosure Rating: NEMA 4X

(d) Display: Back-lit LCD display, 2 lines, 12-16 characters per line

(e) Output: 4-20 mA DC or 0-5 VDC

(f) Output Resolution: 0.5% of selected range

(g) Output Units: Totalized mass flow in cubic feet

(h) Ambient Temperature: -13 to 149°F-25°C to 65°C

H. Rotary (Damper) Position Sensors:

(1) Manufacturers: Kele & Associates, Fisher Controls or Westlock

(2) Provide position 4-20 mA transmitter with potentiometer type (variable resistance) sensor for damper position measurement. Measurement to be linear to damper stroke.

(a) Performance:

1) Power Supply: 24 VDC unregulated
2) Accuracy: ± 1% of output span
3) Repeatability: ± 0.5% of full span
4) Maximum Temperature: 125°F

I. P-E Transducers (Pressure Transmitters for air systems):

(1) Manufacturers: Ashcroft, Mamac, Setra, or GE Modus

(2) Units shall have the following characteristics:

(a) Input: Pressure 0-15 psig (103.42 kPa), minimum

(b) Output Signal: 4-20 mA, 0-5 VDC, 1-5 VDC, 1-10 VDC

(c) Accuracy: 1% of span

(d) Operating Temperature 32 to 125°F

(e) Power Requirements: 24 VDC (10-30 VDC)

(3) Pressure transmitters shall be provided with isolation valve for servicing.

J. Space CO2 Sensors

(1) Manufacturers: Vaisala, Automation Components Inc., Veris, BAPI or approved alternate.

(2) Sensors shall have the following minimum characteristics:

(a) Power Requirements: 24 VAC, 50/60 Hz, 50 VA

(b) Signal Input: Integral Sensor

(c) Signal Output: 4-20 mA DC or 0-10 VDC
(d) Range: 0-2000 ppm
(e) Accuracy: ± 40 ppm at 600 ppm and 1,000 ppm at sea level and 25°C
(f) Drift: ± 5% of range over 5 years
(g) Sensor Infrared CO2 Sensor
(h) Mounting: Wall-mounted

(3) CO2 transmitter may be combined with the space temperature sensor as a single unit.
(4) Provide local display for continuous reading of CO2 levels.
(5) Units shall be certified by manufacturer to require calibration no more frequently than once every 5 years.

K. INSTRUMENT TUBING

(1) Copper Tubing:
(a) Type L, hard or soft seamless, ASTM B88, with wrought copper soldered fittings, ANSI B16.22, except at connections to apparatus, where brass compression-type fittings shall be used. Solder joints shall be made with ASTM B32, 95-5 tin-antimony solder-joint, Bridgit or Silvabrite.

(2) Stainless Steel Tubing:
(a) Manufacturers: Accu-Tube, Parker, Webco Industries, or approved alternate

(3) Plastic Tubing:
(a) Fire resistant virgin polyethylene, meeting stress-crack test ASTM D1693. Individual tube polyethylene or multi-tube instrument tubing bundle shall be classified as flame retardant under UL 94. Polyethylene material shall be rated as self-extinguishing when tested in accordance with ASTM D 635.

PART 3 EXECUTION

5.01 GENERAL

A. Install control equipment, wiring and air piping in neat and workmanlike manner and in accordance with manufacturer's recommendations. Maintain clearances, straight length distances, etc., required for proper operation of each device. Mark and detail on coordination drawings, exact locations of inline devices, wells, and taps to be installed by Mechanical Contractor.

B. Coordinate timely delivery of materials and supervise activities of other trade Contractors to install inline devices such as immersion wells, pressure tappings, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, and other such items furnished by Control Contractor which are to be installed by Mechanical Contractor.

C. Install control devices in accessible location.

D. Mount motor control devices within 5 ft of disconnect switch, or starting device furnished by Electrical Contractor unless noted otherwise. Maintain required NEC clearances.

E. Control Contractor and Mechanical Contractor shall review proposed static pressure sensor and flow meter locations with Owner and Engineer for approval prior to installation.

F. Install control devices in adherence with manufacturers recommendations.

G. Locations of pressure sensing taps in pipes or ducts above ceilings shall be clearly identified on ceiling. Coordinate preferred identification method with Owner/Architect.

5.02 GENERAL INSTRUMENTATION

A. Thermometers (Temperature Indicators):

(1) Install thermometers at each point of temperature transmission and control, except for those that are indicated at local control panels. Install thermometers to permit easy reading from floor or operating platform (within 3 ft of line of sight). Provide remote bulb thermometers with readout indicators mounted within 3 ft of line of sight whenever sensing point is more than 3 ft from line of sight.

(2) Thermometer wells in piping will be installed by Mechanical Contractor.

B. Local Control Panels:

(1) Install remote mounted devices, controllers, I/O terminal blocks, power supplies, etc., inside of local control panels.

(2) Locate panels as shown on drawings.

(3) Locate panels not shown on drawings adjacent to equipment served with minimum of 3 ft clearance in front of door. Provide sufficient clearances to allow full door swing and full access to internal components. Submit proposed panel locations with shop drawing submittals.

(4) Mount top of panels between 5 and 6 ft above floor so that gauges and indicators are at eye level.

C. Pressure Differential Switches (Static Pressure Safety Switches)

(1) Install static pressure switches in an accessible location where the reset switch can be accessed from the floor without the use of a ladder.

D. Pressure Gauges (Pressure Indicators):

(1) Install pressure gauge for indication of supply and control pressure in pneumatic systems at output of controllers, I/P transducers, electric air solenoid valves, pressure switches and other points where visible indication of air pressure is required for operating and maintenance purposes.

(2) Provide test port for quick connection of test gauges at valve, damper motor and other actuator branch lines.

(3) Pressure gauge tappings in piping will be provided by Mechanical Contractor.

E. General Instrumentation at Local Control Panels:

(1) Provide record control drawings of systems served by each local panel, in location adjacent to or inside of panel cover. Provide protective cover for drawing.

5.03 DISCRETE AND ANALOG INSTRUMENTATION

A. Wall Mounted Space Thermostats/Temperature Sensors:

(1) Install space thermostats/sensors where indicated, as required to perform specified control sequences, and as directed to meet job site conditions.

(2) Provide space temperature sensors without remote setpoint adjustment in all public spaces, hallways, and mechanical rooms unless otherwise specified.

(a) Mount space thermostats/sensors at 5 ft above floor unless otherwise indicated.

(3) Provide space temperature sensors with temperature displays and remote setpoint adjustment in all offices, laboratories, common spaces, and conference rooms.

(a) Mount space thermostats/sensors with accessible setpoint adjustment or temperature reading (thermometer or digital temperature readout) at 4 ft above floor meeting ADA requirements.

(4) Space thermostats/sensors located on exterior walls shall be mounted on thermally insulated sub-base.

(5) Relocate space thermostats/sensors if required due to draft, interferences with cabinets, chalkboards, etc., or improper sensing.

(6) Mount space thermostats/sensors in corridors, stairways and public toilets 7 ft above floor.

(7) Space thermostats/sensors in corridors, stairways, and public toilets shall be protected by heavy-duty cast and die formed guard.

B. Low Limit Temperature Switches (Freeze Stats):

(1) Install low limit controls where indicated on drawings or as specified. Unless otherwise indicated, install sensing element on upstream face of cooling coil where cooling coil is provided, or at downstream side of heating coils where no cooling coil is provided.

(2) Distribute sensing element across entire area of medium being sensed. Install controls at accessible location with suitable mounting brackets and element duct collars where required.

(3) For low limit temperature sensors installed on roof top units and other outdoor equipment, install heaters in enclosures housing freeze stats to prevent freeze stat tripping.

C. Duct Mounted Humidity Sensors:

(1) Duct mounted humidity sensors used for discharge humidity or high limit control shall be mounted at minimum 6’ downstream from the humidifier or no less than the steam absorption distance indicated by the humidifier manufacturer.

D. Static Pressure and Air Flow Stations:

(1) Furnish static pressure and air flow measuring stations to Mechanical Contractor for installation.

(2) Stations shall be installed in strict accordance with manufacturer's published requirements. These stations serve as primary signals for airflow control systems; therefore it shall be responsibility of Control Contractor to verify location and installation to assure that accurate primary signals are obtained.

(3) Pressure differential switches shall be piped across device creating differential between fan discharge and fan suction.

E. Outdoor Static Pressure Sensor:

(1) Furnish outdoor static pressure sensor as specified in control sequence. Mechanical Contractor will install sensor and associated pipe to below roof as shown on detail.

(2) Install sensor so that sensor is pointed down stream.

F. Outside Air Temperature Sensors:

(1) Mount on north side of building or in intake area wells for air handling systems. Provide solar shields for installations where sensors may be exposed to sunlight conditions.

G. Building or Space Static Pressure Control System:

(1) Extend 2" pipe between spaces for room pressure control or between space and outside for building static pressure control. Mount velocity sensor in tee fitting with one foot of straight pipe on either side of sensor. Terminal space and points inside of sheet metal plenum attached to return/exhaust grille. Terminate outside sensors on prevailing windward side of building with flapper type damper and full weather cover shroud constructed of aluminum painted to match building exterior.

H. Flow Meters and Flow Switches:

(1) Install flow measuring devices with recommended straight pipe diameters upstream and downstream of elbows, tees, valves, or other fittings that cause uneven turbulent flow conditions.

(2) If no recommendations are given, provide straight pipe equal to 10 pipe diameters upstream and 5 pipe diameters downstream.

(3) Provide flow straighteners as necessary based on actual flow meter location and piping layout.

(4) Flow meters are to be installed in adherence to manufacturers recommendations.

I. Sensor Wells:

(1) Wells mounted in pipe 3" and larger may be installed in horizontal or vertical lines provided that element is always in flow, (for condensate and other gravity return lines, install in bottom of pipe). Wells mounted in pipe 2-1/2" and smaller shall be installed at elbow tee fittings with well pointed upstream. Minimum of 2" pipe size for elbow tee installation.

J. Transmitters, Indicators, and Transducers:

(1) Locate transmitters at sensing devices or within 100 ft of remote mounted transmitters. For hot systems (150°F and higher) mount electronics on side of pipe or remotely mount.

(2) For indicating type instruments, locate indicating element within 6 ft of floor with readout easily visible from floor level. Provide remote readouts if necessary.

(3) Locate transmitters and transducers within 5 ft of floor to allow for calibration and maintenance.

(4) Provide P-E transducers to convert analog pressure signals to analog electronic signals for input to DDC panels.

K. Static Pressure Transmitters/Temperature Sensors

(1) Transmitters/Sensors shall be hardwired back to controller where logic and control outputs to VFD, valves, dampers, etc. will reside. Sharing the transmitter signal via the network shall not be allowed for direct control.

5.04 INSTRUMENT TUBING

A. Conceal all piping, except for piping in mechanical rooms and other areas where mechanical system piping is exposed.

B. Install exposed piping and conduit parallel to or at right angles to building structure and support adequately at uniform intervals.

(1) Provide tubing clamps with insulated standoffs where metallic tubing may come into contact with other dissimilar metals to prevent galvanic corrosion from occurring. Use of wire ties or hose clamps to fasten tubing to structure or other piping is not allowed.

(2) Use of tubing channel designed for mounting polyethylene tubing shall be allowed.

C. Polyethylene tubing not exceeding 18" exposed may be used for connection to instrument or actuator.

D. Install polyethylene tubing with no concealed splices and number code all tubing.

E. Piping type shall be as follows:

(1) Inside Panels:

(a) Use polyethylene/plastic tubing.

(2) Exposed:

(a) Polyethylene/plastic tubing may be used if run in fully enclosed rigid metal raceway or metal conduit where environment is within temperature limits of polyethylene tubing. Use copper tubing or stainless-steel tubing for wet systems.

END OF SECTION 23 09 03

SECTION 23 09 23 - DIRECT DIGITAL CONTROLLERS AND NETWORKS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0903 - Control Instrumentation

C. Section 23 0993 - Control Sequences

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.]

1.03 DEFINITIONS

A. The following abbreviations, acronyms, and definitions may be used in addition to those found elsewhere in Contract Documents.

(1) ASC: Application Specific Controller. A networked device or node that contains a complete, configurable application that is specific to a particular task.

(2) Alarms & Events: The exchange of data between devices related to the occurrence of a predefined condition that meets specific criteria (event).

(3) BC: Building Controller. Provide supervisory control, scheduling, trend logging & alarm handling.

(4) B-OWS: BACnet Operator Workstation

(5) B-BC: BACnet Building Controller. Same as SLC.

(6) B-AAC: BACnet Advanced Application Controller. Same as PPC.

(7) B-ASC: BACnet Application Specific Controller

(8) B-SA: BACnet Smart Actuator

(9) B-SS: BACnet Smart Sensor

(10) BBMD: BACnet Broadcast Management Device

(11) BIBBS: BACnet Interoperability Building Blocks. Specific individual function blocks for data exchange between interoperable devices.

(12) Broadcasting: The propagation of data from a device to the control network. Software objects that broadcast data to the network may include the following parameters:

(13) Send on Delta: An adjustable parameter that defines a requirement to broadcast when the data generated by the software object changes by an amount that exceeds this parameter’s value. For binary data, this parameter defaults to a change of state. The broadcast of data is initiated when this criteria and the minimum send time requirement have been met. Also referred to as a “Change of Value”.

(14) Minimum Send Time: An adjustable parameter that defines a mandatory time period during which no broadcasting of data will occur. Once this time period has been exceeded without a broadcast, the send on delta parameter or the maximum send time parameter shall determine when a broadcast is initiated.

(15) Maximum Send Time: An adjustable parameter that defines the maximum time period between broadcasts of a software object’s data to the network. Should the value of a software object remain constant over an extended period of time, the value will be rebroadcast once every maximum time period.

(16) BTL: BACnet Testing Laboratory.

(17) Channel: One or more segments not containing a router.

(18) Domain: A logical collection of devices on one or more channels.

(19) FLN: Floor Level Network. BACnet MS/TP.

(20) HMI: Human-Machine Interface. Graphical operator BAS interface. Same as Graphical User Interface (GUI).

(21) LAN: Local Area Network. Same as Floor Level Network.

(22) Maximum Send Time: Event driven communication parameter specifying the time period for which data must not be sent more than once.

(23) Minimum Send Time: Event driven communication parameter specifying the time period for which data must be sent at least once.

(24) PICS: Protocol Implementation Conformance Statement. Detailed description for a given BACnet device stating its inherent BACnet capabilities.

(25) Point: Group of data, which corresponds to a hardware input, output, or calculated value.

(26) PPC: Programmable Process Controller. Same as Advanced Application Controller (AAC)

(27) Repetitious Controls: Controls for critical systems where the control is spread across multiple controllers with separate power sources so there is no single point of failure for the entire system.

(28) Scheduling: The exchange of data between devices related to the establishment and maintenance of dates and times at which specified output actions are to be taken.

(29) Send on Delta: Event driven communication parameter specifying the amount of variable change before data is to be sent between the Minimum and Maximum send times.

(30) SLC: Supervisory Level Controller. Same as Building Controller.

(31) Segment: A section of uninterrupted cable where multiple devices may be installed.

(32) Subnet: Logical division of a domain.

(33) Trending: The accumulation of (time, value) pairs at specified rates for a specified period duration.

1.04 SUBMITTALS

A. Shop Drawings:

(1) Submit shop drawings for each hardware device used and submit complete description of software applications used. Submit manufacturer's printed product data sheets for each device or software program used. Datasheets shall be submitted electronically in pdf format with bookmarks provided for each individual device and table of contents listing each device manufacturer and full model number with links to device pages. Organize sheets in order of model number, alphabetically, then numerically. When a manufacturer's data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.

(2) Submittals shall include points list of each control input and output, controlled devices, locations of devices, and symbol or label of each control point in software.

(3) Device data sheets shall be submitted with electronic bookmarks as specified in Section 23 0901 - Control Systems Integration. Refer to PART 1 – GENERAL, subsection SUBMITTALS.

(4) Device data sheets shall be submitted simultaneously with Control Systems Integration submittal. Refer to submittals section in 23 0901.

B. Operating and Maintenance Manuals: Refer to Section 23 0901 - Control Systems Integration.

C. Software Manual:

(1) As part of operating and maintenance manuals, submit one software manual per workstation plus one extra copy for archive use. Software manuals shall be divided into separate parts with tabs for each part.

(2) Software manual parts shall include:

(a) Complete description of operating system including all commands, configuration programs, printouts, logs, database functions and passwords. Describe general operating procedures, starting with system overview and proceeding to detailed description of each software command feature with sample printed displays and system function description for each option. Include instructions on verifying errors, status, changing passwords and initiating or disabling control programs.

(b) Complete description of programming language including all commands, configuration programs, control loop functions and testing. Describe general programming procedures, starting with system overview and proceeding to detailed description of each software command feature. Include instructions on creating or modifying any control algorithm or parameter, debugging, etc. This shall include all control functions, algorithms, mathematic equations, variables, setpoints, time periods, messages, and other information necessary to load, alter, test and execute custom or pre-written programs.

(c) Software Backup: Upon successful completion of acceptance testing, submit to Owner 2 archive copies of all accepted versions of source code and compiled code for all application programs and data files on CD ROM backup disks. All control software must be readily accessible by Owner using BAS workstation hardware and software.

(d) Web server/data historian SQL database schema (table format) for trend data and event/alarm data.

(e) Control Loop Documentation: Submit indexed summary of each control loop program. Summary shall list in tabular form, name of system, name of control loop, all I/O points used, and reference to sheet number in shop drawings to describe control sequence programmed. For each control loop submit complete printed listing of source code used, all setpoints, high/low alarm points, time event schedules, proportional gains, integrals, derivative values, and other database values.

(f) BAS Points List Summary: Provide detailed summary for each point in the system. Summary shall be cross-index listing of all points in alpha/numerical order with list of control loops which use each point. For each point, include an abbreviated point name, expanded point description, detailed description of each input instrument or output device, and detailed description of exact location of all field hardware. Location descriptions shall include room names, column numbers, elevation (above ceiling, bottom of duct, etc.).

1.05 WARRANTY

A. Provide 1 year warranty on all materials and labor.

B. Warranty requirements shall include furnishing and installing software upgrades issued by the manufacturer during the 1 year warranty period.

1.06 FCC COMPLIANCE

A. Digital equipment furnished under this contract shall be tested and made to comply with limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environments. Literature shall so note and equipment shall be so labeled to show this compliance.

PART 2 PRODUCTS

2.01 DIRECT DIGITAL CONTROL (DDC) CONTROLLERS

A. General:

(1) DDC controllers shall be microprocessor based, field programmable controllers, capable of performing control and energy management functions, and shall be UL listed as Signaling Systems. Each controller shall include its own microprocessor, power supply, input/output modules, and termination modules as required to perform intended function.

(2) DDC controller shall receive discrete electrical and/or analog electronic field input signals, convert signals for use by controller, perform control sequences, convert controller information into output signals, and provide control output signals to actuators and field control devices. Inputs and outputs, including communication connections, shall be electrically or optically isolated from controllers.

(3) All DDC controllers shall be provided by the same manufacturer.

(4) DDC controller with analog input modules shall be capable of accepting any form of linear or non-linear voltage (0-5 VDC or 0-10 VDC), current (4-20 mA) or resistive input (0-1000 ohm).

(5) DDC controller with discrete input modules shall be capable of accepting discrete inputs from any device with isolated, dry-type contacts (no grounds or no voltage) of either normally open (NO) or normally closed (NC) configuration. Provide visible status lights (LEDs) to indicate input point status.

(6) Provide input modules capable of interfacing with pulsed output type sensors as required.

(7) DDC controller with discrete output modules shall have isolated, dry-type contacts (no grounds or no voltage) of either normally open (NO) or normally closed (NC) configuration. Provide visible status lights (LEDs) to indicate output point status.

(8) DDC controller shall have capability to scale, offset, and display proper analog value without field hardware modification. DDC controller shall convert analog input signals to digital values (A/D conversion) and convert digital values to analog outputs (D/A conversion) for modulating control purposes. Some application specific controllers may utilize tri-state or Triac outputs for floating point control of control devices. Floating point control should be limited to non-critical room temperature control and mechanical space heating and cooling.

(9) Failsafe hardware shall be provided such that BAS failures result in immediate return to local control. If DDC controller uses database values from other DDC controllers and communication network fails or malfunctions, control loop outputs shall continue to function using last value received from BAS.

(10) Failure of network or control devices (i.e. building level controllers, floor level controllers, application specific controllers, routers, repeaters, etc.) shall be alarmed at the Operator Workstation as a Level 3 Critical Alarm.

(11) All DDC Hardware shall meet the following requirements:

(a) All DDC controllers shall be connected to an ASHRAE 135 MS/TP, BACnet over ARCNET or BACnet/IP control network and communicate via ASHRAE 135 exclusively.

(b) MS/TP controllers shall operate at a minimum baud rate of 38.4 kbps.

(c) All DDCP shall implement all required functionality of the application network interface via BACnet objects, properties, and services.

(d) All DDC controllers shall conform to the BACnet Testing Lab's Device Implementation Guidelines and be BTL Listed.

(e) Application programs and configuration settings shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration settings.

(f) All settings and parameters used by the application shall be fully configurable to the greatest extent possible, via properties of BACnet objects that can be written to via BACnet services or via properties of BACnet objects that can be written to via BACnet services for the following:

1) Setpoint
2) Alarm limit
3) Schedule modification
4) Trend modification

(g) All other settings and parameters that cannot be written to via BACnet services shall be fully configurable via either properties of BACnet objects that can be written to with a configuration tool, or via hardware settings on the controller itself to support the application.

(12) Each DDC panel shall have sufficient I/O capacity to perform specified control sequences and/or include points listed in point schedules. If DDC controller does not have sufficient capacity, provide additional slave I/O panels to achieve required point count.

(13) Analog and critical safety discrete control loops shall have inputs and outputs into/from same DDC panel. Analog control loops for major equipment (chilled water, hot water, convertors, air handling units, etc.) shall have PID control.

B. BACnet Building Controller (B-BC):

(1) BACnet Building Controllers (B-BCs) shall provide direct connection to high speed, BACnet/IP Local Area Network (LAN) and Campus Ethernet network and serve as communications router for other controllers on slower speed BACnet MS/TP or BACnet over ARCNET Floor Level Network (FLN).

(2) Communication between B-BC's shall be through BACnet/IP communication.

(3) B-BC's shall have sufficient processor capabilities, hard-drive storage and RAM to implement all types of custom software applications and shall provide supervisory control, scheduling, trend logging & alarm handling functions as follows:

(a) Scheduling:

1) Each B-BC shall support a minimum of 250 BACnet Schedule Objects and 250 BACnet Calendar Objects.

(b) Trending:

1) Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

2) B-BC shall periodically upload trended data to networked BAS Web Application Server for long term archiving.

3) Archived data shall be stored in standard database format and shall be made available for use in third-party spreadsheet or database programs.

(c) Alarm Generation:

1) Alarms may be generated within the system for any object change of value or state either real or calculated. This includes analog object value changes, binary object state changes, and various controller communication failures.

2) B-BC shall periodically upload alarm logs to networked BAS Web Application Server for long term archiving.

(4) B-BC's shall have uninterrupted real time clocks capable of time of day, week, and year information to the system as needed to perform software functions. Clock shall be programmed to reset twice per year to allow for Daylight Savings Time. Clocks in multiple DDC Controllers shall be synchronized to automatically match designated B-BC's or Web server. Accuracy shall be within 1 second per day.

(5) Batteries shall maintain volatile memory and real time clocks for a period of at least 72 hours during power failure. Batteries shall be maintenance free and have minimum life of 2 years. When power has been restored, the following shall occur automatically:

(a) Orderly startup of controlled equipment (user defined)

(b) Continuation of control algorithms

(c) Database revision

(d) Logging of power interruption and restoration times

(e) Battery recharging

(6) Provide local visual indication and system annunciation of low battery power for each battery.

(7) Each B-BC shall include its own micro-processor, power supply, input/output modules, and termination modules as required to perform intended function.

(8) BACnet UDP port number to always be set to 47808 (BAC0).

C. BACnet Advanced Application Controllers (B-AAC):

(1) B-AACs are defined as having sufficient processor capabilities and RAM to implement all types of custom software applications.

(2) B-AACs shall be capable of communicating to BAS network via BACnet MS/TP connected to Building Controller or via BACnet/IP directly.

(3) All B-AACs controlling major mechanical equipment/systems and lab equipment monitoring shall communicate via BACnet/IP as indicated on BAS Network Architecture drawings.

(4) Provide at least one extra communication port at each B-AAC for direct connecting a notebook computer or hand-held terminal.

D. BACnet Router

(1) BACnet MS/TP to BACnet/IP and BACnet/ARCNET to BACnet/IP Routers shall perform layer 3 routing of BACnet MS/TP or BACnet/ARCNET packets over an IP network in accordance with ASHRAE 135 Annex J. The router shall provide the appropriate connection to the IP network and connections to the BACnet MS/TP or BACnet/ARCNET network. BACnet Routers shall be capable of configuration via DHCP and Write-Broadcast-Distribution-Table messages but shall not rely on these services for configuration.

(2) One router in the IP subnetwork shall be designated as the BBMD (BACnet Broadcast Management Device) and shall be indicated as so on the Network Architecture.

(3) BACnet router functionality can also be incorporated into BACnet Building Controllers.

E. BACnet Gateways:

(1) Provide gateways to connect BACnet to non-BACnet devices, and non-BACnet DDC controlled equipment.

(2) Provide with each gateway an interoperability schedule, showing each point or event on the non-BACnet side that the BACnet "client" will read, and each parameter that the BACnet network will write to. Describe this interoperability in terms of BACnet services, or Interoperability Building Blocks (BIBBS), defined in ASHRAE 135 Annex K. Provide two-year minimum warranty for each gateway, including parts and labor.

(3) The following minimum capabilities are required:

(a) Gateways shall be able to read and view all readable object properties listed in the interoperability schedule on the non-BACnet network to the BACnet network and vice versa where applicable.

(b) Gateways shall be able to write to all writeable object properties listed in the interoperability schedule on the non-BACnet network from the BACnet network and vice versa where applicable.

(c) Gateways shall provide single-pass (only one protocol to BACnet without intermediary protocols) translation from the non-BACnet protocol to BACnet and vice versa.

(d) Gateways shall meet the requirements of Data Sharing Read Property (DS-RP-B), Data Sharing Write Property (DS-WP-B), Device Management Dynamic Device Binding-B (DM-DDB-B), and Device Management Communication Control (DM-DCC-B) BIBBs, in accordance with ASHRAE 135.

(e) Gateways shall include all hardware, software, software licenses, and configuration tools for operator-to-gateway communications. Provide backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

F. Power Supplies:

(1) Power supplies shall operate on nominal 120 V, 60 Hz, single-phase power. DDC Controllers shall be provided with surge and noise protection. Power fluctuation shall not affect control system. Include surge protection on telephone line.

(a) Isolation transformers shall be included when connections are being made between 2 separate buildings.

2.02 DIRECT DIGITAL CONTROL SOFTWARE

A. General:

(1) DDC Controller control strategies shall be Owner definable from engineering workstations.

(2) Software functions and algorithms shall be sufficient to enable implementation of control sequences as specified and shall be able to maintain continuous control as intended.

(3) Control functions shall include both mathematical and logical operators. Control algorithms shall include proportional, integral and derivative control (PID). Adaptive (self-tuning) PID loop parameters, if offered by DDC Controller manufacturer, shall not be used unless adaptive limits are used to adjust limit values based on system status; or written request is submitted and approved by Engineer.

(4) Allow operators to assign unique identifiers of their choice to each connected point. Identifiers shall have at least 8 alpha/numeric characters. References to these points in programs, reports and command messages shall be by these identifiers.

(5) Provide access control (user defined passwords) for system operation. There shall be minimum of 3 access levels. First level shall allow system monitoring only. Second level shall allow monitoring, set point adjustment, and scheduling revision. Third level shall allow modification of control algorithms. System shall return to secured (monitoring only) mode after 5 minutes of inactive operation.

(6) Each DDC Controller shall contain self-diagnostics that continuously monitor proper operation of panel.

(7) If microprocessor malfunctions, control loop outputs shall continue to function using last value received from microprocessor.

B. Building Controller Software:

(1) Provide DDC Controller software application program modules for performing energy management control functions such as time of day change of database values (programmed start/stop, temperature setbacks, etc.), supply air temperature reset based on space load demand, economizer control, optimum start/stop based on current indoor and outdoor psychometrics, duty cycling and client tailored programs required for special applications such as VAV fan matching and supply fan control, enthalpy control, intermediate season or "dead band" control, totalizing, and holiday programming.

(2) Provide manufacturer's standard operating system for real time control of system interactions, including database information requests/transfers by system hardware or by operators. Operating system shall also have the following additional capabilities (given that operator has appropriate security access level):

(a) User interface and online system configuration software embedded in Building Controller.

(b) Support for Web services at the automation network level.

(c) Displaying database (point) value including measured values, controlled variables, setpoints, gain factors, and any other adjustable parameters.

(d) Changing or overriding any database value.

(e) Error detection, correction, re-transmission of database values, arithmetic or logical faults.

(f) Alarm reporting including sending alarms to remote workstations, User Interface Web Server or Data Historian on network.

(g) Alarm buffer to retain alarms in order of importance without losing any alarms.

(h) Creating and displaying historical trend logging of any value, limited only by available memory.

(i) Creating new variable database values (soft points) based on arithmetic calculation (including summation or totalizing) on other database values.

(j) Adding new hardware points without overall BAS shutdown.

2.03 OPERATOR'S WORKSTATION

A. Operator Workstations shall communicate with BAS Web Server via standard web interface software. Provide Operator Workstations for operator interface to BAS for monitoring, control, and database management as indicated on BAS Network Architecture Drawings. Proprietary software shall not be required for proper monitoring and control of HVAC systems.

B. Owner will furnish operator's workstations for operator interface to BAS for monitoring, control, and database management. Provide network interface cards, all required cables and other associated hardware for connecting each of Owner's workstations to BAS network and other remote devices specified.

2.04 ENGINEERING WORKSTATION

A. Refer to Operator Workstation section for requirements.

2.05 DDC ENGINEERING (PROGRAMMING) - SOFTWARE

A. Provide engineering software for 1 Engineering Workstations and 1 laptop.

B. Software shall have the same characteristic and capabilities as DDC Controllers. In addition, operator's workstations shall have the following features.

C. User Programmability:

(1) Engineering workstation software shall include field-engineering tools (software & hardware) for programming all controllers supplied.

(2) All application software shall be interactive, fully prompted, and menu driven and shall provide the following functionality as a minimum:.

(a) Determine control strategies, which have been defined for specific piece of equipment.

(b) Add control loops to system using English language type program language equal to BASIC or other easily learned language or function block programming. (PASCAL, C, or other assembly type languages are not acceptable.)

(c) Add points to system.

(d) Create, modify or delete control strategies.

(e) Create, modify or delete system graphics.

(f) Assign sensors and/or actuators to control strategy.

(g) Tune control loops through adjustment of control loop parameters.

(h) Enable or disable control strategies.

(i) Generate hard copy records of control strategies on printer or soft copies to files compatible with Microsoft Office applications.

(j) Select points to be alarmable and define alarm state(s).

(k) Select points to be trended over a period of time and initiate recording of values.

(l) Override Input/Output points for each individual controller.

2.06 OPERATOR WORKSTATION - SOFTWARE

A. Custom Database Functions:

(1) Operator shall be capable of generating long term historical trend logs and displaying information in tabular or graphic formats. Provide all software options for standard and custom report generators.

B. Color Graphics:

(1) Provide color graphics software package compatible with manufacturer’s standard software. Provide mouse or other special hardware required to operate software. Software shall be capable of user editing of text fields, graphics, alarms, and real-time variables.

(2) Software shall be capable of importing files in AutoCAD format, directly or via translators.

2.07 NETWORK HARDWARE

A. Provide network interface hardware for each device connected to network. Each device shall have sufficient performance as not to degrade specified processing speed.

B. Provide network cabling with sufficient performance as not to degrade specified communication speed. Cabling shall be compatible with proposed system and shall comply with requirements specified in Section 23 0901 - Control Systems Integration.

C. Provide other network support devices that are required for proper operation of network, such as file servers, signal repeaters, network hubs, etc.

D. Provide network diagnostic tool for measuring/confirming bandwidth usage on IP layer.

PART 3 EXECUTION

3.01 GENERAL

A. Install control equipment in neat, professional manner to satisfaction of Architect and Engineer.

B. Coordinate timely delivery of materials and supervise installation of DDC Controllers and network cabling and devices.

C. Install DDC Controllers and network control devices in accessible locations.

3.02 OVERALL BAS ARCHITECTURE

A. Provide hardware/software to update database in less than 1 second for fast-acting control loops such as pressure control, air or water flow rate control, and air handling unit temperature control, or 10 seconds or less for other control loops.

B. Control software algorithm and inputs and outputs for a single system or piece of equipment shall reside on a single controller and shall not be distributed amongst multiple controllers. If multiple pieces of equipment are to be interlocked, a single “Master” controller shall provide control for all interlocked pieces of equipment, i.e. an AHU and interlocked return fan and exhaust fans.

C. Control loop software algorithm for each analog control loop shall reside on same controller as inputs and outputs required for that specific control loop.

D. Networks that operate via polled response or other types of protocols that rely on central processors, file servers, or other such devices to maintain or manage peer-to-peer communications, shall have redundant components to maintain network in event of failure at central device. Provide automatic changeover (without operator intervention) to redundant device upon failure of any central type processor.

E. Floor Level Network (FLN) network shall be multi-drop digital transmission network utilizing BACnet MS/TP (38.4kbs) communication.

F. Each multi-drop trunk shall be within manufacturer's allowable line lengths without signal degradation. Multi-drop trunks shall be interfaced to system via standard EIA or other industry recognized interfaces so that single failure does not disrupt or halt network.

G. Communications between Building Level DDC Controllers and operator's workstations shall be peer-to-peer, allowing multiple users to access and use system simultaneously with no loss of system performance.

H. Provide levels of connected networks to connect all DDC Controllers, including terminal DDC Controller. Communications to terminal devices shall be similar to capabilities and functions of other DDC Controllers and shall be transparent to operator.

I. Quantity of nodes (devices connected) on any one FLN (MS/TP) shall not exceed 50% of maximum node capacity published by equipment manufacture and Building Controller processor usage shall not be greater than 30% nominal. Provide additional hardware to meet this requirement.

J. Alarm reports from DDC Controllers shall not be impeded by use of either remote or local monitor, or control stations on network either in access mode or programming mode.

3.03 DIRECT DIGITAL CONTROLLERS

A. DDC Controller Usage:

(1) Select DDC Controller to provide speed of response required for each control loop type. Pressure, flow rate, and air handling unit temperature control must be via Building Level DDC Controller. Application specific DDC Controller may be used for other control loop types.

(2) Each DDC Controller shall have sufficient I/O capacity to perform specified control sequences and/or include points listed in any point schedules. If DDC Controller does not have sufficient capacity, provide additional slave panels to achieve required point count.

(3) Analog and critical safety discrete control loops shall have inputs and outputs into/from same DDC Controller. Analog control loops for major equipment (chilled water, hot water, convertors, air handling units, etc.) shall have PID control. Air terminal control loops may utilize floating point control from tri-state or Triac outputs from the controller, but require some type of feedback device to prove position.

(4) Provide at least one Building Level DDC Controller per mechanical equipment room and, if required, at each PC workstation location.

(5) For valves and dampers within 100 ft of associated DDC Controller, mount current to pneumatic (I/P) converter within DDC Controller panel or in adjacent panel. Otherwise mount I/P converters at valve or damper. Provide pressure gauges on main air, and all control output signals.

B. Point Capacity:

(1) Provide 20% point capacity required plus spare I/O point capacity in each B-AAC. Spare I/O point capacity is defined as terminal connections, which are ready to accept digital or analog inputs, dry contacts for digital outputs, and variable voltage or current terminals for analog outputs. Universal type points are acceptable for both discrete and analog type points. Spare points do not include any input or output conversion devices.

C. Building Controllers:

(1) Provide one BBMD in each IP subnet.

(2) BACnet UDP port number to always be set to 47808 (BAC0).

D. Gateways:

(1) Gateways may be used for communication with non-BACnet control hardware subject to all of the following limitations:

(a) Non-BACnet control hardware shall not be used for controlling built-up units.

(b) Non-BACnet control hardware shall not perform system scheduling functions.

E. Cabinets:

(1) Provide local control cabinets for DDC Controllers. DDC Controller cabinets for air terminals may be used directly if enclosures are rated for NEMA 1. All cabinets shall utilize a single master key. Provide 2 spare key sets to Owner.

(2) All control cabinets shall be labeled. Labels shall be keyed to the unique identifiers shown on the As-Built drawings

F. Controller Firmware

(1) Provide latest version of controller firmware. Include firmware updates for period of one year after system acceptance, coinciding with warranty period. If the upgrade of firmware causes the need to upgrade or reconfigure/reprogram related systems, controllers or software, Contractor shall notify Owner prior to upgrade and provide additional work scope in coordination with other Contractors, as required, at no cost to Owner.

3.04 OPERATOR/ENGINEERING WORKSTATIONS

A. Locate workstations as indicated on plans and Network Architecture.

B. Furniture is provided by others. Provide all necessary connections and extensions to integrate hardware with furniture system.

C. Security access levels for the engineering workstation software shall be setup as follows:

(1) Guest (View-only) access level shall have the ability to perform the following tasks:

(a) View Data

(b) View Trends

(2) Operator access level shall have the ability to perform the following tasks:

(a) View Data

(b) Acknowledge Alarms

(c) View Reports

(d) Override Points

(e) Change Setpoints

(f) View Trends

(g) Edit Schedules

(3) Engineer access level shall have the same access as Operator level with the ability to perform the following additional tasks:

(a) Add Devices

(b) Address Changes

(c) Create Applications

(d) Download Applications

(e) Configure ASCs

(f) Setup Trends

(g) Setup Reports

(h) Modify Alarm Settings

D. Provide security access level setup for 10 users. Coordinate user names, access levels and passwords with Government.

E. System shall provide an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for 5 minutes. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

3.05 DDC SOFTWARE INSTALLATION

A. Operating system (OS): Contractor shall configure the OS on workstations and laptops for their software to operate correctly plus configure usernames and passwords.

B. Virus Protection software: Contractor shall coordinate virus protection software with owner.

C. Contractor shall install and configure all software packages required to maintain and configure all types of controllers provided as part of this project on each engineering workstation.

D. Software from panels shall be permanently stored on CD ROM and on at least one hard disk at operator's workstation or Web Application Server. Provide auto re-boot feature on power up from system failure. System failures shall not necessitate manual reprogramming to restore normal system function.

E. Provide the latest version of all standard software, including operating system and control software. Include any software updates for period of one year, coinciding with warranty period. Beta released software shall not be used.

3.06 INITIAL PROGRAMMING

A. Control Contractor shall provide initial programming of controllers to accomplish sequences specified.

B. Provide back-up documentation per software manual submittals for all programs, in both written and electronic media formats.

C. Outputs, whether sequenced or not, shall have separate programmable hardware outputs. For air handling units, minimum outside air, maximum (economizer) outside air, return air, relief air, smoke dampers, heating valves, cooling valves, humidifier valves, etc., shall each have separate output.

D. BACnet Naming and Addressing

(1) Every BACnet device shall have an assigned and documented MAC Address unique to its network. For Ethernet networks, document the MAC Address assigned at its creation. For MS/TP, assign from range as indicated by vendor documentation.

(2) Assign unique numbers to each new network installed on the BACnet internetwork. Provide ability for changing the network number; either by device switches, network computer, or field operator interface. The BACnet internetwork (all possible connected networks) can contain up to 65,534 possible unique networks.

(3) Every BACnet Building Controller (B-BC) and BACnet Router UDP port number shall be set to 47808 (BAC0).

(4) Assign unique Device "Object_Identifier" property numbers or device instances for each device on the BACnet internetwork. Provide for future modification of the device instance number; either by device switches, network computer, or field interface. BACnet allows up to 4,194,302 possible unique devices per internetwork.

(5) The Object Name property field shall support 32 minimum printable characters. Assign Object Name properties with plain-English names descriptive of the application. Examples include "Zone 1 Temperature" and "Fan Start/Stop".

E. Minimum BACnet Object Requirements

(1) For the following points and parameters, use standard BACnet objects, where all relevant object properties can be read using BACnet's Read Property Service, and all relevant object properties can be modified using BACnet's Write Property Service: all device physical inputs and outputs, all set points, all PID tuning parameters, all calculated pressures, flow rates, and consumption values, all alarms, all trends, all schedules, and all equipment and lighting circuit operating status.

(2) The Object Description property shall support 32 minimum printable characters. For each object, complete the description property field using a brief, narrative, plain English description specific to the object and project application. For example: "HW Pump 1 Proof." Document compliance, length restrictions, and whether the description is writeable in the device PICS.

(3) Support and provide Description and/or Device Type text strings matching signal type and engineering units shown on the points list.

(4) Support and provide Inactive Text and Active Text property descriptions matching conditions shown on the points list.

(5) For devices with scheduling capability, provide at least one Calendar Object with ten-entry capacity. Enable the writeable Date List property and support all calendar entry data types.

(6) Use Schedule Objects for all building system scheduling.

(7) Use Loop Objects or equivalent BACnet objects in each applicable field device for PID control. Regardless of program method or object used, allow authorized operators to adjust the Update Interval, Setpoint and all constraints associated with Object, such as Proportional Constant, Integral Constant, and Derivative Constant for Loop Object, using BACnet read/write services.

F. Minimum BACnet Service Requirements

(1) Use commandable BACnet objects to control machinery and systems, providing the priority levels listed below.

	Priority Level	Application
(a)	1	Manual-Life Safety
(b)	2	Automatic-Life Safety
(c)	3	(User Defined)
(d)	4	(User Defined)
(e)	5	Critical Equipment Control
(f)	6	Minimum On/Off
(g)	7	(User Defined)
(h)	8	Manual Operator
(i)	9	(User Defined)
(j)	10	(User Defined)
(k)	11	Load Shedding
(l)	12	(User Defined)
(m)	13	(User Defined)
(n)	14	(User Defined)
(o)	15	(User Defined)
(p)	16	(User Defined)

G. Data Sharing:

(1) Data communication from Building Controllers to Engineering Workstation and BAS web server shall be programmed to use Change of Value (COV) data sending and not continuous data polling to limit net work traffic.

(2) Data communication parameters for analog values shall be operator configurable and setup as follows:

(a) Minimum Send Time: 2 seconds

(b) Maximum Send Time: 60 seconds

(c) Send on Delta (COV) :

1) Space Temperature: ±0.5°F

2) Process Temperature: ±0.5°F

3) Air Pressure, AHU: ±0.05“ W.C.

4) Relative Humidity: ±0.5%

5) Air Flow: ±200 cfm

6) Water Flow: ±50 gpm

7) Water Pressure ±0.2 psi (0.00 kPa)

8) Space Pressure: ±0.01“ W.C.

(3) Digital data points shall be sent whenever a state change occurs.

H. Historical Trending:

(1) All inputs and analog outputs shall be trended and shall fully configured and operational. Sample time shall be one minute.

(2) Program historical file for run-times and quantity of start/stops of motor driven equipment

(3) Trend logs are to be stored at the building controllers and uploaded to the BAS web server or data historian when the building controller trend buffer size reaches 90% full or every 30 minutes (FA).

(4) Data points indicated to as “LEED M&V” in the DDC Point Schedules shall be have a sampling time of one minute and averaged over 15 minutes.

I. Alarm/Event Management:

(1) All alarm handling shall be fully configured with consistent alarm messages and priorities or category numbers to identify the system from which the alarm originates.

J. Provide programming of menus to assist new users in accessing screen displays of each point group. Point groups (user definable) shall be initially arranged by DDC Controller for major equipment and by floor and area for terminal devices. Terminal devices shall also be grouped by air handling system where applicable.

K. When adding to an existing system, groupings, tag names, descriptions, engineering units, etc. shall match the existing system. Transitions from the existing system to the new system shall be seamless in look, functionality, and operation. Controls Contractor shall verify with Owner if any standard naming conventions are being used and continue with those naming conventions when applicable.

L. Program historical file for run-times and quantity of start/stops of motor driven equipment.

M. Program maintenance alarms based on run-times and quantity of start/stops for motor driven equipment.
   (1) Provide the following additional alarms:
      (a) Controller loss of communications for each controller.
      (b) Controller battery alarm for each controller (where available)
      (c) Out-of-range, bad, or missing data (fault) for each device.

N. Program alarms using the following levels:
   (1) Level 1 - Maintenance Alarm, requiring attention within 1 to 2 days. (Examples: 2-3°F temperature variance from set point; 15-25% relative humidity variance; etc.)
   (2) Level 2 - Low Level Alarm, requiring attention within 8 h, preferably during the same shift. (Examples: More than 3°F variance from set point, 30 percent relative humidity or more variance from set points; excess start/stops per day; etc.)
   (3) Level 3 - Critical Alarm, requiring immediate attention. (Examples: Non-operation of primary equipment; H-O-A overrides; failure of controllers, routers and repeaters.)
   (4) Level 1 and 2 alarms shall not interrupt current user operation, but shall be logged into alarm summary file, indicating status, acknowledgment, and by whom. Level 3 alarms shall interrupt user via audible and/or flashing warning until acknowledged, without losing any work in progress. When alarms are acknowledged, program shall display point group or appropriate graphic display. Level 3 alarms shall also be logged into alarm summary file in similar manner as Level 1 and 2 alarms.

O. Time Schedules:
   (1) Provide time schedules for HVAC components/systems as indicated in Control Sequences.
   (2) All time schedules shall be fully configured with weekly schedules and all holidays identified by the Owner.
   (3) Time schedules are to reside in the Building Controllers.

3.07 POINT LIST

A. Provide points required to implement control sequences specified, whether or not they are listed in schedules. In addition to control points, provide additional points listed in point schedules or defined in Control Sequences.

B. All points shall be programmed with a point name and detailed description. Control contractor shall submit point naming convention to Laboratory/Engineer for approval prior to system programming.

C. Work jointly with Owner to develop point naming convention prior to start of programming.

3.08 AUTO-DIAL ALARM MESSAGES

A. Program up to 30 types of prerecorded voice and text messages assigned to different alarm types. Assign up to 10 phone numbers for each message. BAS shall automatically call phone numbers without answering machines in predetermined order. If an acceptable phone response is not received after 6 rings (adjustable), system shall automatic retry 3 times (adjustable) before calling next number. Systems shall print level 3 alarm message if no phone numbers were reached.

3.09 GRAPHICS PROGRAMMING

A. Graphics shall be designed to match any existing graphic displays on the existing system when new system is to fully integrate with existing system. Transition from existing graphics to new graphics shall be seamless transition for operator in look, functionality, and operation.

B. On new system, program color graphic displays for each system as described herein. Graphic displays shall consist of pictorial presentations on display monitor/workstation with text description, system schematic, or picture; alarm fields; and database fields for all associated points, including dynamic input values, output values, set points, gains, time schedules, etc. Provide single keystroke access to text file description of control sequence(s) in detail.

C. Make use of color to highlight system components. Components of similar type shall be of same color for all graphics (example: dampers shall be purple, valves yellow, etc.). Alarm fields shall be flashing white letters on red background. Affected component shall also turn red whenever alarm status is indicated. Database fields shall be white letters on black background and shall be dynamically updated and re-displayed on screen by periodically polling database points not less than once every minute.

D. Display time, date, outside temperature and humidity on displays in same location on each graphic. Display command line with English prompt in same location on each graphic. Provide command to direct specific displays without accessing main menu. Provide means of displaying directory of screens. Arrange displays by group and type.

E. Graphic displays shall be designed to be easily understood. When display screen is too cluttered due to size, limit information to important monitoring data. Provide sub-graphic(s) to display data not displayed on main display.

F. Graphics shall include, but not be limited to:
   (1) Site Plans, including each building, building name, and status of all exterior points such as lighting, etc.

(2) Overall building plan of each building. Indicate location of mechanical rooms and areas served by each air handling unit.

(3) Floor plans for each area depicting locations of terminal units, areas served by terminal units, and other remotely located points. Plans shall include full height partitions, column numbers, room numbers, and room names with special functions (not offices, corridors, toilets, storage, etc.).

(4) Schematic type graphics for:

(a) Each air handling system

(b) Supply fan control loop

(c) Return fan control loop

(d) Cooling coil control loop

(e) Heating coil control loop

(f) Humidifier control loop

(g) Damper control loops

(h) All air terminal devices shown on floor plans

(i) Main chilled water system showing all components

(j) Each heating hot water system showing all components

(5) Indicate systems to be graphically represented.

(6) Submit sample graphics (one per type) for review and approval by Owner prior to starting graphics programming.

END OF SECTION 23 09 23

SECTION 23 21 16 - PIPE AND PIPE FITTINGS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01 8113 – Certification Requirements

B. Section 20 0573 – Mechanical Systems Firestopping

C. Section 23 0594 - Water Systems Test Adjust Balance

D. Section 23 0902 - Control Valves and Damper (Valves)

E. Section 23 0903 - Control Instrumentation (Wells, Taps or In-line Devices)

F. Section 23 2118 - Valves

G. Section 23 2120 - Piping Specialties

H. Section 23 2514 - Chemical Treatment Systems (Pipe Cleaning)

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

A. Specification of an item in this or any other sections shall not relieve Contractor from providing all items, articles, materials, operations, methods, labor, equipment and incidentals necessary for a complete and functional system.

B. Use only new material, free of defects, rust and scale, and guarantee for services intended.

C. Use material meeting the latest revision of ASTM specifications as listed in this specification.

D. Follow local codes if they require other types of pipe or joints.

E. Use only long radius elbows having centerline radius of 1.5 pipe diameters unless otherwise indicated.

F. Manufacturer, pressure class, size and heat code of each fitting and flange shall be permanently identified on its body in accordance with MSS SP-25.

G. Where size for a pipe segment is not indicated, the pipe segment size shall be equal to the largest pipe segment to which it is connected. Transition to smaller size shall occur on the side of fitting where smaller size is indicated.

H. Unless otherwise indicated, fittings and accessories connected to pipe shall be of the same material as the pipe.

I. Unless otherwise indicated, construct piping for highest pressures and temperatures in respective system in accordance with the latest revision of the applicable Sections of ASME Code for pressure piping, ASME B31 including the following:

(1) B31.9 Building Services Piping

(2) B31.3 Process Piping

J. Boiler external piping shall comply with the latest revision of Section 1 of ASME Boiler and Pressure Vessel Code. This Contractor shall be responsible for materials, installation, testing and certification in accordance with the Code.

K. Non-metallic piping is acceptable only for services indicated. It is not acceptable in occupied spaces and ventilation plenum spaces.

1.04 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.05 SUBMITTALS

A. Please embed pdf bookmarks in submittals to enhance navigation and facilitate review process.

B. Shop Drawings for each piping system for all pipe sizes including, but not limited to, the following:

(1) Name of system
(2) Pipe; ASTM number, grade if known, type, wall thickness, material
(3) Fittings; ASME number, grade if known, class, type, wall thickness, material
(4) Joint type
(5) Flanges; ASTM number, grade, class, type, material
(6) Bolts and nuts; material
(7) Thread joint sealants; material
(8) Flange gaskets; material, rating
(9) Unions; ASTM number, type, material, rating
(10) Type of welding
(11) Welding Quality Control Program
(12) Test pressure and media
(13) Pipe flushing/cleaning plan
(14) Pipe cleaning method
(15) All other appropriate data

C. Submit pipe certification as specified under Pipe Certification in this Section.

D. Submit required documents as specified under Pipe Welding in this Section.

E. Provide Flushing and Cleaning Plan:

(1) Submit pipe flushing/cleaning plan for water, fluid, steam and condensate systems for approval. Plan shall detail methods for compliance with requirements of this section, including:
(a) Flushing and cleaning procedure narratives.
(b) Size, power source, and connection points of contractor provided pumps that will be used for flushing and cleaning.
(c) If Contractor proposes to utilize project system pumps, method of protecting pumps from damage and developing required velocity of section of piping to be flushed.
(d) Method of sectionalizing piping to obtain required velocity.
(e) Minimum velocities at each section of pipe, clearly indicating any sections where 6 fps cannot be achieved.
(f) Location and means of temporary bypasses for coils, control valves and other equipment.
(g) Flushing schedule and drawings or diagrams that will be used for inspection and sign off prior to and after procedure, at Owner's option.
(2) Submit documents showing verification of flushing/cleaning following specified requirements and results.

F. LEED Submittal

(1) Complete provided Product Data Reporting Form in spec section 01 8113 and provide the following:
(a) VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.
(b) VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Furnish pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling to prevent pipe-end damage and eliminate dirt and construction debris from accumulating inside of pipe.

B. Where possible, store materials inside and protect from weather. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

C. Before shipping, all carbon steel piping shall be free of rust and scale, and furnished with plastic end caps/plugs on each end of pipe.

1.07 PIPE WELDING

A. Procedure and Welding Qualification Records:

(1) Submit Welding Procedure Specifications (WPSs) and their supporting Procedure Qualification Records (PQRs) to be used on the work to Engineer for review and approval prior to performing any welding. These documents shall meet requirements of ASME B31.1 and B31.9, as applicable.

(2) Unless otherwise indicated, welding shall be done using only the following processes:

(a) Shielded Metal Arc Welding (SMAW), also known as "stick" welding

(b) Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc welding

(c) Gas Metal Arc Welding (GMAW), also known as MIG welding

(d) Flux-Cored Arc Welding (FCAW), a variation of GMAW

(e) Submerged Arc Welding (SAW)

(3) Unless otherwise stated, fabrication, installation, inspection, examination and testing shall be in accordance with ASME B31.1 or B31.9, as applicable.

(4) Backing rings (chill rings) or consumable inserts are not allowed, unless specifically requested by Owner or Engineer.

B. Quality Control Program:

(1) Submit written quality control program for review and approval prior to implementing any welding on this project. Quality control program shall include the following as minimum:

(a) Explanation of how Contractor will assure proper fit-up for each weld.

(b) Explanation of how Contractor will document welds performed by individual welding operators for systems under ASME B31.1.

(c) Explanation of how Contractor will assure that proper welding procedure is being followed.

(d) Credentials of personnel responsible for required weld examinations.

C. Weld Inspection and Examination:

(1) Provide examination services for all welding for this Project. Examination shall be in accordance with requirements of ASME B31.1, Table 136.4 or B31.9, as applicable.

(2) Periodically, as welding progresses, submit report, signed by weld examiner, indicating status of project welding quality.

(3) Arrange with Owner's Inspector for observation of fit-up and welding methods prior to implementing any welds, including shop welds, on this Project.

(4) In addition, Owner's Inspector will perform any additional observations deemed necessary before, during, or after fabrication to assure, to Owner's satisfaction, that proper welding is provided. Owner reserves the right to perform independent examination of welds. If Owner has any concern as a result of such examination Owner reserves the right to stop in progress welding work, without any cost to Owner, until resolution satisfactory to Owner is reached.

D. Welder Qualifications:

(1) Each welder and welding operator must qualify by passing required procedure test before performing any project welds. Submit copy of Manufacturer's Record of Welder or Welding Operator Qualification Tests (WPQS) as required by Section IX of ASME Boiler and Pressure Vessel Code for all welding procedures to be performed by welding operator.

(2) Welder qualifications must be current. If qualification test is more than 6 months old, provide record of welding continuity for each welder.

(3) Record of welding continuity is intended to show that welder has performed welding at least every 6 months since the date that welder qualification test was passed for the submitted welding procedure specification.

(4) Record of welding continuity shall include, at minimum, the following:

(a) Welder's employer name and address

(b) Date Welder Qualification Test was passed

(c) Dates indicating welding continuity

(5) Welders shall be qualified as required by ASME B31.1 or B31.9, as applicable. In addition, there shall be an independent witness of welder tests. That witness shall be representative of independent testing laboratory, Authorized (Code) Inspector, Owner's or Engineer's Inspector or consultant approved by National Certified Pipe Welding Bureau.

(6) Welder qualifications must cover all pipe sizes and wall thickness used on this project. Test segments or coupons shall be appropriately selected for qualification. Test position shall be arranged in "6G position."

1.08 PIPE CERTIFICATION

A. Certification is required for all pipe within scope of ASME B31.1. Submit certification papers, as outlined below, within 30 days of delivery of pipe to project site.

B. Type E or S Pipe:

(1) Furnish manufacturer's mill certificates (material test report) including dimensions, heat numbers, chemical analysis and tensile test results for pipe shipped to project site.

1.09 FLANGES

A. Use either flat faced or raised-face flanges for mating with flat-faced or raised-face flanges.

B. Welding Neck Flanges:

(1) All flanges shall be welding neck type unless otherwise indicated.

C. Slip-on Flanges:

(1) Slip-on flanges shall not be used without specific approval of Engineer. Contractor shall submit written request for use of slip-on flange for specific instance where use of welding neck flange is problematic. Slip-on flanges over 4” pipe size are prohibited for any application under ASME B31.1.

D. Bore dimension of flange shall match inside diameter of connecting pipe.

E. Bolts and Nuts:

(1) Threads shall be in accordance with ANSI/ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse-thread series except that alloy steel bolting 1-1/8" and larger in diameter shall be 8 pitch thread series.

(2) Threaded rods are not allowed in lieu of bolts.

PART 2 PRODUCTS

2.01 HEATING HOT WATER (THROUGH 250 PSIG/250°F)

A. 2" and Smaller:

(1) Pipe: ASTM B88 seamless, Type L, hard temper copper tube

(2) Fittings: ASME B16.22, wrought copper solder joint

(3) Joint: ASTM B32, lead free solder, similar to Bridgit, Silvabrite, Silverflow or Canfield

(4) Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for line sizes 3/4" and smaller. Unions shall be used for line sizes over1"and larger.

(5) Flanges: Class 150, ASME B16.24, ASTM B61 or ASTM B62 cast copper alloy

(6) Bolts and Nuts

(a) Type 316 stainless steel bolts conforming to ASTM A193 Grade B8M Class 1 or Class 2 with Type 316 stainless steel nuts conforming to ASTM A194 Grade 8M. Use 316 SS washers.

(7) Gaskets:

(a) ASME B16.21 and ASTM F104 flat ring type, asbestos-free, compressed inorganic fiber with nitrile binder.

(b) Gasket thickness 1/16”

(c) Maximum Seating Stress (y) 3050 psi (21029.02 kPa)

(d) Minimum Gasket Factor (m) 4.2

(8) Use solder joints for valves and piping specialties in copper piping, unless otherwise specified.

(9) Press Joint Option:

(a) Contractor may use press copper fittings as manufactured by Viega, Other acceptable manufacturers are Nibco and Elkhart. “Push-to-connect” or “push-in” fittings, which are not press-type, will not be accepted.

(b) Fittings: Copper press fittings with EPDM seal, 0 to 250°F, maximum 200 psi (1378.95 kPa).

(c) Joints: Press joints by fitting manufacturer approved tool.

B. 2-1/2” and Larger:

(1) Pipe: ASTM A53 Grade B, Type E or S or ASTM A106 Grade B, standard weight, carbon steel

(2) Fittings: ASTM A234 Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld

(3) Flanges:

(a) ANSI Class 150, ASTM A105 Grade II, ASME B16.5 or ASME B16.47 Series A or B, welding neck

(4) Bolts and Nuts:

(a) ASTM A193 Grade B7 or B16 with nuts conforming to ASTM A194 Grade 2H.

(5) Gaskets

(a) ASME B16.21 and ASTM F104 flat ring type, asbestos-free, compressed inorganic fiber with nitrile binder.

(b) 2-1/2” thru 8”

1) Gasket thickness 1/16”

2) Maximum Seating Stress (y) 3050 psi (21029.02 kPa)
3) Minimum Gasket Factor (m) 4.2

(c) Garlock, Klingersil or J.M. Clipper, similar to Garlock 3000.

2.02 PRIMARY CHILLED WATER, CHILLED WATER, AND IMAGING CHILLED WATER

A. 2" and smaller:

(1) Pipe: ASTM B88 seamless, Type L, hard temper copper tube
(2) Fittings: ASME B16.22, wrought copper solder joint
(3) Joint: ASTM B32, lead free solder, similar to Bridgit, Silvabrite, Silverflow or Canfield
(4) Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for lines sizes 3/4" and smaller. Unions shall be used for line sizes 1"and larger.
(5) Flanges: ASME B16.24, Class 150, ASTM B61 or ASTM B62 cast copper alloy
(6) Bolts and Nuts:
(a) Bolts conforming to ASTM A193, Grade B8M Class 1 or Class 2 with nuts conforming to ASTM A194, Grade 8M. Use 316 SS washers.
(7) Use solder joints for valves and piping specialties in copper piping, unless otherwise specified.
(8) Press Joint Option:
(a) Contractor may use press copper fittings as manufactured by Viega. Other acceptable manufacturers are Nibco and Elkhart.
(b) Fittings: Copper press fittings with EPDM seal, 0 to 250°F, maximum 200 psi (1378.95 kPa).
(c) Joints: Press joints by fitting manufacturer approved tool.

B. 2-1/2" and Larger:

(1) Pipe: ASTM A53 Grade B, Type E or S or ASTM A106 Grade B, standard weight, carbon steel
(2) Fittings: ASTM A234 Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld
(3) Flanges:
(a) ANSI Class 150, ASTM A105 Grade II, ASME B16.5, welding neck
(4) Bolts and Nuts:
(a) ASTM A193 Grade B7 or B16 with nuts conforming to ASTM A194 Grade 2H.
(5) Gaskets
(a) ASME B16.21 and ASTM F104 flat ring type, asbestos-free, compressed inorganic fiber with nitrile binder.
(b) 2-1/2” thru 10”
1) Gasket thickness 1/16”
2) Maximum Seating Stress (y) 3050 psi (21029.02 kPa)
3) Minimum Gasket Factor (m) 4.2
(c) Garlock, Klingersil or J.M. Clipper, similar to Garlock 3000.

2.03 VENTS AND RELIEF VALVES

A. Unless otherwise indicated, use pipe and pipe fittings as indicated for the system to which relief valve or vent is connected.

B. ASTM A53, Grade B, Type E or S, carbon steel pipe with standard weight, carbon steel fittings may be used for steam vents smaller than 4”.

2.04 PRESSURE GAUGES AND TAPPINGS

A. Use pipe and pipe fittings as indicated for the system to which pressure gauge or tapping is connected. Use "Threadolets", "Sockolets" or tee fittings for tappings. Refer to Part 3 under General for use of "Threadolets" and "Sockolets".

B. Gauge pipe shall be 1/4" unless otherwise indicated.

2.05 COOLING COIL CONDENSATE DRAIN

A. Piping shall be the following, unless otherwise indicated on drawings:

(1) Copper
(a) Pipe: ASTM B88 Type M, hard temper copper tubing
(b) Fittings: ASTM B16.22 wrought copper fittings
(c) Joint: ASTM B32, 95-5 tin-antimony solder, Bridgit or Silvabrite

2.06 POLYVINYL CHLORIDE (PVC) PIPING

A. All Sizes:

(1) Pipe: Schedule 80, ASTM D1785, and D-2467

(2) Fittings: ASTM D3467 socket type, 125 psi (861.84 kPa) rating fittings

(3) Joint: ASTM D2564 PVC solvent cement

2.07 DIELECTRIC UNIONS, FLANGES AND FITTINGS (STEEL PIPE TO COPPER PIPE)

A. 2" and Smaller:

(1) Use bronze ball valves specified in Section 23 2118 for dielectric purpose.

(2) Dielectric fittings similar to Victaulic Style 647 or Clearflow Dielectric Waterway fittings may be used in lieu of dielectric unions for pipe sizes 2" and smaller.

(a) Clearflow fittings shall be ASTM A53 electro zinc-plated steel pipe with high temperature polyolefin polymer liner, suitable for continuous use at temperatures up to 230°F and pressures up to 300 psig (2068.43 kPa).

(3) ASTM A197/ASME B16, equal to Stockham Figure 693-1/2, Watts Series 3000 or Wilkins (Zurn) Model DU series dielectric unions with EPDM dielectric gasket, 250 psi (1723.69 kPa) at 180°F.

B. 2-1/2” through 4”:

(1) Watts dielectric flange fittings Series LF 3100/LF 3110 with dielectric gasket, 175 psi (1206.58 kPa) at 180°F.

(2) Dielectric fittings similar to Victaulic Style 647 or Clearflow Dielectric Waterway fittings may be used in lieu of dielectric unions for pipe sizes 2-1/2” and larger.

(a) Clearflow fittings shall be ASTM A53 electro zinc-plated steel pipe with high temperature polyolefin polymer liner, suitable for continuous use at temperatures up to 230°F and pressures up to 300 psig (2068.43 kPa).

2.08 DIELECTRIC UNIONS, FLANGES AND FITTINGS (STEEL TO STEEL PIPE)

A. 1" and Smaller: Similar to Epco model HA-B with dielectric gasket, 250 psi (1723.69 kPa) at 210°F

B. 1-1/2" and Larger: Similar to Epco model W with bolt insulators, dielectric gasket, bolts and nuts, 175 psi (1206.58 kPa) at 210°F). Pikotek model VSC dielectric gasket with viton sealing element, G-10 sleeve and double washers, suitable to 350°F, may be used with specified flanges.

2.09 THREADED JOINT SEALANTS

A. Paste type for brush application or cord type. Products shall be non-toxic, chemically inert, non-hardening, rated for -50°F to 400°F and up to 10,000 psi (68947.60 kPa) and 2000 psi (13789.52 kPa), certified by UL, CSA, and NSF.

B. Use sealant similar to Loctite Model 54531 for piping handling oil or petroleum products.

2.10 WELD BRANCH OUTLET FITTINGS (WELDOLETS, THREADOLETS AND SOCKOLETS)

A. Weld branch outlet fittings shall conform to MSS-SP-97, ASME B16.9 for weldolets, ASME B1.20.1 for threadolets and ASME B16.11 for sockolets.

B. Materials shall match material of header piping and wall thickness of outlet or branch end shall match wall thickness of branch pipe.

PART 3 EXECUTION

3.01 GENERAL

A. Remove foreign materials before erection. Ream ends of piping to remove burrs.

B. Install piping parallel to building walls and ceilings and at such heights so as not to obstruct any portion of window, doorway, stairway, or passageway. Install piping to allow adequate service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical piping plumb. Where interferences develop in field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings or other architectural details before installing piping.

C. Provide anchors, expansion joints, swing joints and expansion loops so that piping may expand and contract without damage to itself, equipment or building.

D. Mitered elbows, welded branch connections, notched tees and "orange peel" reducers are not allowed. Unless specifically indicated, reducing flanges and reducing bushings are not allowed. Reducing bushings may be used for air vents and instrumentation connections.

E. Unless otherwise indicated, use fittings as specified in Part 2 of this Section for elbows, tees, reducers, etc.

F. "Weldolets" with outlet size 2-1/2” and larger and "Threadolets" or "Sockolets" with outlet size 2" and smaller may be used for branch connections up to one pipe size smaller than main. Use "Threadolets" where threaded fittings are specified and use "Sockolets" where socket weld fittings are specified. Install in accordance with PFI (Pipe Fabrication Institute) Standard ES49.

G. Install drains throughout systems to permit complete drainage of entire system.

H. Do not install piping over electrical panelboards, switchgear, switchboards or motor control centers.

I. Install valves, control valves and piping specialties, including items furnished by others, as specified and/or detailed.

J. Make connections to equipment installed by others where that equipment requires piping services indicated in this Section.

K. For piping within the scope of ASME B31.1 Power Piping, transfer piping material specification and "Heat Number" to each segment of pipe prior to cutting.

3.02 THREADED PIPE JOINTS

A. Threads of pipe and fittings shall conform to ASME B1.20.1.

B. Ream pipe ends after cutting and clean before erection. Apply thread sealants to cleaned male threads. Assemble joint to appropriate depth and remove any excess pipe joint compound from tightened joint.

3.03 FLANGED JOINTS

A. Clean flange surfaces and align them parallel. Bolt holes of gaskets shall be cut slightly larger than bolt diameter. Gasket ID shall be slightly larger than flange ID.

B. Position gasket concentrically so compression is equally distributed over entire gasket surface.

C. Lubricate bolts and run nuts down by hand.

D. By using torque wrench, tighten nuts in the proper sequence so gasket is compressed evenly, and to the appropriate torque specified by bolt manufacturer.

E. Re-torque bolts 12 to 24 h after start up.

3.04 WELDED PIPE JOINTS

A. Inspect pipe and pipe fittings for roundness before they are fit-up or set in place.

B. Properly clean and prepare pipe base material before fit-up. Verify joint land and bevel.

C. Preheat pipe base material as required by welding procedure specification. Temperature of pipe material must be minimum of 50°F before welding.

D. Properly align and adjust joint as required by welding procedure and thickness of material. Verify tolerances after tacking sequence.

E. Use weld material diameter as procedurally required for type and thickness of work being done.

F. Use sufficient argon pre-purge and argon post-purge for GTAW processes. Post purge should be until weld is no longer glowing plus 5 seconds. Maintain purge for at least 2 layers of weld material.

G. Properly store welding materials.

H. Clean tacks before welding out. Remove slag after each pass by grinding to avoid slag inclusion.

I. Weld reinforcement shall not exceed limits established in Chapter V of ASME B31.1.

J. Brush each weld free of rust and paint with rust resistant product that matches piping surface color.

K. For piping within scope of ASME B31.1, each weld shall be permanently marked by welder performing weld. Each welder shall sign and date field welding log record for all welds performed by welder as indicated in Part 1.

L. Conduct radiographic test for sections or joints that cannot be tested by hydrostatic test methods (such as joints cut into existing piping systems) by qualified radiographic testing firm.

3.05 COPPER PIPE JOINTS

A. Cutting of tubing shall not make tubing out of round. Ream cut tube ends to full inside diameter.

B. Remove slivers and burrs remaining from tube cut by reaming and filing both pipe surfaces. Clean fitting and tube with emery or sand cloth. Remove residue from cleaning operation, apply flux and assemble joint. Use solder or brazing to secure joint as specified for specific piping service.

C. Press Joint Option:

(1) Cut pipe square and ream before assembly

(2) Insert pipe fully into fitting and mark on pipe at shoulder of fitting

(3) Check fitting alignment against mark on pipe to ensure pipe is fully engaged

(4) Press joint with press tool approved by fitting manufacturer

3.06 POLYVINYL CHLORIDE (PVC) PIPING

A. Install PVC piping in strict accordance with pipe and fitting manufacturer's recommendations, including support spacing, compensation for thermal expansion and contraction and solvent cementing.

3.07 WATER SYSTEMS

A. Unless otherwise indicated, install horizontal piping level. Install manual air vents at all high points where air may collect. If vent is not in accessible location, extend air vent piping to nearest code acceptable drain location with vent valve located at nearest accessible location to pipe.

B. Main branches and runouts to terminal equipment may be made at top, top 45°, side or bottom 45° of main provided that there are drain valves suitably located for complete system drainage and manual air vents are located as described above.

C. Unless otherwise indicated, use top or top 45° connection to main for upfeed risers, and use side or bottom 45° connection to main for downfeed risers. Bottom connection is not allowed.

D. Use minimum of 3 elbows in each pipeline to terminal equipment to provide flexibility for expansion and contraction of piping systems. Offset pipe connections at equipment to allow for service, such as removal of terminal device.

E. Unless otherwise indicated, use concentric fittings for changes in pipe sizes and for valves smaller than pipe sizes.

F. Notch and dimple branch tubes. Braze joints. Apply heat properly so that pipe and tee do not distort. Remove distorted connections.

G. Where mechanically formed tee fittings are allowed, form mechanically extracted collars in continuous operation, consisting of drilling pilot hole and drawing out tube surface to form collar having height of not less than 3 times thickness of tube wall. Collaring device to be adjustable.

3.08 VENTS AND RELIEF VALVES

A. Install vent and relief valve discharge lines as indicated on drawings, as detailed, and as specified for each specific valve or piping specialty item.

3.09 COOLING COIL CONDENSATE DRAIN

A. Cooling coil condensate drains shall be provided with waterless traps as specified in specification sections . Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes.

B. Pitch pipe down at not less than 1/8" per foot for proper drainage.

C. Where copper piping is allowed, joints and fittings may be secured with 95-5 tin-antimony solder or brazing alloys.

3.10 DIELECTRIC UNIONS AND FITTINGS

A. Install dielectric unions, flanges or fittings in main and branch piping of water systems at each point where copper to steel pipe connection occurs. Dielectric unions or fittings shall not be used at terminal device connections.

B. Concealed dielectric unions and fittings are not allowed.

C. Install steel to steel pipe dielectric unions or flanges in hot water and chilled water piping at each point where interior steel piping is connected to exterior underground steel piping.

3.11 UNIONS AND FLANGES

A. Install union or flange at each automatic control valve and at each piping specialty or piece of equipment that requires tube pull or removal for maintenance, repair or replacement. If required, provide additional unions or flanges in order to facilitate removal of piping sections that interfere with tube pulls or equipment removal. Where valve is located at piece of equipment, provide flange or union connection on equipment side of valve.

B. Concealed unions or flanges are not allowed.

3.12 PIPING SYSTEM PRESSURE TESTS

A. Owner and/or Owner's representative may elect to witness pressure test. Notify Owner and/or Owner's representative at least 3 days in advance.

B. Conduct pressure test prior to flushing and cleaning of piping systems.

C. Conduct hydrostatic (HYDRO) test in accordance with ASME B31.1 137.4. Test pressure shall be in accordance with ASME B31.1, but shall not be lower than the minimum test pressure listed below.

D. If leaks are found, repair with new materials and repeat test until leaks are eliminated. Caulking will not be acceptable.

E. Pressure tests may be made of isolated portions of piping systems to facilitate general progress of installation. Any revisions made in piping systems require retesting of affected portions of piping systems.

F. No systems shall be insulated until it has been successfully tested. If required for additional pressure load under test, provide temporary restraints at expansion joints or isolate them during test. Unless otherwise noted, minimum test time shall be 4 h plus such additional time as may be necessary to conduct examination for leakage.

G. No pressure drop shall occur during test period. Any pressure drop during test period indicates leakage.

H. Provide pumps, gauges, instruments, test equipment, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.

I. For hydrostatic tests, remove air from piping being tested by means of air vents. Measure and record test pressure at high point in system. Where test pressure at high point in system causes excessive pressure at low point in system due to static head, portions of piping system may be isolated and tested separately to avoid undue pressure. However, every portion of piping system must be tested at the specified minimum test pressure.

J. Conduct pressure tests with parameters indicated below:

SYSTEM	MINIMUM TEST PRESSURE	REMARKS
HEATING HOT WATER	**100 PSIG (689.48 KPA)**	**HYDRO**
PRIMARY CHILLED WATER, CHILLED WATER, AND IMAGING CHILLED WATER	**100 PSIG (689.48 KPA)**	**HYDRO**

K. Contractor shall provide all pumps, gauges, instruments; test equipment, flow meters, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.

L. If piping system is drained after testing and left empty or untreated for more than 3 days, provide vapor phase corrosion inhibitor, such as Cortec VpCI, or engineer approved equivalent, at recommended dosages for dry system lay-up. Provide specific treatment compatible with type of pipe installed following manufacturer's recommendations. Provide isolation valves or other provisions to isolate lay-up portions from non-lay-up portions. Re-apply lay-up treatment at intervals according to manufacturer's recommendations. Prior to placing lay-up piping into service, remove lay-up treatment and prepare system in accordance with manufacturer's recommendations.

(1) Confirm all piping system materials and components receiving treatment are compatible with applied inhibitor and lay-up treatment.

(a) Note: High heat may cause VpCI to "cake". If piping system will be exposed to heat alternative treatment shall be used.

(2) Provide cleaning and treatment plan for owner's review and approval. Plan shall include duration of lay-up and maintenance of lay-up through anticipated lay-up period(s).

3.13 FLUSHING AND CLEANING PIPING SYSTEMS

A. Notify Owner and/or Owner's representative at least 7 days in advance.

B. Flush new water, fluid, steam and condensate systems thoroughly for 15 minutes or longer, as required to ensure removal of dirt and foreign matter from piping system. Bypass pumps and equipment and remove strainers from strainer bodies. Provide circulation by Contractor-supplied portable pumping apparatus.

C. Provide temporary piping or hose to bypass coils, control valves, heat exchangers, other factory-cleaned equipment, and any component that may be damaged.

D. Sectionalize system to obtain minimum velocity of 6 fps. Provide temporary piping to connect dead-end supply and return headers as necessary. Flush bottoms of risers.

E. After initial flushing of system, use portable pumping apparatus to circulate cold water detergent for water systems. Refer to Section 23 2514 - Chemical Treatment Systems for pipe cleaning.

F. After initial flushing of system, use portable pumping apparatus for continuous 24 h minimum circulation of cold water detergent similar to Nalco 2567 cleaner. Flush detergent clear with continuous draining and raw water fill for additional 12 h or until all cleaner is removed from system. Dispose of all cleaning and rinse water per local jurisdiction requirements and Facility Owner's requirements. Replace strainers and reconnect permanent pumping apparatus and all apparatus bypassed.

G. Refer to Section 23 2514 - Chemical Treatment Systems for water analysis.

3.14 INITIAL SYSTEM FILL AND VENT

A. Fill and vent systems with proper working fluids.

B. Use fluids chemically treated as specified in Section 23 2514 - Chemical Treatment Systems.

C. Glycol system shall be filled with treated glycol as specified in Section 23 2514 - Chemical Treatment Systems.

END OF SECTION 23 21 16

SECTION 23 21 18 - VALVES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 20 0700 - Mechanical Systems Insulation

B. Section 23 0902 - Control Valves and Dampers

C. Section 23 2120 - Piping Specialties (Flow Sensors and Meters)

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

A. Shop Drawings for each system for all sizes including, but not limited to, the following:

(1) Name of system

(2) Manufacturer's name

(3) Type

(4) Model number

(5) Materials of construction

(6) Temperature/pressure ratings

(7) Manufacturer's data sheets clearly cross-referenced

(8) All other appropriate data

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Gate valves, globe valves, check valves, and drain valves: Crane, Nibco, Stockham, Powell, Milwaukee, Hammond, or Grinnell equal to manufacturer's Figure number listed. Provide valves of same make for these services.

B. Other valves: acceptable manufacturers and Figure Number listed under each item.

2.02 WATER SYSTEM VALVES

A. General:

(1) Valves 2" and smaller in steel piping shall have threaded ends.

(2) Valves 2" and smaller in copper piping shall have solder ends.

(3) Press Ends:

(a) Valves with press ends will be acceptable where press joints are allowed, provided valves meet requirements specified in this section. Temperature and pressure ratings shall be equal to or exceed ratings of press fittings used.

(4) Provide valve stem extensions with sufficient length to allow for insulation where insulation is specified.

B. Ball Valves:

(1) 2" and Smaller: ASTM B584 bronze body, chrome plated brass/bronze or stainless steel ball, full port for 3/4" and smaller and conventional port for 1” and larger, Teflon seat rings, blowout-proof stem, 2-piece construction, 600 psi (4136.86 kPa) WOG, 150 psi (1034.21 kPa) SWP, Nibco Fig. T(S)-580-70, Apollo No. 70, Watts, Milwaukee BA-150, Hammond, FNW or Anvil

C. Spring Loaded Check Valves:

(1) 2" and Smaller: bronze or iron body, Class 125 200 psi (1378.95 kPa) WOG), Nibco Figure T(S)-480, Mueller Figure 303-AP or Metraflex No. 700

(2) 2-1/2" and Larger: cast iron or ductile iron body, flanged or wafer type, 302/304 or 316 stainless steel spring, aluminum bronze, carbon steel or ductile iron totally encapsulated in EPDM disc, Buna-N or electroless nickel plated seat, Class 125 200 psi (1378.95 kPa) WOG), Nibco Figure F-910 or W-910, Milwaukee 1800 or 1400, Metraflex No. 700, Stockham Figure WG-970, Mueller Sure Check Model No. 71, or Crane Duo-check II

(3) For valves 8” and larger, provide lifting lugs or threaded holes for lifting eye bolts.

D. Shut-Off Valves:

(1) 2" and Smaller: ball valves as specified in this Section

(2) 2-1/2" and Larger: butterfly valves as specified in this Section

E. Balancing Valves (Multi-Turn Type):

(1) 2" and Smaller:

(a) Variable orifice with multiple turn valve type as manufactured by Armstrong Series CBV or ABV, Tour & Andersson (Victaulic) Series 786 or 787, NIBCO 1709 or 1710. Maximum Allowable Working Pressure, 250°F Maximum Allowable Operating Temperature. Furnish valve with adjustable memory stop and quick disconnect taps with built-in check valve for pressure differential measurement, integral valve setting index and memory locking device.

(b) Valves shall measure down to 0.3 gpm with accuracy of ±5%.

(c) Valves shall be leak-tight at full rated working pressure.

(d) Unless otherwise indicated, size balancing valves so that at design flow rate, pressure drop across balancing valve with valve approximately 50% open will be at minimum 25% of reading range of meter used for balancing.

(2) 2-1/2" and Larger:

(a) Armstrong Series CBV or Tour and Anderson (Victaulic) Series 788/789, ductile iron body, ASME/ANSI B16.42 Class 150 flange, 250 psi (1723.69 kPa) Maximum Allowable Working Pressure (MAWP), 250°F maximum operating temperature.

(b) Fixed orifice with ball valve or butterfly valve as manufactured by FDI, Presco or Gerand, Class 150 flange, 225 psi (1551.32 kPa) maximum working pressure, 250°F maximum operating temperature will be acceptable up to 4" size. Butterfly valves, as specified in this Section, together with averaging Pitot tube flow sensors, as specified in Section 23 2120 - Piping Specialties, under Flow Sensors and Meters may be used when sizes for Armstrong or T/A valves are not available. Locate flow sensor in common pump discharge pipe with hot tap. Furnish butterfly valves with adjustable memory stops to limit return of valves to preset open position after shut-off.

(3) Furnish portable meter kit within durable case similar to Gerand Model "R". Furnish meter with minimum 4-1/2" diameter aluminum or brass body/brass internals with reading range of either 0" to 50" or 0" to 100" water column differential as appropriate, 200°F maximum temperature, 300 psi (2068.43 kPa) working pressure. Meter accuracy shall be ± 2% full scale. Provide in kit: equalizing valves, 10 ft purge hose and size devices specified. Meter shall become property of Owner.

F. Terminal Unit Valve Assembly

(1) Terminal unit valve assembly may be used instead of individual valve and other components, provided each valve and component meets specified requirements.

(2) Victaulic, Nexus, Griswold, HCi, IMI Flow Design or Hays are acceptable.

(3) Inlet Assembly: combination of isolation ball valve, y-strainer with 20 mesh SS screen and blowdown valve, union, and PT test port.

(4) Outlet Assembly: Union assembly consisting of union, manual air vent and PT test port at coil outlet (control valve inlet) and ball valve, union, PT test ports and balancing valve at control valve outlet. Balancing valves shall be as specified under Balancing Valves in this Section.

(5) Components: Assembly shall have minimum pressure/temperature ratings to 400 psi (2757.90 kPa)/ 230°F.

(6) Flexible Hose:

(a) Flexible hoses up to 18” in length may be used in inlet and outlet assemblies for 1” and smaller.

1) EPDM Core:

1. Flexible hose shall be constructed of EPDM core, stainless steel braided cover, stainless steel ferrules, and brass end connections. Maximum Allowable Operating Pressure (MAOP) shall be not less than 300 psi (2068.43 kPa) at 230°F.

2) Stainless Steel (Corrugated) Core:

1. Flexible hose shall be constructed of corrugated 300 series stainless steel core, 300 series stainless steel braided cover, stainless steel ferrules, and 304 stainless steel end connections. Maximum Allowable Operating Pressure (MAOP) shall be not less than 400 psi (2757.90 kPa) at 600°F.

G. Butterfly Valves:

(1) 2-1/2" through 10”:

(a) Manufacturers: DeZurik, Keystone, Nibco, Milwaukee, or Bray

(b) Ductile iron body, stainless steel shaft, aluminum-bronze disc, or Nylon 11 coated ductile iron disc, upper thrust bearing, EPDM resilient seat, rated at 200 psi (1378.95 kPa) bidirectional shut-off pressure , suitable for continuous operation at temperature up to 225°F, compatible to ANSI B16.1 Class 125/150 flange standards, conforming to MSS-SP-67.

(c) Dead end pressure rating shall be 150 psi (1034.21 kPa) with no downstream flange/piping attached.

(d) For valves 6" and smaller, provide 10-position lever actuators with locking devices. For valves 8" and larger, provide worm gear operators with adjustable position stop and position indicators. Size hand wheel operators with no higher than 80 lb rim pull at full valve pressure rating.

(e) External disc-to-stem connections using screws or pins are not allowed.

(f) Valve necks shall be of sufficient length to allow for insulation where insulation is specified. Wheel shaft shall be sufficient length so wheel does not touch insulation.

(g) Provide full lug type valves permitting removal of down stream piping while using valve for system shut-off.

(h) Furnish valves used for balancing with adjustable memory stops.

H. Water Pressure Regulating Valves:

(1) Manufacturers: Thrush, Watts, Cash-Acme, Taco, or B & G

(2) Brass or bronze body, spring and diaphragm operated, pressure adjustable with check valve and inlet strainer and designed for Maximum Allowable Working Pressure (MAWP) of 125 psig (861.84 kPa) and Maximum Allowable Operating Temperature (MAWT) of 160°F.

I. Drain Valves:

(1) Ball valve as specified above with threaded hose adapter and cap. If 3-piece ball valves are specified, use 2-piece ball valves with same construction.

J. Automatic Flow Control (limiting) Valves:

(1) All metal construction, factory set to automatically maintain flow rate within plus/minus 5% accuracy over operating pressure differential range of at least 2 - 30 psi (206.84 kPa), self-contained spring loaded perforated cartridge control mechanism, passivated stainless steel internal working parts, rated for not less than 200 psi (1378.95 kPa) pressure at 250°F.

(2) Valves 2" and under shall have threaded ends with ground joint union; 2-1/2"and larger to have flanged ends.

(3) Each automatic flow control valve shall have pressure tappings with quick disconnect fittings suitable for use with portable measuring instrument specified, to verify pressure differential across flow control orifice.

(4) Certified performance data based on independent laboratory tests shall be available.

(5) Manufacturers: Griswold, IMI Flow Design (FDI) or Dole

(6) Hays Fluid Controls automatic flow-control valves utilizing elastomeric diaphragm and polyphenylsulfone orifice is acceptable.

(7) Furnish to Owner portable pressure-temperature measuring kit consisting of 2 pressure gauges with 4-1/2" dial, air bleed device, hoses, quick-connect fittings, protected thermometer, instructions and carrying case. Kit to be used to read pressure drop across flow control orifice and temperature at that point.

2.03 WATER PRESSURE RELIEF VALVES

A. Closed-Loop Fluid System (Pump Inlet) Applications:

(1) Bronze or iron body, direct pressure actuated, non-metallic seat, stainless steel stem and spring. Valve shall be provided with plain lever-type manual lifting device.

(2) ASME stamp not required, but valve carrying ASME “UV” Stamp will be acceptable.

(3) Valve setpoint, overpressure, and capacity shall be as scheduled.

(4) Manufacturers: Kunkle, Watts,

PART 3 EXECUTION

3.01 GENERAL

A. Install valves as shown on plans, details and according to manufacturer's installation recommendations.

B. After piping systems have been pressure tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust, replace packing or replace valves to stop leaks.

C. Install control valves furnished under Control Systems. Provide reducing fittings as required.

D. Refer to Section 23 2116, Part 3 for reducing fittings requirement for valves smaller than pipe size.

E. Provide chain operators for manually operated valves furnished with gear operators, which are located more than 8 ft above equipment room floor.

3.02 SHUT-OFF VALVES

A. Provide shut-off valves at all equipment, at riser take-offs at each floor, and at each automatic valve for servicing.

B. Install steam system shut-off valves in horizontal piping. Shut-off valves are not allowed in vertical piping.

3.03 BALANCING VALVES

A. Provide balancing valves where indicated on drawings and as required for complete balancing of water systems.

B. Provide straight inlet and outlet pipe length in accordance with manufacturer's recommendation.

C. Balancing valve at pump discharge line is not required where pump is driven by variable frequency drive (VFD).

D. For buildings with multiple stories, provide balancing valve in return line at riser take-offs at each floor. Provide shut off valve in supply line at each riser take-off.

3.04 GAUGE VALVES

A. Provide gauge valves at each pressure gauge as shown and at each pressure tapping where pressure sensing tubing is connected.

3.05 DRAIN VALVES

A. Provide drain valves at all low points of piping systems for complete drainage of systems.

B. Unless otherwise indicated, provide 1/2" drain valve for 1/2" piping and minimum 3/4" drain valve for 3/4" and larger piping, except strainer blowdown valves shall be blowdown connection size.

3.06 WATER PRESSURE REGULATING VALVES

A. Set valves for pressure required or as scheduled.

3.07 SPRING LOADED CHECK VALVES

A. Provide spring loaded check valve in each pump discharge line.

3.08 SWING CHECK VALVES

A. Provide swing check valves at steam condensate lines if lifted at outlet of traps. Install check valve between trap and gate valve.

B. Install check valves in horizontal piping.

3.09 AUTOMATIC NON-RETURN STOP VALVES

A. Install automatic non-return stop valve in each steam boiler outlet before header in high pressure steam systems. Automatic non-return stop valves shall be properly sized and furnished by boiler manufacturer or supplier.

3.10 LIQUID OR WATER PRESSURE RELIEF VALVES

A. Closed Loop Pump Suction Application:

(1) Provide non-code relief valve in each closed water system in the pump inlet piping. ASME UV Stamped pressure relief valve will be acceptable in lieu of non-code valve.

(2) Locate relief valve on main piping between expansion tank branch connection and pump suction isolation valve.

(3) Install valves in accordance with manufacturer’s instructions.

(4) Unless otherwise indicated, pipe discharge to within 8" of floor with outlet of discharge pipe pointing down.

B. Bypass Relief Application:

(1) Provide bypass relief valve where indicated on drawings.

(2) Install valves in accordance with manufacturer’s instructions.

(3) Valve discharge piping shall be as indicated on drawings.

3.11 SAFETY RELIEF VALVES

A. For liquid-to-liquid heat exchangers, provide safety relief valve on each liquid circuit of heat exchanger between heat exchanger and isolation valve.

B. Install safety relief valve in accordance with manufacturer’s instructions.

C. Unless otherwise indicated, pipe discharge to within 8" of floor with outlet of discharge pipe pointing down.

D. No stop valves shall be installed between safety relief valve and pipe main or on outlet side of safety relief valve.

3.12 TERMINAL UNIT VALVE ASSEMBLY

A. Flexible hoses used in terminal unit valve assemblies shall be installed with lateral offset not to exceed 4" from centerline of pipe.

END OF SECTION 23 21 18

SECTION 23 21 20 - PIPING SPECIALTIES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01 8113 – Certification Requirements

B. Section 23 0594 - Water Systems Test Adjust Balance

C. Section 23 0903 - Control Instrumentation (Temperature and Pressure Sensing Requirements)

D. Section 23 2118 - Valves

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 REFERENCE STANDARDS

A. Metal bellows expansion joints shall be constructed and applied in accordance with "Standards of the Expansion Joint Manufacturer's Association", 10th Edition.

1.04 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.05 SUBMITTALS

A. Shop Drawings for all items in this Section including, but not limited to, the following:

(1) Manufacturer's name and model number

(2) Identification as referenced in the Documents

(3) Materials of construction

(4) Dimensional data

(5) Capacities/ranges

(6) Temperature/pressure ratings

(7) Pressure drop

(8) Expansion joint schedule indicating joint tag no., system, proximity to rotating or reciprocating equipment, required movement in all planes, service pressure, test pressure, service temperature, fluid velocity and cycles to failure (both thermally and seismically, if applicable).

(9) All other appropriate data.

B. LEED Submittal

(1) Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

(a) VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

(b) VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified, select devices for highest pressures and temperatures existing in respective systems in accordance with ANSI Specifications.

B. Piping specialties in copper piping shall have bronze or brass body with solder ends.

2.02 THERMOMETERS

A. Manufacturers: Trerice, Weksler, Miljoco, Winters, or Weiss

B. Pipeline mounted thermometers: 9" scale cast aluminum case and frame, clear acrylic plastic window front, permanently stabilized glass tube with mercury free indicating fluid, adjustable angle stem, extended neck suitable for insulated piping as required, and compatible with sockets as specified herein.

SERVICE	SCALE RANGE	INCREMENT
PRIMARY CHILLED WATER, CHILLED WATER, AND IMAGING CHILLED WATER	**0°F TO 100°F**	**1°F**
HEATING HOT WATER	**30°F TO 180°F**	**2°F**

C. Range of thermometers shall be:

D. Thermometers by temperature control manufacturer meeting above Specification will be acceptable.

2.03 THERMOWELLS AND TEST WELLS

A. Brass construction with threaded connections suitable for thermometer stems or bulbs and temperature control sensing elements, well length suitable for pipe diameter with extended neck as required to suit pipe insulation. For test well, furnish with brass cap and short chain to secure cap to body.

B. Stainless steel construction for stainless steel piping.

2.04 PRESSURE GAUGES

A. Manufacturers: Ashcroft, U.S. Gauge, Marsh, Trerice, Miljoco, Marshalltown, Weksler, Winters or Weiss equal to Trerice 600 Series

B. Minimum 4-1/2" diameter die cast aluminum case, glass or acrylic plastic window, phosphor bronze bourdon tube with bronze bushed movement, recalibration from front of gauge dial and 1/4" NPT forged brass socket.

C. Gauge accuracy shall meet ANSI B40.100 Grade 1A (±1% full scale).

D. Select gauge range so that normal operating pressure is at midpoint of gauge.

SERVICE	SCALE RANGE
PRIMARY CHILLED WATER, CHILLED WATER, AND IMAGING CHILLED WATER	**0 TO 200 PSIG (1378.95 KPA)**
HEATING HOT WATER	**0 TO 200PSIG**

E. Reading range of gauges shall be:

F. Pressure Snubbers:

(1) 1/4" or 1/2" size, matching gauge pipe size as specified in Section 23 2116 - Pipe and Pipe Fittings, 1000 psig (6894.76 kPa) WP. Brass for carbon steel pipe or copper pipe. Stainless steel for stainless steel pipe.

G. Coil Syphons:

(1) 1/4" or 1/2" size, matching gauge pipe size as specified in Section 23 2116, 500 psig (3447.38 kPa) WP. Material shall match gauge pipe material.

PIPE SIZE	PERFORATION SIZE
2" AND SMALLER	**1/50" (30 MESH)**
2-1/2" TO 10"	**3/64"(.045")**

2.01 BASKET STRAINERS

A. Cast steel body with Class 150 260 psi (1792.64 kPa)/200°F) flanged ends, full pipeline size with bolted covers. Furnish stainless steel baskets with 1/8" perforations. Provide valved drain connection from each blowdown tapping.

2.02 EXPANSION TANKS

A. Manufacturers: Amtrol, Taco, Bell and Gossett, Armstrong, Wheatley, or Wessels

B. Tanks shall be replaceable bladder type air pre-charged to initial fill pressure as scheduled. Furnish tank suitable for 125 psig (861.84 kPa) WP, constructed, tested and stamped in accordance with ASME Code, and sealed-in elastomer bladder suitable for operating temperature of 240°F. Bladder shall be compatible with water and with ethylene and propylene glycol. Furnish mounting saddles for horizontal tanks and mounting base for vertical tanks. Furnish tanks with system connections; drain connections for floor-mounted tanks, and air charging valves.

2.03 AIR AND DIRT SEPARATORS

A. Manufacturers: Spirotherm Spirovent or approved equal.

B. Coalescing type combination air and dirt separator, designed for 150 psig (1034.21 kPa) WP, temperature up to 270°F stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels. Connections 2-1/2" and larger shall be flanged. Connections 2" and smaller may be flanged or threaded.

C. Coalescing medium shall consist of copper core tubes or stainless steel tubes with enhanced surface to facilitate coalescing action.

D. Coalescing medium shall be removable for inspection.

E. Provide Standard-velocity or High-velocity units as indicated in Schedule.

(1) Standard-velocity units shall be rated up to 4 fps and pressure drop shall not exceed 2 ft water head.

(2) High-velocity units shall be rated up to 10 fps and pressure drop shall not exceed12 ft water head.

F. Unit air and dirt removal performance shall be certified by independent third-party testing agency.

(1) Air elimination efficiency shall be certified for 100% of free and entrained air.

(2) Dirt separation efficiency shall be certified for 80% removal of particles 30 microns and larger within 100 passes.

G. Venting chamber shall be provided with integral full-port float actuated venting mechanism or high capacity air vent, similar to B&G Model 107A, with isolation ball valve located between separator and air vent.

H. Unit shall include valved side tap for flushing of floating dirt or liquids and for quick venting of air during system fill or refill.

I. Drain valve at bottom of unit for flushing/dirt removal, 1" for units size 12" and smaller, 2" for units size 14" and above.

2.04 PUMP SUCTION DIFFUSERS

A. Manufacturers: Bell & Gossett, Armstrong, Mueller Steam Specialty, Wheatley or Taco

B. Cast iron or ductile iron body with angle pattern flow straightening vanes and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings, 175 psig (1206.58 kPa) WP, at 250°F. Threaded ends for 2" and smaller and flanged ends for 2-1/2" and larger. Orifice cylinder shall have free area of at least 5 times cross section area of pump suction opening. Furnish each unit with disposable 16 mesh start-up strainers, gauge tappings, blow down connection, and adjustable support foot to carry weight of suction piping.

2.05 AIR VENTS

A. Manual Air Vents:

(1) Manufacturers: Bell & Gossett Model 4V, 125 psig (861.84 kPa) at 210°F or approved equal. Use 1/2" ball valve for main pipes.

B. Automatic Air Vents:

(1) Manufacturers: Amtrol, Watson McDaniel, B&G, or Hoffman

(2) Metal construction, non-corrosive working parts, 150 psig (1034.21 kPa) WP at 240°F

(3) Normal capacity vent shall be similar to B&G Model 87

(4) High capacity vent shall be float actuated and shall have minimum air elimination rate of 10 cfm at 100 psig (689.48 kPa), similar to B&G Model 107A.

C. Thermostatic Air Vents:

(1) Balanced pressure type, cast bronze body, bronze bellows caged in stainless steel, stainless steel valve and seat, 1/2" threaded connection, 125 psig (861.84 kPa) WSP, equal to Armstrong Model TV-2.

2.06 VACUUM RELIEF/BREAKERS

A. Kadant Johnson Series VB-8 with brass body, stainless steel ball, EPR seat, stainless steel spring, suitable for pressures to 300 psig (2068.43 kPa) at 365°F, or Sarco Model VB-14.

2.07 FLOW ELEMENTS (MEASURING STATIONS) AND METERS

A. Venturi Flow Elements:

(1) Manufacturers: Hyspan, Gerand, or Preso

(2) Elements shall be flanged ends for 2-1/2" and larger and threaded ends 2" and smaller. Furnish tubes with quick disconnect taps and shut off valves, suitable for 125 psig (861.84 kPa) WP. Select tubes for size and pressure drop as scheduled and tag for mark number, flow and pressure drop as specified.

(3) Provide portable meter kit within durable case. Furnish with 6" diameter forged brass meter having dial range from 0" to 50" WG. Provide in kit equalizing valves, vent hose and size devices specified. Meter shall become property of Owner.

2.08 STRAIGHTENING VANES

A. Manufacturers: Daniel Industries, Inc., Houston, Texas or approved equal

B. Straightening vane assembly shall consist of series of carbon steel pipes firmly welded together and to line size pipe. Furnish vanes with class 150 psi (1034.21 kPa) flanges for insertion into piping system.

PART 3 EXECUTION

3.01 GENERAL

A. Install piping specialties as indicated on plans, details and according to manufacturer's recommendations.

3.02 THERMOMETERS

A. Install thermometers in thermowells in locations indicated.

3.03 THERMOMETER TEST WELLS

A. Install test wells in locations as shown and at each point where temperature-sensing device is required under Control Systems.

3.04 PRESSURE GAUGES

A. Install gauges for services other than steam with pressure snubbers and gauge valves.

B. Install gauges for steam service with coil syphons and gauge valves.

3.05 PRESSURE GAUGE TAPPING

A. Install tappings with gauge valves at each point where sensing device is required under Control Systems and at gauge locations as shown.

B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.06 PRESSURE/TEMPERATURE TEST STATIONS

A. Pete's plug may be used in lieu of thermometer test well and pressure gauge tappings.

B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.07 PIPE EXPANSION DEVICES

A. Stretching of expansion joints or connectors to correct for piping misalignment is not allowed.

B. Install expansion loops, where shown on drawings and as necessary to allow expansion and contraction in piping systems.

C. Flexible Expansion Loops:

(1) Install loops in neutral or pre-extend condition as required for application. For steam service, install loops with flexible legs horizontal to prevent condensate buildup. Install and guide per manufacturer's recommendations.

D. Flexible Ball Joints:

(1) Unless otherwise indicated, use minimum 2 ball joints at each station to accomplish required off set.

(2) Manufacturer's authorized representative shall be available for inspection of ball joints installation.

3.08 PIPELINE STRAINERS

A. Provide drain valve at each strainer blowdown connection with hose threaded adapter and cap. Valve size shall be same as blowdown connection size.

B. Install strainers in steam system on entering side of all automatic control valves and as indicated elsewhere. Install Y-type strainers in horizontal lines so that basket is in horizontal plane to prevent condensate build-up in basket.

C. Install strainers in water systems on suction side of all pumps, entering side of automatic control valves of heating and cooling coils of air handling units, and as indicated elsewhere.

D. Install clamped cover basket strainers in condenser water system as indicated.

3.09 AIR SEPARATORS

A. Provide valved blow down connections and extend drain piping to nearest floor drain.

3.10 PUMP SUCTION DIFFUSERS

A. Pipe blow down to the nearest floor drain with drain valve at unit.

B. Remove disposable fine mesh start-up strainers after start-up. Clean permanent strainer and replace after pipe cleaning process.

3.11 AIR VENTS

A. Install manual air vents at all high points in water systems where air may collect and where shown on drawings.

B. Install automatic air vent at top of air separator and where shown on drawings. Provide shut-off valve to isolate air vent from system. Pipe automatic air vent to the nearest floor drain.

C. Install high capacity automatic air vent at air separator.

3.12 THERMOSTATIC AIR VENTS

A. Install thermostatic air vents where shown. Install vents at the highest points of steam chambers. Locate vents higher than outlet connections to chambers.

3.13 VACUUM BREAKERS

A. Install vacuum breakers as required for proper condensate drainage at any steam using apparatus.

3.14 FLOW ELEMENTS/FLOWMETERS

A. Flow elements/flowmeters located in common piping after multiple pump discharge lines shall be furnished with hot tap feature.

B. If flow elements/flowmeters are furnished by Control Contractor, this Contractor shall install them in accordance with manufacturer's installation instructions. Wiring of flowmeters will be provided by Control Contractor.

3.15 STRAIGHTENING VANES

A. Provide straightening vanes where flow sensor manufacturer's installation instructions require greater length of straight upstream piping than can be obtained in available space.

END OF SECTION 23 21 20

SECTION 23 21 23 - PUMPS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0514 - Variable Frequency Drive (VFD) System

C. Section 23 0550 - Vibration Isolation

D. Section 23 2120 - Piping Specialties

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

(1) Manufacturer's name and model number

(2) Identification as referenced in the documents

(3) Capacities/ratings

(4) Pump curves with operating point clearly indicated. For parallel pump applications, indicate operating point of combined case as well as operating point of only one pump.

(5) Motor data (refer to Section 20 0513 - Motors)

(6) Seals

(7) Materials of construction

(8) Dimensions and weights

(9) Manufacturer's installation instructions

(10) All other appropriate data

1.04 DESIGN CRITERIA

A. Pump sizes, capacities, pressures and operating characteristics shall be as scheduled.

B. Pumps shall meet or exceed operating efficiencies scheduled.

C. Furnish pumps complete with motors, impellers, drive assemblies, bearings and accessories as hereinafter specified. Furnish pump couplings with OSHA compliant coupling guards.

D. Where pump is indicated for parallel operation, scheduled conditions are for that pump with two pumps operating; i.e., total system flow rate is twice that scheduled for single pump. When only one of two pumps are operating, operating point of that pump must fall within manufacturer's recommended operating range.

E. Select motor with sufficient hp rating for non-overloading operation over entire pump curve.

F. Furnish each pump and motor with nameplate giving manufacturer's name, serial number of pump, capacity in gpm and head in ft at design condition, hp, voltage, frequency, speed and full load current.

G. Test pumps hydraulically at 150% of rated pressure per Hydraulic Institute Standards, clean and paint before shipment. Manufacturer shall certify all pump ratings.

H. Pumps shall operate without objectionable noise or vibration.

I. After completion of balancing, if water balancing results in pump discharge balancing valve being closed 50% or more, replace or trim impeller so that balancing valve is opened at least 75% to maintain design flow rate. Where pumps are driven by VFDs, balancing should be performed with pumps at design speed.

J. Furnish one spare seal for each pump to Owner.

K. Head for pumps submitted for pumping through evaporators and condensers of chillers and water coils shall be increased, if necessary, to match the equipment approved for project.

PART 2 PRODUCTS

2.01 VERTICAL IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Armstrong Series 4300 or approved equal.

B. Pumps shall be pipeline mounted, single suction type with cast iron casing, bronze fitted with working pressure of 175 psi (1206.58 kPa) and continuous operating temperature of 225°F.

C. Casings shall have tapped and plugged openings for vent, drain, and suction and discharge gauge connections.

D. Impellers to be single suction enclosed type made of bronze, hydraulically and dynamically balanced, keyed and locked to pump shafts and protected by replaceable bronze shaft sleeves.

E. Impellers shall be directly hung from motor shafts without using flexible couplings.

F. Pump shafts shall be high strength carbon steel or alloy steel, sealed and gasketed from pumped fluid.

G. Pump seals shall be stainless steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat. Provide with 316 stainless steel gland plate.

H. Coupling shall be designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and to be replaced without disturbing the pump or motor.

I. Bearing assemblies and motors shall have oil lubricated sleeve bearings or regreasable ball bearings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pumps in strict accordance with manufacturer's instructions to avoid any stress and misalignment.

B. Install full line size spring loaded check valve in pump discharge piping. Provide balancing valve in pump discharge piping for pumps without VFDs.

C. Where pump connection size and indicated line sizes are not identical, provide reducing fittings at pump connection. Unless otherwise indicated, use concentric reducers. Use eccentric reducers, installed flat-on-top, for horizontal pump suction pipe. Valves and piping specialties shall be full line size.

3.02 STARTUP

A. Verify that piping system has been flushed, cleaned and filled.

B. Prime pump, vent air from casing and verify that rotation is correct. To avoid damage to mechanical seals, never start or run pump in dry condition.

C. Verify lubrication of motor and pump bearings and lubricate properly in accordance with manufacturer’s recommendation and Section 20 0000, Part 3, under LUBRICATION.

D. After several days' operation, verify removal of disposable startup strainer in suction diffuser and turn them over to Owner.

E. Perform field mechanical balancing, if necessary, to meet vibration tolerance specified in Section 23 0550 - Vibration Isolation.

END OF SECTION 23 21 23

SECTION 23 31 14 - DUCTWORK

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01 8113 – Certification Requirements

B. Section 20 0529 - Piping and Equipment Supporting Devices

C. Section 20 0700 - Mechanical Systems Insulation

D. Section 23 0550 - Vibration Isolation

E. Section 23 0595 - Air Systems Test Adjust Balance

F. Section 23 0902 - Control Valves and Dampers

G. Section 23 3314 - Ductwork Specialties

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.04 SUBMITTALS

A. For each duct system, submit schedule utilizing reinforcement tables from SMACNA HVAC Duct Construction Standards Metal and Flexible where applicable. Each duct system schedule shall include, but not be limited to, the following:

(1) Name of Contractor/manufacturer fabricating each duct system

(2) Material and gauge

(3) Pressure class

(4) Transverse joint type and length and reinforcement rigidity class with designated joint T number or proprietary duct connection if utilized for each system

(5) Certified test results of proprietary joint products, if used, tested in accordance with SMACNA procedures

(6) Intermediate reinforcement spacing and rigidity class with metal angle dimensions and gauge

(7) Type of longitudinal seam

(8) Fitting construction details

(9) Support methods including spacing, upper attachments, and lower attachments

(10) Sealant and gasket

(11) Sealing class

B. Duct leakage testing methods, apparatus and apparatus certification signifying meter is in conformance with ASME Requirements for testing meters.

C. Submit shop drawings for manufactured duct system products

D. Submit the following information for welded sheet metal ductwork:

(1) Welding Procedure Specification (WPS) for welded joints. Form to be similar to ANSI/AWS D9.1-2006 Code, Appendix "D".

(2) Procedure Qualification Record (PQR) for each WPS. Form to be similar to ANSI/AWS D9.1-2006 Code, Appendix "E".

(3) Welder and Welding Operator Qualification Test Record (satisfactory performance) for each field or shop welder. Form to be similar to ANSI/AWS D9.1-2006 Code, Appendix "F".

E. LEED Submittals:

(1) Complete provided Product Data Reporting Form in spec section 01 8113 and provide the following:

(a) VOC Emissions Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

(b) VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant.

1.05 DELIVERY, STORAGE AND HANDLING

A. Protect duct and fittings from damage due to normal handling during shipment and storage. Protection shall be applied to ends of duct to prevent dirt and moisture from entering ducts and fittings.

1.06 DESCRIPTION

A. Furnish and erect ductwork free of objectionable vibration, chatter, and pulsations. Verify dimensions at site, making field measurements and drawings necessary for fabrication and erection.

B. Duct sizes indicated are net inside dimensions.

C. Where size for a duct segment is not indicated, the duct segment size shall be equal to the largest duct segment to which it is connected. Transition to smaller size shall occur on side of fitting where smaller size is indicated.

1.07 DESIGN CRITERIA

A. All products shall conform to NFPA 90A, and shall possess flame spread rating of not over 25 and smoke developed rating no higher than 50.

B. Unless otherwise indicated, construct all ductwork of galvanized sheet metal for pressure class not less than 2” WG for positive pressure ductwork and not greater than -2” WG for negative pressure ductwork.

C. Ductwork shall comply with Local, State and Federal requirements.

D. Unless otherwise indicated, pressure class for VAV system supply ductwork between supply fan discharge and air terminal device inlet shall be equal to static pressure at fan discharge but not less than 4” WG; pressure class for ductwork on suction side of air handling unit and suction side of return fan shall be equal to static pressure at inlet of return fan but not less than -2” WG.

E. Unless otherwise indicated, pressure class for fume hood exhaust ductwork between exhaust fan inlet and exhaust air terminal device outlet shall be equal to static pressure at exhaust fan inlet but not less than -4” WG.

F. Duct transverse joints and reinforcement material, including angle ring flanges and stiffeners, shall be of same material as duct.

G. Except as modified in this Section of specifications or on drawings, use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications:

(1) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition, 2005, for rectangular and round ductwork up to positive 10” WG and negative 10” WG and flat oval ductwork up to positive 10” WG.

(a) Tie rods shall be 1/2” or 3/4”, galvanized steel EMT/conduits with bolt assembly consisting of rubber washer and friction anchored threaded insert similar to Ductmate Easyrod or PPI Condu-Lock.

(b) Internal tie rods are not allowed for welded ductwork and special exhaust systems, such as fume hood exhaust, BSC exhaust, animal room exhaust, BSL-3 exhaust, cagewash exhaust, shower room exhaust, kitchen hood exhaust, dishwasher exhaust, etc.

(2) Round Industrial Duct Construction Standards, 2nd Printing 1999

(3) Rectangular Industrial Duct Construction Standards, 2nd Edition, 2004

(4) Accepted Industry Practice for Industrial Duct Construction, 2nd Edition, 2008, for round ductwork -4” to 20” WG (Table 1-A) and for rectangular ductwork -4” to 20” WG (Table 2-A).

(a) Adhesives and sealants used on installation of ducts shall comply with South Coast Air Quality Management District (SCAQMD) Rule #1168; Indoor Environmental Quality Section, Credit EQ-4.

1.08 WELDING REQUIREMENTS

A. The following requirements cover arc and braze welding of nonstructural sheet metal ductwork for HVAC, architectural metal and other FDA process applications where pressures do not exceed 120" WG (positive or negative). These requirements also apply to welding of structural members whose sole purpose is stiffening, supporting, or reinforcing of sheet metal material, as well as attachment of brackets or other accessories/components required to provide complete systems.

B. Procedure and Qualification:

(1) Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) shall be prepared by installing contractor and/or fabricator prior to execution of related work. Qualification of welding procedure shall meet or exceed requirements of the latest revision of American Welding Society, Sheet Metal Welding Code ANSI/AWS D9.1.

(2) Provide certification of satisfactory performance testing for all welders and welding operators, which provide welding services on Project.

(3) Establish and provide written quality assurance/quality control (QA/QC) procedures to ensure compliance with specification requirements. Clearly identify appropriate steps for safe welding procedures (review Appendix J of D9.1) including additional safety material, screens, eye, personnel and clothing protection, fire suppression equipment, and fume extraction equipment needed adjacent to welding work area.

PART 2 PRODUCTS

2.01 GALVANIZED STEEL SHEET

A. Lock Former Quality (LFQ), cold rolled, open hearth soft steel sheet capable of double seaming without fracture, ASTM A924/A924M or ASTM A653/A653M. Galvanized coating shall be G90.

B. Use G90 Galvaneal or Zinc grip where painting is specified.

2.02 ALUMINUM SHEET

A. Aluminum alloy, ASTM B209, Type 3003H-14 capable of double seaming without fracture.

2.03 STAINLESS STEEL SHEET

A. First quality, cold rolled annealed, pickled, ASTM A240 and A480, Finish No. 2B for concealed work and Finish No. 4 for exposed work. Unless otherwise indicated, use Type 304L where welded duct construction is specified and Type 304 where non-welded duct construction is allowed.

2.04 FLEXIBLE DUCT

A. Manufacturers: Thermaflex, or Flexmaster

B. Factory fabricated, UL listed under UL-181 as Class 1 duct, meeting requirements of NFPA 90A with flame spread of 25 or less and smoke developed rating of 50 or under.

C. Flexible duct shall have minimum ratings as follows:

(1) Operating Temperature: -20ºF to 250ºF

(2) Internal Working Pressure: Positive: 6" WG

(3) Negative: 1" WG

(4) Burst Pressure: 2-1/2 times working pressure

(5) Velocity: 5000 fpm

D. Unless otherwise indicated, duct shall be nonmetallic insulated type composed of polyester film, polyethylene film, nylon film, CPE film, or coated woven fiberglass liner bonded permanently to corrosion resistant coated steel wire helix without adhesive.

E. Insulation shall be flexible fiberglass insulation with minimum R-value of 6 at mean temperature of 75ºF. Vapor barrier jacket shall be aluminum foil reinforced, polyethylene, or metalized polyester film with maximum perm rating of 0.05 permper ASTM.

F. Insulation material shall not be exposed to air stream.

G. Lined flexible duct shall have the following minimum acoustical performance in accordance with ARI Standard 885. Dynamic Insertion Loss in each octave band of 5 ft or 10 ft straight duct shall not be less than the following:

Duct Diameter (in)	Dynamic Insertion Loss (dB) Octave Band Center Frequency (Hz) (Based on 5 ft length)					
	125	250	500	1000	2000	4000
6"	6	9	18	22	24	15
8"	6	10	18	20	21	12

10”	5	11	18	18	18	9

2.05 MANUFACTURED ROUND DUCTWORK (POSITIVE PRESSURE)

A. Single Wall:

(1) Manufacturers: Lindab, Semco or McGill AirFlow, equal to McGill AirFlow Uni-Seal duct and fittings suitable to positive 10” WG.

(2) Ducts shall be machine formed round and/or flat oval as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Longitudinal seam construction may be used for ductwork over 80” diameter with minimum 16 ga. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

(3) Unless otherwise indicated, connection shall be slip type with minimum 2” insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct.

(4) Internal bracing is not allowed.

(5) Pre-sealed snaplock pipe system “Greenseam +” as manufactured by Ductmate Industries may be used for low pressure supply air duct.

B. Double Wall (insulated):

(1) Manufacturers: Lindab, Semco or McGill AirFlow duct and fittings suitable to positive 10” WG.

(2) Ducts shall be machine formed round as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Inner liner shall be perforated or solid as indicated, and annular space shall be filled with 1” thick fiberglass insulation. Use fittings with solid liner as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

(3) Unless otherwise indicated, connection shall be slip type connection with minimum 2” insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct.

(4) Internal bracing is not allowed.

2.06 MANUFACTURED ROUND DUCTWORK (NEGATIVE PRESSURE)

A. Manufacturers: McGill AirFlow Industrial duct and fittings. Semco and Lindab are acceptable manufacturers, provided meeting requirements in this Section.

B. Ducts shall be machine formed round duct constructed of G90 galvanized steel. Use spiral lockseam construction unless otherwise indicated. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

C. Connection shall use slip coupling, angle ring or Van Stone connectors in accordance with manufacturer's recommendations.

D. Fitting gauge shall be one even gauge heavier than the lightest allowable gauge of connecting downstream section of duct.

2.07 MANUFACTURED SELF-SEALING ROUND DUCTWORK SYSTEM

A. Single-wall:

(1) Manufacturers: Lindab Spirosafe, Eastern Sheet Metal (ESM) Eastern Tight, or Tambe Metal Products Zip Seal

(2) Ductwork system shall consist of fittings with factory-fitted sealing gasket and spiral duct which will seal duct joints without use of duct sealer.

(3) Ducts shall be machine formed round as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

(4) Unless otherwise noted, duct and fittings shall be constructed per SMACNA’s Duct Construction Standards (+10” WG) shown in the following table:

DIAMETER (”)	GALVANIZED SPIRAL DUCT	GALVANIZED FITTINGS
3 - 14	**26 GA**	**24 GA**
16 - 26	**24 GA**	**22 GA**
28 - 36	**22 GA**	**20 GA**
38 - 50	**20 GA**	**20 GA**

(5) All fitting ends shall have factory equipped with double-lipped, U-profile or tubular EPDM rubber gasket. Gasket shall be classified by Internationally Recognized Laboratory Authority to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.

(6) Ductwork system performance shall meet SMACNA’s Leakage Class 3 Requirements from -20” WG to +12” WG.

2.08 DUCT SEALANTS AND GASKETS

A. Sealant:

(1) Flexible, water based, adhesive sealant compounded specifically for sealing joints and seams in ductwork. Hardcast, McGill AirSeal, Ductmate PROseal, Mon-Eco Industries, Childers, DP1010 or H.B. Fuller/Foster.

(2) Sealants shall be UL 723 (ASTM E84) classified, and meet NFPA 90A and 90B.

(3) Sealants shall comply with requirements for LEED EQ 4.

(4) Select sealants as recommended by manufacturer for specific application.

(5) Submit sealant manufacturer's data sheets including performance data, pressure ratings, surface burning characteristics data, VOC compliance with LEED EQ 4, detailed installation instructions.

(a) Sealants for exterior ductwork shall include explicit statement by manufacturer indicating suitability for application.

(b) Sealants for exposed (uninsulated) exterior ductwork shall be UV resistant and include explicit statement by manufacturer indicating suitability for exposed exterior application.

(6) Duct tapes are not allowed.

B. Gaskets:

(1) Butyl, copolymer or neoprene based tape similar to Ductmate 440 Gasket Tape or Neoprene Gasket Tape for flanged joints.

C. Duct Sealant and Gaskets for Fume Hood Exhaust Ductwork:

(1) Sealant shall be similar to Hardcast Sure-Grip 404 or Ductmate Proseal.

(2) Gasket material shall be Butyl tape similar to Ductmate 440 Gasket tape or neoprene gaskets.

(3) Gasket thickness and width shall be as required for flange and surface irregularities to seal joint air tight.

D. Duct sealant for high temperature ductwork:

(1) Sealant shall be 100% silicone and rated to 500°F continuous operation, similar to Surebond SB-188 or ASI 600.

2.09 CABLE SUSPENSION SYSTEM

A. Suspension system shall be similar to Gripple Hang-Fast as manufactured and supplied by Gripple Incorporated or Ductmate Industries “Clutcher” cable hanging system.

B. Suspension system shall be load rated and verified by SMACNA Testing and Research Institute to be in compliance with SMACNA HVAC Duct Construction Standards, 2005, Chapter 5.

2.10 ACOUSTIC DUCT COVERING

A. Sound barrier material shall be similar to Kinetics Model KNM-100B or EAR Lag-10. Barrier material to have acoustic ratings of STC-27, 1.0 lb/ft2 weight, and minimum continuous operating range from -10°F to 180°F.

B. Minimum sound transmission loss at each octave band shall be as follows:

SOUND TRANSMISSION LOSS (DB)					
OCTAVE BAND CENTER FREQUENCY (HZ)					
125	**250**	**500**	**1000**	**2000**	**4000**
15	**18**	**21**	**27**	**32**	**37**

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise indicated, install ductwork level, parallel , and/or perpendicular to building structure, walls, and ceilings and at such heights not to obstruct any portion of ceiling, window, doorway, stairway, or passageway. Install ductwork to allow adequate access and service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical ductwork plumb. Where interferences develop in field, offset or reroute ductwork as required to clear such interferences. In all cases, consult drawings for exact location of duct spaces, ceiling heights, door and window openings or other architectural details before installing ductwork.

B. Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Check plans showing work of other trades and consult with Engineer in event of interference. Transform, divide, or offset ducts as required, in such a manner as to maintain same cross sectional area of duct as indicated on drawings. Where it is necessary to install pipes or similar obstructions through ducts, consult with Engineer and obtain written approval from Engineer and Owner. If approved, provide streamlined encasement or collar designed in accordance with SMACNA Standards and seal to prevent air leakage.

C. Ductwork shall be free of kinks and dents.

D. Fabricate and install duct, fittings, joints, seams, reinforcement, supports, sealing, liner, etc., in sizes indicated on drawings and in accordance with manufacturer's published data and SMACNA Standards except as modified in this section of specifications or on drawings.

E. Provide transitions where different size or different shape ductwork segments are connected. Use concentric transitions unless otherwise shown. Unless otherwise indicated, make diverging transitions with maximum angle of 15□ per side (30□ total diverging) and converging transitions with maximum angle of 25□ per side (50□ total converging).

F. Provide transitions at ductwork system components and connections to equipment. Refer to Specification Section 23 3713 – Diffusers, Registers, and Grilles, for additional information regarding diffuser/register/grille connections.

G. Refer to ductwork symbols list on drawings for additional and dimensional requirements for fittings.

H. Seal duct seams and joints to meet SMACNA Class A as minimum for all ductwork including low-pressure ductwork.

I. Construct ductwork so that interior surfaces are smooth. Internal duct hangers and internal bracing are not allowed. Refer to Part 1, Design Criteria for internal tie rods.

J. Support coils, filters, air terminals, dampers, sound attenuator devices or other devices installed in duct systems with angles or channels, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets, nuts, bolts and washers.

K. Air terminal devices may be supported by strap hangers if air terminal manufacturer approves. Strap hangers are not allowed for fan powered devices, double wall type and Titus Steri-Loc type devices.

L. Install outside air intake duct to pitch down at minimum 1” per 20 ft toward intake louver or plenum and to drain to outside of building. Solder or seal seams to form watertight joints.

M. Install exhaust air duct to pitch down at minimum 1” per 20 ft toward exhaust louver.

N. Blank off unused portion of outside air intake or exhaust louvers.

O. Where 2 different metal ducts meet, install joint in such a manner that metal ducts do not contact each other by using proper gasket seal or compound.

P. Install motor operated dampers and connect to or install equipment furnished by others. Provide necessary blank-off plates or transitions to mount control dampers as specified in Section 23 0901 - Control Systems Integration.

Q. Do not install ductwork over electrical panelboards, switchgear, switchboards or motor control centers.

R. When original galvanized finish is altered or damaged, apply field galvanizing paint as follows:

(1) Prepare surface with use of power sanders or wire brushes to remove rust, paint, etc.

S. Apply cold galvanizing material equal to ZRC Products, Inc.

3.02 ELBOWS

A. Rectangular Duct (SA/RA/EA):

(1) Use radius elbows with centerline radius to width ratio of 1.5 (SMACNA Type RE 1).

(2) Where 1.5 centerline radius elbows do not fit, use radius elbows with centerline radius to width ratio of 1.0 (SMACNA Type RE 3).

(3) Where 1.0 centerline radius elbows do not fit, use radius elbows with centerline radius to width ratio of 0.75 (SMACNA Type RE 3) or 45° throat with radius heel elbows (SMACNA Type RE 8).

(4) Use splitter vanes for 1.0 radius elbows, 0.75 radius elbows and 45° throat with radius heel elbows as follows;

(a) No vanes for duct with width less than 24”

(b) Single vane for duct with width 24” to 36”

(c) Two vanes for duct with width over 36”

(5) Fabricate splitter vanes in accordance with SMACNA HVAC Duct Construction Standards, Chart 4-1, (p. 4.11) and Figure 4-9 (p. 4.13).

(6) Square throat elbows with or without turning vanes are not allowed unless specifically indicated. Square throat elbows without turning vanes may be used for transfer air ducts.

B. Round and Oval Duct:

(1) Unless specific type is indicated, use radius elbows with centerline radius to diameter ratio of 1.5 regardless of duct velocity. Where 1.5 radius elbows do not fit, use 1.0 radius elbows.

3.03 LONGITUDINAL SEAM

A. Rectangular Duct:

(1) Unless otherwise indicated, use Pittsburgh lock seam.

(2) Seal longitudinal seams with approved sealant or pre-sealed with encapsulated mastic.

(3) Button punch snap lock construction (SMACNA L-2) may be used for ductwork that is both 2” WG (+ or -) and lower, and 36” and smaller in width or height. For ductwork over 24” in width or height, add screw 4” from each end.

(4) Button punch snap lock construction is not allowed for ductwork in chases, areas above inaccessible ceiling, and aluminum ductwork.

B. Round and Oval Duct:

(1) Unless otherwise indicated, longitudinal seams shall be in accordance with SMACNA HVAC Duct Construction Standards with the following exceptions.

(a) SMACNA seam types RL-3, 6A, 6B, 7 and 8 shown in Figure 3-2 are not allowed.

3.04 TRANSVERSE JOINT

A. Rectangular Duct:

(1) Transverse joints shall be in accordance with SMACNA HVAC Duct Construction Standards.

(2) Ductmate 25/35/45 connection systems with corner clips or optional nuts and bolts may be used. Incorporate use of all Ductmate accessories to ensure integrity of transverse connection. Install joints in strict accordance with the latest edition of Ductmate 25/35/45 Assembly and Installation Instruction Manual and Duct Construction Standards. Nexus or WDCI will be acceptable.

(3) Lockformers TDC or Engles TDF may be used in accordance with T-25 flanges of SMACNA HVAC Duct Construction Standards Metal and Flexible, 2005, provided that corner pieces with bolts are used. If TDF/TDC flanges are damaged, replace the damaged joint(s) by straightening and reinforcing with minimum 1-1/2” x 1-1/2” x 1/4" angle at each side of transverse joint.

(4) Where any type of flanged transverse joint is used for exterior uninsulated ductwork, top flange shall have continuous sheetmetal cap or continuous cleat to protect joint.

B. Round Duct:

(1) Unless otherwise indicated, use beaded sleeve joints (SMACNA RT-1) with minimum 2” insertion length or flange joints (SMACNA RT-2 or RT-2A).

(2) Connection systems manufactured by Ductmate Industries (Spiralmate and Ovalmate) or McGill AirFlow (Uni-flange) may be used for supply air ductwork.

(3) AccuFlange connected systems may be used with gaskets specified in Part 2 of this Section.

3.05 DUCT SUPPORTS

A. Unless otherwise indicated, use straps or Z bar hangers with 3/8” rods to support rectangular ducts 60” wide and smaller and trapeze hangers with rods or angles to support rectangular ducts over 60” wide.

(1) Use trapeze hangers to support externally insulated ductwork with weight bearing inserts. Refer to Section 20 0700 – Mechanical Systems Insulation and details.

B. For round ducts 24” diameter or smaller, use single hanger.

(1) Cable Suspension System may be used up to 24” diameter at spaces higher than 8 ft above floor or platform.

(2) Round Duct Strap Bracket by Ductmate Industries may be used up to 24” diameter.

C. For round ducts 25” diameter or larger, use 2 minimum 3/8” rods, with trapeze in accordance with the following schedule:

Duct Size	Trapeze (Half Round)
25” to 36”	1-1/2” x 1-1/2” x 1/8"
37” to 48”	1-1/2” x 1-1/2” x 1/4" or 2” x 2” x 1/8"
49” to 60”	2” x 2” x 1/4"
61” to 84”	2-1/2” x 2-1/2” x 1/4"

D. Refer to Section 20 0700 - Mechanical Systems Insulation for ductwork insulation, weight bearing inserts and insulation protection shield requirements.

E. Support ducts located on roof as detailed.

F. Support vertical ducts at every floor, but not exceeding 12 feet (365.76 cm)

G. The following upper attachments, upper attachment devices, lower hanger attachments, hanger devices, and/or hanger attachments are not allowed except where specifically indicated:

(1) Hook or loop

(2) Nailed pin fasteners

(3) Expansion nails without washers

(4) Powder actuated fasteners (forced entry anchors). Forced entry anchors may be used for upper attachments of flexible ductwork supports.

(5) Beam or "C" clamps without retaining clips or friction clamps (provide retaining clips for "C" clamps)

(6) Non-factory manufactured upper attachments for metal pan deck including wire coil and double circle (Items 16 and 17 of Fig 5-4 of SMACNA HVAC Duct Construction Standards 2005)

(7) Wire hanger

(8) Trapeze hangers supported by wires or straps

(9) Rods, straps or welded studs directly attached to metal deck

(10) Drilled hole with attachment to structural steel
(11) Lag screw expansion anchor
(12) Rivets
(13) Non-metallic hangers or straps

H. Supporting devices shall be standard products of manufacturers having published load ratings.

I. Refer to Section 20 0529 - Piping and Equipment Supporting Devices for additional support requirements including attachments to structures.

J. For welded ducts, soldered ducts or ducts with water tight joints, do not use supports utilizing screws or other penetrations into ductwork.

K. Unless Architectural Documents indicate the required framing, provide angle iron framing around roof opening where duct penetrates through roof decking, to maintain roof decking structural integrity in accordance with roof decking manufacturer's recommendations. This is not required for concrete decking. For concrete decking, consult with the project structural engineer for location and size of opening prior to execution of Work.

3.06 SHEET METAL WELDING

A. Welded ductwork shall be butt-welded unless otherwise indicated.

B. Attach welding cable leads directly to base metal to be welded. Do not jumper welding cable leads through building structure, to avoid emission of stray voltage/current through building structure.

C. Welds on exposed ductwork in occupied spaces shall be brush polished with stainless steel brush.

D. Welds at exterior of building shall be ground smooth and brush polished with stainless steel brush to prevent atmospheric contamination and rust formation.

3.07 PROTECTION OF DUCTWORK

A. Protect ductwork during construction against entry of foreign matter and construction dirt.

B. Keep ductwork capped when work is complete for the day or when duct is not being worked on or added to. Use of polyvinyl (VISQUEEN) with duct tape wrap is an adequate measure as long as it is secure with no openings or tears in product.

C. If ductwork is not protected, remove dirt and foreign matter from the duct system and obtain inspection and approval from Engineer upon completion of cleaning before operating fans.

D. Return fans are not allowed to operate during construction to avoid intake of construction dirt/dust into return air ductwork.

3.08 DUCT LEAKAGE TEST

A. Refer to Test and Balancing portion of Section 20 0000 - General Mechanical Requirements.

B. Owner and/or Owner's representative may elect to witness leakage tests. Notify Owner and/or Owner's representative at least 3 days in advance.

C. Test each supply, return, and exhaust ductwork as follows, unless otherwise indicated in this section or in schedules.

(1) Test 25% of total installed duct area for duct pressure positive or negative Class 3” wg and higher.
(2) Test 10% of total installed duct area for duct pressure positive or negative Class 2” wg.
(3) Test 100% of total installed duct area for ductwork located in inaccessible spaces including shafts.
(4) Engineer will select sections of ductwork to be tested.
(5) If test results are acceptable to Engineer, remainder of ductwork is permitted to proceed without further testing. If ductwork fails test, repair all ductwork including ductwork not tested. Then repeat leakage tests for new sections of ductwork as described above.

D. Leakage test procedures shall be in accordance with test method described in Section 3 of SMACNA HVAC Air Duct Leakage Test Manual, except as modified in this Section. Test apparatus shall be in accordance with Section 5 of SMACNA HVAC Air Duct Leakage Test Manual.

E. Test pressure shall be equal to duct pressure class. Negative pressure ductwork shall be tested with negative test pressure.

F. Air leakage shall not exceed limits specified or scheduled. If leakage exceeds allowable limits, identify leaked areas, repair, seal and retest.

G. Provide filter system on duct inlet to test blower. Filter system shall be equal to final filtering efficiency of AHU supply air duct system. Filters are not required for negative pressure testing.

H. Do not insulate ductwork until it has been successfully tested.

I. Maximum permitted leakage (L) in cfm/100 sf duct surface area of each ductwork shall be calculated by:

(1) $L = CL \times P0.65$

(2) P = test pressure (duct pressure class).

(3) CL = duct leakage class, 2 for round/oval ducts and 4 for rectangular ducts and flexible ducts.

(4) Total allowable leakage in a duct section:

(5) = L x (total duct surface area of the section)

J. Welded ductwork shall be air and watertight and shall have no air leakage with allowance stated below.

(1) When using test apparatus and procedure described in SMACNA HVAC Air Duct Leakage Test Manual, 1st Edition, Chapter 5 (modified for negative pressure), the following losses can be expected during testing and are acceptable:

(a) 1 cfm per 1” WG of static pressure is allowed for the test equipment and test connections (e.g. 3 cfm when testing at 3” WG).

(b) 0.10 cfm per inch of diameter of temporary caps, regardless of pressure (e.g. 1 cfm for a cap on 10” diameter duct).

(2) To the extent possible, walk and observe welded ductwork under test to check for cracked or hissing welds. All leaks in welded sections of ductwork shall be reported to the Client’s Representative and repaired by welding. No caulking or sealing is allowed.

3.09 LOW PRESSURE DUCT CONSTRUCTION (PRESSURE CLASS 2” WG AND UNDER)

A. Use welds, rivets or nuts, and bolts for fabricating ductwork. Fully threaded sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if screw does not extend more than 1/2” into duct. Sheet metal "TEK" screws 3/4” in length may be used as fasteners in conjunction with factory made transverse joints.

B. Unless otherwise indicated, construct branch take-off fittings as follows:

(1) For branch take-offs including branch ducts serving more than one diffuser or grille, use 45□ entry fittings. For supply air ducts, conical taps may be used.

(2) For take-offs serving single diffuser, register or grille, use straight spin-in collars with manual balancing dampers.

C. Splitter dampers and/or extractors are not allowed.

3.10 HIGH PRESSURE DUCT CONSTRUCTION (GREATER THAN PRESSURE CLASS 2” WG)

A. Use manufactured ductwork or contractor fabricated ductwork meeting specified Construction Standards and fitting performance.

B. Submit construction details including materials, type of service, reinforcing methods, and sealing procedures.

C. Use elbows, tees, laterals, crosses and accessory fittings as shown on drawings and as required to fabricate duct system.

D. Use conical tees for round ductwork and 45 degree entry fittings for branch take-offs from mains unless otherwise indicated.

E. Provide manufactured bellmouth fittings at each fan supply air plenum to provide smooth entrance of air into duct system.

3.11 AIR HANDLING UNIT SYSTEM DUCTWORK PRESSURE CLASS

A. Air Handling Unit AHU-1, AHU-2, AHU-3, AHU-4

(1) Duct pressure class to be as follows:

(a) Outside air intake plenum to AHU inlet -2” WG

(b) Ductwork located in shafts, mechanical room +4” WG

(c) From shaft riser take-off to inlet of air terminal device +4” WG

(d) From air terminal device to diffuser +2” WG

3.12 FLEXIBLE DUCT

A. Install flexible ducts in accordance with manufacturer's installation instructions and SMACNA Standards, except as modified in this Section of Specifications.

B. In supply air systems with air terminal devices, flexible ducts shall be used for duct connections to diffusers, grilles, and registers for sound attenuation purposes, except above non-accessible ceilings. Flexible ducts shall be 5 feet (152.4 cm) long.

C. In exhaust air systems with air terminal devices, flexible ducts shall be used for duct connections to grilles and registers for sound attenuation purposed, except above non-accessible ceilings and in laboratory spaces. Flexible ducts shall be 5 feet (152.4 cm) long.

D. Centerline radius of bends shall not be less than one duct diameters. FlexFlow Elbow supports by Thermaflex or similar products shall be used at diffuser/grille connection to assure full radius elbow.

E. Support flexible ductwork as recommended by manufacturer and with minimum 0.5” wide saddles with maximum sag of 0.5” per ft between supports. Spacing of supports shall beat a maximum of 5 ft on center , with no portion lying on ceiling supporting system.

F. Individual sections of flexible ductwork shall be of one-piece construction. Splicing of short sections is not allowed.

G. Connect flexible duct liner to collars and rigid duct in accordance with manufacturer’s installation instructions. If manufacturer’s installation instructions do not include stainless steel draw-bands, provide stainless steel draw-bands in addition to manufacturer’s installation instructions. One draw-band shall secure flexible duct to rigid duct and another shall secure flexible duct outer jacket to rigid duct. If collars have beads, position draw bands behind beads.

H. Pull insulation and vapor barrier jacket over liner connection and secure with draw band. For terminations at externally insulated ductwork, fittings, grilles, diffusers, etc., secure flexible duct jacket to ductwork insulation jacket with compatible vapor barrier tape.

I. Flexible ducts are not allowed above non-accessible ceilings.

J. Flexible ducts are not allowed in high pressure ductwork.

K. Flexible ducts are not allowed for supply air systems serving BSL-3, BSL-3Ag, or BSL-4 spaces.

L. Flexible ducts are not allowed to pass through any partition, wall, floor or ceiling.

3.13 ACOUSTIC DUCT COVERING

A. Wrap outside of duct with inner layer material. Apply outer layer material over inner layer material. Do not rigidly tie outer layer material to ductwork.

B. If manufactured barrier materials are used, install in accordance with manufacturer's installation instruction.

C. Apply covering to the following ductwork:

END OF SECTION 23 31 14

SECTION 23 33 14 - DUCTWORK SPECIALTIES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01 8113 – Certification Requirements

B. Section 23 0595 - Air Systems Test Adjust Balance

C. Section 23 0902 - Control Valves and Dampers (Control Dampers)

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 LEED PERFORMANCE REQUIREMENTS

A. VOC Emissions Evaluation: For adhesives and/or sealants used for installation, products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1-2010 or CDPH Standard Method v1.2-2017, using the applicable exposure scenario. The manufacturers' or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

B. VOC content requirements for wet-applied products: For adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must meet the applicable VOC limits for Adhesive and Sealant Applications, as per the SCAQMD Rule 1168, October 6, 2017, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may be intentionally added in paints, coatings, adhesives, or sealants.

1.04 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

(1) Manufacturer's name and model number

(2) Capacities

(3) Temperature/pressure ratings

(4) Materials of construction

(5) Dimensions

(6) Manufacturer's installation instructions and/or detailed drawings

(7) All other appropriate data

B. LEED Submittals:

(1) Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

(a) VOC Emission Evaluation: Provide documentation that product complies with one of the following: SCS Indoor Advantage Gold, FloorScore, MAS Certified Green, UL Greenguard Gold or CRI Green Label Plus. The third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. The Claims of compliance must also state the range of total VOCs after 14 days, measured as specified in CDPH Standard Method v1.1 or CDPH Standard Method v1.2-2017.

(b) VOC content requirements for wet-applied products: Provide MSDS or manufacturers cutsheet showing VOC requirements testing and compliant according to SCAQMD Rule 1168, October 6, 2017, or Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264) or the CARB 2007 SCM for Architectural Coatings, SCAQMD Rule 1113, February 5, 2016, or European Decopaint Directive (2004/42/EC). If a product cannot be reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, Part 1; ASTM D6886-03; or ISO 11890-2. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealant

1.05 DESIGN CRITERIA

A. Products and materials shall conform to NFPA Section 90A, possessing flame spread rating of not over 25 and smoke developed rating no higher than 50.

B. Ductwork specialties exposed to air stream, such as dampers, turning vanes and access doors, shall be of same material as duct or unit at where the specialties are mounted, unless otherwise noted.

C. Unless otherwise noted, ductwork specialties shall be designed and constructed for pressure class of ductwork in which they are installed.

PART 2 PRODUCTS

2.01 MANUAL BALANCING DAMPERS

A. Manufacturers: Ruskin, Greenheck, Vent Products, Pottorff or Air Balance, constructed in accordance with SMACNA HVAC Duct Construction Standards, except as modified below.

B. Rectangular Dampers:

(1) For low pressure ductwork, for damper blade height up to 12”, use single blade type with minimum 22 ga galvanized steel blade with minimum 3/8” rod for blade width up to 18”, and with minimum 18 ga galvanized steel blade with minimum 1/2” continuous rod for blade width from 19” to 48”. For damper blade height more than 12”, use multiple blade type with minimum 16 ga galvanized steel channel frames, opposed blade linkage operation, with blades minimum 16 ga and 6” to 8” maximum blade width, minimum 1/2” continuous rod and 1/2” x 1/2" galvanized steel angle blade stops. Bearings shall be nylon or molded synthetic. Construct dampers over 48” in width or height in multiple sections with mullions.

(2) For high pressure ductwork, dampers shall be constructed to withstand maximum pressure of 5” WG WG at closed position and maximum velocity of 2000 fpm at open position. Frame and blades shall be constructed of minimum 16 ga with minimum 1/2” diameter or square rod.

C. Single Blade Round Dampers:

(1) For low pressure ductwork, damper shall have blade 24 ga, but no less than two gauges more than duct gauge. Rod shall be minimum 3/8” diameter or square continuous. Bearings shall be nylon or molded synthetic.

(2) For high pressure ductwork, damper blade shall be minimum 16 ga. Rod shall be minimum 1/2” square continuous and tack welded to blade. Provide sealed end bearing similar to Ventlok #609 and acorn nut type dial regulator similar to Ventlok #635 or 641.

D. Provide damper operators with locking devices and damper position indicators. Sheet metal screws are not allowed in construction or installation of dampers. Use rivets or tack welds.

E. Dampers shall be properly stiffened and fabricated to prevent vibration, flutter or other noise.

F. Extend damper shafts through duct insulation or use elevated regulators for externally insulated ducts to accommodate specified insulation thickness.

G. Segmented Blade (Iris) Dampers:

(1) Damper shall be segmented blade (iris) type with 22 ga galvanized steel or 316 stainless steel frame and blades. Casing leakage shall not exceed 6 cfm.

(2) Iris blade segments shall be internally linked and driven by manual adjustment knob. Linkage parts shall be fully encapsulated and out of air stream. Manual adjustment knob shall be factory calibrated to the exact aperture position and aligned with the K factor set point to provide linear response flow control.

(3) Accuracy of flow measurement shall be ±5%. Assembled units shall be furnished with specific charts designed for exact size and blade aperture configuration. Air pressure taps shall be integral to damper frame and positioned on either side of blade segments.

(4) Dampers shall be similar to Ruskin Model VFBD35.

2.02 SPLITTER VANES AND TURNING VANES

A. Radius Elbow Splitter Vanes (SMACNA Type RE-3):

(1) Splitter vanes for radius elbows shall be constructed in accordance with SMACNA HVAC Duct Construction Standards Chart 4-1, (p. 4.11) and Figure 4-9 (p. 4.13).

B. Turning Vanes (SMACNA Type RE-2):

(1) Turning vanes are not allowed unless specifically indicated.

2.03 BACKDRAFT DAMPERS

A. Manufacturers: Ruskin or Greenheck

B. Dampers shall be multi-blade, weighted type with counter-balanced blades and with 12 ga galvanized steel frame and extruded aluminum airfoil-shaped blades equal to Ruskin Type CBS 92. Blade edges shall have silicon rubber seals with ball bearings. Dampers shall be suitable for flange and gasket connection to ductwork or fan outlet.

C. Dampers shall be rated to maximum velocity of 4000 fpm, maximum temperature of 250°F and maximum system pressure of 5” WG for damper width of 60” and 14” WG for damper width of 12”.

D. Maximum damper leakage shall be 13.5 cfm/sf based on pressure differential of 1” WG.

2.04 FIRE DAMPERS

A. Manufacturers: Air Balance, NCA, Greenheck, Nailor, Cesco, Pottorff, Prefco, United Air, or Ruskin

B. Fire damper assemblies shall be listed by UL 555 with 165°F fusible link and shall meet construction standards as set forth in NFPA 90A.

C. Dampers shall be dynamic type dampers suitable for maximum air velocity and pressure to which they are subjected, but not less than 2000 fpm and 4” WG.

D. Dampers shall be curtain type with blades out of air stream when in open position. Where curtain type dampers are not available because of size, use multiple blade type dampers Fire damper shall be style B (High free area).

E. For round ducts, dampers similar to Ruskin Model FDR25 may be used where products are suitable for duct size, velocity and static pressure.

F. Damper fire rating shall be compatible with rating of building surface in which damper is used.

G. Submit UL installation details showing mounting method and duct connection method.

H. Where ceiling fire dampers are used, they shall be similar to Ruskin CFD(R) 2 or 3, UL Classified for installation in fire rated floor or roof/ceiling assemblies.

2.05 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Air Balance, NCA, Greenheck, Nailor, Cesco, Pottorff, Prefco, United Air, or Ruskin, similar to Ruskin FSD 60.

B. Dampers shall meet requirements of NFPA 90A. Dampers shall be 1-1/2 or 3 h rated as shown on drawings, smoke dampers and actuators shall be qualified for up to 30 minutes exposure at 250˚F, leakage rated at no higher than leakage Class I (4 cfm/ft2 at 1" WG and 8 cfm/ft2 at 4" WG) under UL 555/555S at temperature category 350°F, and compatible with system static pressures. Furnish dampers with factory-mounted, caulked sleeves and damper operators.

C. Dampers shall use airfoil shaped damper blades. Dampers shall be suitable for maximum air velocity and pressure to which they are subjected, but not less than 4” WG static pressure and 4000 fpm air velocity.

D. For round ducts, dampers similar to Ruskin Model FSDR 25 may be used up to air velocity 4000 fpm and pressure 4” WG.

E. Operators shall be 120 V electric powered with auxiliary switch built in for position indication, factory installed outside airstream, linked to dampers for fail closed operation, and be UL Listed and labeled for the application. Operators to be capable of closing damper at pressures encountered in system.

F. Dampers shall be furnished with heat sensor set at 165°F.

G. Furnish damper test switch similar to Ruskin Model DTS.

H. Duct smoke detectors shall not be provided for combination fire and smoke dampers per University of Arkansas fire marshal.

I. Submit UL installation details showing mounting method and duct connection method.

2.06 SMOKE DAMPERS

A. Manufacturers: Air Balance, Johnson Controls, Greenheck, Nailor, NCA Manufacturing, Cesco, Pottorff, Prefco, United Air, or Ruskin, similar to Ruskin SD-60.

B. Dampers shall be leakage rated at no higher than Leakage Class I (4 cfm/ft2 at 1" WG and 8 cfm/ft2 at 4" WG) under UL 555S at temperature category 250°F. Smoke damper and actuators shall be qualified for up to 30 minutes exposure at 250˚F. Furnish dampers with factory-mounted, caulked sleeve and actuator assemblies. Damper shall have 16 ga or heavier frame with air foil-shaped blades, rated to minimum 4” WG in closed position and to 4000 fpm in open position.

C. For round ducts, dampers equal to Ruskin Model SDRS 25 may be used.

D. Actuator assemblies shall be installed outside airstream, linked to damper for fail (normally) closed operation. Actuator shall be capable of closing damper at pressures encountered in system.

E. Size smoke dampers as close as possible to duct size, but in no case is damper size to be less than duct size.

F. Actuators shall be 120 V electric powered with auxiliary switch built in for position indication.

G. Furnish damper test switch similar to Ruskin Model DTS.

H. Duct smoke detectors shall not be provided for smoke dampers per University of Arkansas fire marshal.

2.07 ACCESS DOORS

A. Access doors shall be rectangular, minimum 22 ga frame and minimum 24 ga door, fit air tight with neoprene gasket and shall be suitable for duct pressure class. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners are not acceptable.

B. Low Pressure Ducts (Pressure Class 2” and Under):

(1) Doors shall be hinged type with sash lock for exposed application and non-hinged type with cam latches for concealed application.

(2) Access doors constructed in accordance with SMACNA HVAC Duct Construction Standard (Figure 7-2) or similar to Ruskin Model ADC or ADH will be acceptable.

(3) Sandwich style access doors made by Ductmate, Ward Industries, Greenheck, or Flexmaster are acceptable, provided that they meet insulation requirements.

C. High Pressure Ducts (Pressure Class 3" and Over):

(1) Use access doors factory fabricated and rated by manufacturer's published literature for installation in systems with pressures to positive or negative 10" WG.

(2) Sandwich access doors made by Ductmate, Ward Industries, Pottorf, Greenheck, or Flexmaster are acceptable, provided that they meet insulation requirements.

2.08 DUCT FLEXIBLE CONNECTIONS

A. Manufacturers: Unless specifically indicated, Ventfabrics, Inc., Ductmate or Duro Dyne. Material shall be glass fabric, fire retardant, waterproof, air tight and comply with NFPA 90A and 701 (formally UL 214).

B. General Supply, Return and Exhaust Ductwork:

(1) Material for indoor use to be 30 oz per square yard, double coated with neoprene, tensile strength (warp/fill) of 475 lbs / 375 lbs, tear strength of 13 lbs x 13 lbs, suitable for -40°F to 200°F continuous operation.

(2) Material for outdoor use shall be combination of inner layer of Duro Dyne Neoprene or similar and outer layer of 24 oz per square yard, coated with Hypalon, UV resistant, suitable for -40°F to 250°F, similar to Duro Dyne Durolon.

2.09 SOUND ATTENUATING DEVICES

A. Manufacturers: Semco, United McGill, Aeroacoustic, Vibro-Acoustics, VAW Systems, Price, or Ruskin

B. Units shall be tested in accordance with ASTM E-477-99 silencer test standard in aero-acoustic test facility which is NVLAP accredited for ASTM E-477-99 Standard. Each test shall have been conducted within last 12-month period. Submit copy of laboratory's NVLAP accreditation certificate on dynamic insertion loss, self-noise power levels, and aerodynamic performance.

C. Outer casing of units shall be not less than 22 ga G90 galvanized steel in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork for 8" WG or pressure class indicated for duct system, if it is higher than 8" WG. Seams shall be lock formed or continuously welded and mastic filled.

D. Acoustic Materials:

(1) Media shall be long fiber fiberglass protected with covering material and lined with not less than 26 ga galvanized perforated steel. Filler and facing material shall meet requirements of NFPA 90A with flame spread rating of 25 or less, and smoke development rating of 50 or less.

(2) Media shall be non-fiberglass containing 100% natural cotton fibers treated with EPA registered, non-toxic borate solution, "flash dried" to actively inhibit growth of mold, mildew, bacteria and fungi. Media shall not contain any formaldehydes, phenolic resins or Volatile Organic Compounds (VOC's) that can off-gas, and/or cause health concerns. Media shall be 100% recyclable. Media shall comply with UL181 and NFPA 90A. Media shall not cause or accelerate corrosion of aluminum or steel.

E. Covering Materials:

(1) Covering material shall be glass fiber cloth, high tensile strength, long strand glass fiber woven to thread count of 44 x 32 and have minimum weight of 6 oz per square yard, minimum breaking strength 250 x 200 lbs/in, similar to Burlington Style 1675, BGF Industries Style 1528, or JP Stevens Style 7628.

(2) Covering material shall be Mylar film.

(3) Provide spacers between covering material and perforated metal.

F. Ends of attenuators shall be covered at factory with plastic, heavy-duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuators. Caps shall not be removed until attenuator is installed in duct system.

G. Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

H. Sound Attenuating Devices for Exhaust Air Terminal Units Serving Fume Hood and Snorkel Exhaust:

(1) Tubular type constructed entirely of Type 304 stainless steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be continuously welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8" WG, inside to outside of casing.

(2) Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

I. Sound Attenuating Devices for General Exhaust Air Terminal Units of Laboratory or Vivarium Exhaust Systems:

(1) Tubular type constructed entirely of galvanized steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be continuously welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8" WG, inside to outside of casing.

(2) Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

J. Sound Attenuating Devices for Fume Hood Exhaust Fans:

(1) Provide units at exhaust fan intakes and discharges as scheduled. Unit length shall be as scheduled.

(2) Rectangular type constructed entirely of Type 304 stainless steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be continuously welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8" WG inside to outside of casing.

2.10 LOUVERS

A. Louvers will be provided by General Contractor.

2.11 BIRD AND INSECT SCREENS

A. Bird screens shall be 1/2" square mesh formed with 0.063" diameter aluminum wire. Insect screen to be 18 x 16 with 0.017" diameter aluminum mesh.

B. Frame shall be removable type of minimum 12 ga, extruded aluminum.

2.12 AIR FLOW MEASURING UNITS

A. Furnished by Control Contractor.

2.13 ELECTRONIC REMOTE OPERATED VOLUME CONTROL DAMPERS

A. Similar to Pottorff Model RD-10 or Greenheck Model RBDR-50, furnished with handheld remote and wall/ceiling plates.

2.14 PRESSURE RELIEF DOORS

A. Similar to Ruskin Model PRD 18, Kees Model BO, or Pottorff Model PPR-B0 for positive pressure and Ruskin Model NRD 18, Kees Model BI, or Pottorff Model NPR-BI for negative pressure applications.

B. Doors and frames shall be 12 ga galvanized steel with seal around door perimeter. Use galvanized steel or stainless steel to match ductwork material. Doors shall be double-wall, insulated, when installed in insulated ductwork.

C. Doors shall open automatically to relieve excess pressure above set point and to close when pressure is reduced to less than 3" WG. Setting shall be adjustable from 3" to 8" WG with 1" WG increments in between.

2.15 INSTRUMENT TEST HOLES

A. Manufacturers: Ventlok 699 (up to 1" insulation thickness) or Ventlok 699-2 (over 1" insulation thickness).

B. Use concave gaskets for round ductwork.

2.16 CONTROL DAMPERS

A. Furnished by Control Contractor.

PART 3 EXECUTION

3.01 MANUAL BALANCING DAMPERS

A. Install manual balancing dampers in supply, return and exhaust branch ducts, as shown on drawings and as required to regulate airflow to meet air balance requirements.

B. Install manual balancing damper in branch duct to each diffuser and grille. Install dampers as close as possible to take-offs.

C. Install balancing dampers so as not to flutter or vibrate and as far as possible upstream from the air outlet.

D. Do not install balancing dampers in supply ductwork upstream of air terminal devices.

E. Balancing dampers are not required for exhaust ductwork at outlet side of air terminal devices.

F. Balancing damper is not required where terminal air device serves a single diffuser or grille.

G. Do not install manual balancing dampers in the following exhaust ductwork:

(1) Fume hood exhaust ductwork.

3.02 SPLITTER VANES AND TURNING VANES

A. Install splitter vanes (SMACNA Type RE-3) as shown on drawings and as specified in Section 23 3114 – Ductwork, for rectangular radius elbows. Install splitter vanes in accordance with SMACNA Standards and/or manufacturer's recommendations.

B. Turning vanes (SMACNA Type RE-2) are not allowed unless specifically indicated.

3.03 BACKDRAFT DAMPERS

A. Install backdraft dampers where indicated on drawings.

B. Where motorized dampers are shown in exhaust fan discharge duct, or in duct connecting to relief or exhaust louver, backdraft dampers are not required unless specifically indicated. Where motorized dampers are not shown, provide backdraft dampers in these locations.

3.04 FIRE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

A. Install dampers where shown on drawings in accordance with manufacturer's installation instructions and requirements of NFPA 90A. Install dampers complete with mounting collars, retaining angles, connections to adjoining ductwork and duct access doors. Install duct access door at each damper with door size large enough to permit replacement of fusible links and resetting of dampers.

B. Test and demonstrate proper operation of each damper after system is installed and ready for operation.

(1) Manually test each damper for proper operation by removing fusible link or actuating EFL or PFL. Repair or replace any damper that does not close completely. Replace fusible link and certify in writing that each damper was installed according to manufacturer's installation instructions and that each damper can be expected to close completely when fusible link melts.

(2) Notify Owner and/or Owner’s representative at least 48 h prior to testing to allow for witnessing.

C. Contractor shall provide letter from manufacturer's representative indicating that dampers are installed per manufacturer's installation instructions.

3.05 ACCESS DOORS

A. Install access doors where specified, indicated on drawings, and in locations where maintenance, service, cleaning or inspection is required, including automatic dampers, fire dampers, smoke dampers, fan bearings, heating and cooling coils, reheat coils, humidifiers, filters, bird/insect screens, valves and control devices within duct or casing, at outside air intake duct and at inlet side of turning vanes in return ductwork.

B. Locate access doors for greatest ease of access.

C. Size and quantity of duct access doors shall be sufficient to perform intended service, but not less than the following:

Rectangular Duct Size	Minimum Access Door Quantity and Size
10”and smaller	(1) 8” x 8”
12” to 15” and smaller	(1) 10” x 10”
16” to 21”	(1) 14” x 14”
22” to 27”	(1) 18” x 18”
28” to 51”	(1) 24” x 24”
52” to 96”	(2) 24” x 24”
Round Duct Size	Minimum Access Door Size
10” and smaller	8” x 4”
15” and smaller	12” x 8”
29” and smaller	16” x 12”
30” and over	24” x 18”

D. Increase duct size to accommodate access door size indicated above where required.

E. Access doors for life safety dampers shall be adequate size for inspection and maintenance, but not less than 12” x 12”. If adjacent duct or damper is smaller than 12” x 12”, provide larger size duct or damper to accommodate minimum access door size without transition.

3.06 DUCT FLEXIBLE CONNECTIONS

A. Connect ductwork to fans or casings containing rotating equipment or mounted on vibration isolators with duct flexible connections. Installed width shall be suitable for specific application but shall not be less than 4”. Install flexible connections in accordance with SMACNA Standards with double lock or "Grip Loc" connection.

3.07 SOUND ATTENUATING DEVICES

A. Install sound attenuating devices as indicated on drawings and/or as scheduled.

B. For modular installation of sound attenuators, install galvanized steel holding frame, gaskets, seals, supports and fasteners in accordance with manufacturer's recommendations for multiple unit installation.

3.08 BIRD AND INSECT SCREENS

A. Provide bird screens or insect screens as indicated on drawings at louvers and at intake/exhaust openings.

B. Unless otherwise indicated, provide bird screens where filters are specified and insect screens where filters are not specified.

3.09 AIR FLOW MEASURING UNITS

A. Install where indicated on the drawings and/or as scheduled and in accordance with manufacturer's recommendations.

3.10 REMOTE OPERATED VOLUME CONTROL DAMPERS

A. Install remote operated volume control dampers and remote operators as indicated on drawings and where manual balancing dampers cannot be accessed.

B. Install connecting wire in the wall.

3.11 PRESSURE RELIEF DOORS

A. Install doors vertically where shown on drawings and in accordance with manufacturer's recommendations.

3.12 CONTROL DAMPERS

A. Install dampers in locations indicated on drawings, as detailed and according to manufacturer's instructions.

B. Install blank-off plates or transitions as specified in Control Sections.

C. Provide adequate operating clearance and access to operators.

D. For dampers located outdoor, provide weather protection enclosure for parts of damper such as linkage and actuator located outside of duct. Enclosure shall be removable and made of galvanized steel sheet.

3.13 SMOKE DAMPERS AND DETECTORS

A. Install smoke dampers in locations indicated on drawings. Allow room for operator installation and access to operator. Install access door in ductwork for access to damper. When damper is installed in location other than in smoke or fire rated wall, use SMACNA seal class A for ductwork between smoke damper and smoke rated wall for affected zone.

3.14 INSTRUMENT TEST HOLES

A. Provide instrument test holes at air entering and air leaving side of all internal air handling system components for static pressure differential (Delta P) or temperature differential (Delta T) measurements.

B. Provide ductwork instrument test holes as shown on drawings, or as directed by TAB personnel, or Engineer.

END OF SECTION 23 33 14

SECTION 23 34 00 - FANS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0514 - Variable Frequency Drive (VFD) System

C. Section 23 0550 - Vibration Isolation

D. Section 26 2816 - Enclosed Switches and Circuit Breakers

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

(1) Manufacturer's name and model number
(2) Identification as referenced in the documents
(3) Capacities/ratings
(4) Fan curves
(5) Materials of construction
(6) Sound power levels
(7) Fan type, size, class, drive arrangement, discharge/rotation, bearings, drives
(8) Wheel type, diameter, rpm, tip speed
(9) Required fan hp including drive losses
(10) Motor data (refer to Section 20 0513 - Motors)
(11) Vibration isolators furnished with fans
(12) Dimensions and weights
(13) Special coatings where applicable
(a) Product descriptive data
(b) Complete chemical resistance charts
(c) Coating manufacturer’s base metal preparation requirements (cleaning/pretreatment)
(d) Facility where special coatings will be applied
(e) Recommended method of repairing damaged coating
(14) Color selection charts where applicable
(15) Manufacturer's installation instructions
(16) All other appropriate data

B. Fan curves shall include series of curves indicating relationship of flow rate (cfm) to static or total pressure for various fan speeds, brake hp curves, and selection range (surge curves, maximum rpm, etc.).

C. Indicate performance data, based on both design air quantity and 110% of design air quantity.

D. For variable air volume application, indicate operating points at 100, 80, 60 and 40% of design capacity on fan curves including data to indicate effect of variable frequency drives on flow, pressure and hp.

1.04 DESIGN CRITERIA

A. Fan ratings shall be tested and certified in accordance with AMCA Standards 211 and 311 and fans shall bear AMCA Seal.

B. Fans shall be furnished complete with motors, wheels, drive assemblies, bearings and accessories as hereinafter specified. Motors for V-belt drives shall be furnished with adjustable rails or bases.

C. Where backward Inclined or backward curved (BI) centrifugal fans are indicated, fans shall have solid (single-thickness) blades.

D. Each fan wheel shall be statically and dynamically balanced to Balance Quality Grade G6.3 per ANSI S2.19 and AMCA 204-05. Complete fan assembly shall be factory balanced statically and dynamically in accordance with Standard AMCA 204-05 for Balance Quality and Vibration Levels for Fans and meet or exceed guidelines in Application Category BV-3.

E. For fans furnished with 5 hp or larger hp motors, each fan assembly shall have factory run test including vibration signatures taken on each bearing in horizontal, vertical and axial direction. Filter-in reading as measured at fan's scheduled rpm shall not exceed the following values when fan is rigidly mounted.

(1) Belt Drive (except Vane Axial) 0.15 inch (3.81 mm)/sec peak velocity

(2) Belt Drive Vane Axial 0.08 inch (2.03 mm)/sec peak velocity

(3) Direct Drive 0.08 inch (2.03 mm)/sec peak velocity

(4) Written records of run test and vibration test shall be available upon request.

F. Unless otherwise indicated, vibration level of installed fan assembly flexibly mounted shall not exceed 0.35 inch (8.89 mm)/sec.

G. Unless otherwise indicated, belt drives shall be V-belt drives selected for 150% of motor nameplate hp.

H. Furnish fans specified with V-belt drives with either variable-pitch or fixed-pitch sheaves for drives 3 hp and smaller and fixed-pitch sheaves for drives 5 hp and larger. Select variable pitch sheaves to drive fan at such speed as to produce specified capacity at approximate midpoint of sheave adjustment.

I. When fixed-pitch sheaves are furnished, system air balancing shall be accomplished by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves. This Contractor shall provide necessary trial and final sheaves and drive belts as required by TAB Contractor.

J. Select each fan to operate at single stable operating point as predicted by fan curve. Fans having 2 potential operating points on fan curves are not acceptable.

K. Provide OSHA Compliant belt and shaft guards for belt driven fans. Provide speed test openings at shaft locations. Paint guards bright yellow.

L. Sound power levels shall be based on tests performed in accordance with AMCA Standards 300 and 301.

M. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. Motor furnished with fan shall not operate into motor service factor in any of these cases.

N. Consider drive efficiency in motor selection according to manufacturer's published recommendation, or according to AMCA Publication 203, Appendix L.

O. Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of change and system effect factor calculations indicating increased static pressure requirements as described in AMCA Publication 201. This Contractor shall be responsible for costs associated with any motor, drive, and/or wiring changes required as a result of duct configuration changes at fan.

P. Exhaust fans serving fume hoods shall be marked with arrows to indicate proper direction of rotation.

Q. Fans having spark resistant construction shall be electrically grounded so as to prevent static electricity from building up.

PART 2 PRODUCTS

2.01 CENTRIFUGAL SIDEWALL EXHAUSTER

A. Manufacturers: Greenheck, Twin City, Cook, PennBarry, Jenn-Air, ACME, or Carnes.

B. Exhausters shall be dome type with spun aluminum housing, solid (single-thickness) backward inclined (BI), non-overloading centrifugal wheel, and motor housed in separate ventilated compartment.

C. Exhausters shall be belt or direct driven, as scheduled, with factory mounted NEMA standard disconnect switches.

D. Provide with gravity backdraft dampers and birdscreen.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install units as shown on drawings, and according to manufacturer's installation instructions. On units provided with drain connection, install drain valve and cap discharge of drain.

B. Verify lubrication of motor and fan bearings and lubricate properly in accordance with manufacturer's recommendation and Section 20 0000, Part 3 under LUBRICATION.

C. Perform field mechanical balancing, if necessary, to meet vibration tolerance specified in Part 1 of this Section.

END OF SECTION 23 34 00

SECTION 23 36 00 - AIR TERMINAL DEVICES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0993 - Control Sequences

C. Section 23 3114 - Ductwork (Support)

D. Section 23 3314 - Ductwork Specialties (Access Doors)

E. Section 23 8214 - Heating and Cooling Terminal Devices

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

(1) Manufacturer's name and model number

(2) Identification as referenced in the documents

(3) Capacities/ratings

(4) Materials of construction

(5) Sound rating data

(6) Dimensions

(7) All other appropriate data

B. LEED Submittal:

(1) Product Data for IEQ Prerequisite 1: Documentation indicating that units comply with ASHRAE 62.1 – 2010, Section 5 – “Systems and Equipment.”

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70 by qualified testing agency and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1 – 2010, Section 5 – “Systems and Equipment” and Section 7 – “Construction and System Start-Up.”

1.05 DESIGN CRITERIA

A. Where any of air terminal devices are indicated on drawings to control space conditions in conjunction with reheat coil, that reheat coil may be furnished as integral part of or standard accessory to devices specified below. See related work above.

B. When air terminal devices are furnished with reheat coils, either integrally or remotely mounted, control panels of terminal devices shall be mounted on the same side of air terminal device as reheat coil piping connection.

C. Unless otherwise stated, units shall be system pressure independent and maintain air volume within ± 5% of required airflow regardless of system air pressure. Inlet velocity pressure sensor shall be multi-point center averaging type and be capable of amplifying pressure signals.

D. Unless otherwise stated, unit casings shall be constructed of galvanized steel or aluminum meeting SMACNA or ASHRAE Standards, but not lighter than 22 ga.

E. Joints and seams of air terminal devices shall be sealed with appropriate sealant to minimize casing air leakage.

F. Unit leakage test shall comply with ASHRAE Standard 130 – Laboratory Methods of Testing Air Terminal Units.

G. Unit performance shall be certified in accordance with AHRI Standard 880 including sound rating data certified for both casing discharge and radiated sound levels from 125 through 4000 Hz.

H. Supply air units shall be capable of operating from minimum inlet static pressure scheduled to 3” WG.

I. Provide supply air units with internal thermal insulation faced with minimum 0.001” thick aluminum foil. Insulation shall be compressed glass fiber with minimum 3/4” thick, 4 lb/ft3 density with R-value of 3.5(h·ft2·°F)/Btu. Insulation and facing shall meet requirements of UL 181 (Air Erosion, Mold growth and Humidity), and NFPA 90A (Flame 25/Smoke 50) and ASTM C665 (Fungi Resistance). Secure liner with full-seam-length, galvanized steel angles or Z-strips, which enclose and seal all edges. Tape or adhesive will not be acceptable. Liner assembly shall be similar to Titus Steri-Loc.

J. Supply air units shall be lined with engineered polymer foam insulation, minimum 3/4" thick, 1.5 lb/ft3 density and thermal conductivity not more than 0.25(h·ft2·°F)/Btu at 75°F. Insulation shall meet requirements of UL 181 (Air Erosion, Mold Growth and Humidity), NFPA 90A (Flame 25/Smoke 50) and ASTM C665 (Fungi Resistance).

K. Sound attenuators, where specified or required to meet sound performance specified for air terminal devices, shall be constructed of all metal or sound attenuating fiber material with erosion protection liner as required to meet sound requirement specified. Refer to Section 23 3314 - Ductwork Specialties for sound attenuators and erosion protection.

L. Unit manufacturer or manufacturer's designated representative will be required to verify air terminal device performance and adjust or replace device within warranty period when it is determined that problem exists in area served by device.

1.06 CONTROLS COORDINATION

A. Unit manufacturer shall provide unit inlet flow sensor, pneumatic tubing and control enclosure for Control Contractor's use.

B. Control Contractor shall furnish all actuators, linkages if required, differential pressure transmitters, controllers and any other devices required for unit control that are not provided by unit manufacturer for unit manufacturer's factory mounting. Unit manufacturer and Control Contractor shall coordinate for proper factory installation.

C. Unit manufacturer shall factory install devices furnished by Control Contractor to result in complete functioning unit. Unit manufacturer shall be responsible for reviewing compatibility of devices furnished by Control Contractor with units being provided.

D. Control Contractor's field mounting will be acceptable, provided Control Contractor coordinates proper installation with unit manufacturer. Control Contractor shall be responsible for complete functioning unit.

PART 2 PRODUCTS

2.01 VARIABLE VOLUME AIR TERMINAL DEVICES

A. Manufacturers: Titus, Price, Krueger, Enviro-Tec (ETI), Nailor, Carnes, Tuttle and Bailey, Metalaire, Trane, JCI or Carrier

B. Units shall be suitable for 24 V electric control system. Control Contractor shall be responsible for wiring from control panels to each terminal unit.

C. Furnish units with reheat coils having capacities as indicated in schedules.

D. Casing leakage rates shall not exceed the following maximum values:

A. Unit Size	Max. Casing Leakage (cfm)	
	0.5" WG	1.0" WG
4, 5, 6	2	3
7, 8	4	5
9, 10	4	6
12	5	7
14	6	9
16	7	10

E. Provide access doors for all air terminal devices with reheat coils at inlet side of coils. Refer to Section 23 3314 - Ductwork Specialties for access doors. Unit manufacturer's standard access doors are acceptable, provided that access doors are appropriately sized and internally lined with same materials as unit casing. If access doors are provided in separate sections as extension of units, these sections shall be internally lined in same manner as units.

2.02 RETURN OR EXHAUST AIR TERMINAL DEVICES

A. Manufacturers: Titus, Price, Krueger, Enviro-Tec (ETI), Nailor, Carnes, Tuttle and Bailey, Metalaire, Trane, JCI or Carrier

B. Units shall be suitable for 24 V electric control system. Control Contractor shall be responsible for wiring from control panels to each terminal unit. Units shall be similar to Titus Model ECV.

C. Unit casing shall be minimum 22 ga galvanized steel unless otherwise specified.

D. Damper shall be heavy gauge steel. Shaft shall be steel with bronze iolite self-lubricating bearings. Damper shall incorporate mechanical stop to prevent overstroking and synthetic seal to limit close-off leakage to 2% of the nominal catalog rating at 3" water gauge inlet static pressure when tested in accordance with ASHRAE 130.

E. Unit shall incorporate multi-point, center averaging velocity sensor. Sensor shall provide signal measurable by controller at inlet velocities of 500 fpm. Sensor shall provide control signal accuracy of ±5%, with the same size inlet duct at any inlet condition. Multi-point flow sensor shall be able to be readily removable for servicing and replacing without removal of connected duct.

2.03 VENTURI TYPE AIR TERMINAL DEVICES

A. Refer to Specification 23 3614 Laboratory Temperature and Airflow Control System.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install units as shown on drawings and according to manufacturer's installation instructions.

B. Install units with sufficient service space to unit control, actuators and access panels.

C. Provide minimum length of 3 times box inlet diameter of straight rigid duct at box inlet.

D. Provide access doors for terminal devices with reheat coils at inlet side of coils.

E. Provide access panels compatible with ceiling for all units located above non-accessible ceilings.

F. If air terminal devices that are not factory lined with thermal insulation are used for supply air application, provide external insulation in accordance with Section 20 0700 - Mechanical System Insulation.

END OF SECTION 23 36 00

SECTION 23 37 13 - DIFFUSERS, REGISTERS AND GRILLES

SECTION 23 37 13 – DIFFUSERS, REGISTERS AND GRILLES

PART 1 GENERAL

2.01 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

2.02 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

(1) Manufacturer's name and model number
(2) Identification as referenced in the Documents
(3) Capacities/ratings
(4) Materials of construction
(5) Sound ratings
(6) Dimensions
(7) Finish
(8) Color selection charts where applicable
(9) Manufacturer's installation instructions
(10) All other appropriate data

2.03 DESIGN CRITERIA

A. Performance data shall be based on tests conducted in accordance with ASHRAE Standard 70-2006.

B. Screw holes on surface shall be counter sunk to accept recessed type screws.

PART 2 PRODUCTS

3.01 MANUFACTURERS

A. Titus, Price, Carnes, Nailor, Anemostat, Metalaire, Krueger, Tuttle & Bailey, Trane, and Envirotec.

B. Acceptable manufacturers for specialty products are listed under each item.

3.02 CEILING DIFFUSERS

A. Diffusers shall be aluminum or steel as scheduled, unless otherwise indicated, and furnished with frame type appropriate to installation. Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 times duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

B. Diffuser models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, diffusers shall have baked enamel or powder coat finish with color selected by Architect.

C. Perforated face ceiling diffusers shall have minimum 51% free face area and pattern controllers accessible through removable or hinged faceplate. Unless otherwise indicated, pattern controllers shall be curved vane type mounted in neck of diffuser. Unless otherwise indicated, furnish diffusers with round neck inlets with minimum 1” depth.

3.03 ARCHITECTURAL SQUARE PANEL CEILING DIFFUSERS

A. Architectural square panel ceiling diffusers shall be similar to Titus Model OMNI diffuser.

B. Diffusers shall have one piece 18 ga face panels. Face panel shall be removable by means of four positive locking posts. Exposed surface of face panel shall be smooth, flat, and free of visible fasteners and have rounded off corners. Face panel shall project no more than 3/8” below outside border of diffuser back pan. Back of face panel shall have an aerodynamically shaped, roller edge to ensure tight horizontal discharge pattern.

C. Ceiling diffusers with 24” x 24” full face shall have no less than 18” x 18” face panel size.

D. Back pan shall be one piece die-stamped and shall include integrally drawn round inlet. Diffuser back pan shall be constructed of 22 ga steel. Diffuser neck shall have minimum of 1-1/4” depth available of duct connection. Back pan shape with face panel shall deliver 360□ radial horizontal air pattern.

E. Unless otherwise indicated, diffusers shall have baked enamel or powder coat finish with color selected by Architect.

3.04 REGISTERS AND GRILLES

A. Registers and grilles shall be aluminum or steel as scheduled unless otherwise indicated, and furnished with frame type appropriate to installation.

B. Supply registers and grilles shall be double deflection type blades to provide for air deflection adjustment in all directions.

C. Exhaust registers and grilles shall have fixed blade core.

D. Exhaust registers and grilles shall include roughing filters where scheduled.

E. Registers shall be furnished complete with opposed blade volume control dampers, operable from face.

F. Register and grille models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, registers and grilles shall have baked enamel finish with color selected by Architect.

3.05 ADJUSTABLE LINEAR DIFFUSERS

A. Linear diffusers shall be extruded aluminum and furnished with frame type appropriate to installation with diffuser elements being removable from frame. Diffuser vanes shall provide both air pattern and flow rate adjustment with air pattern having full 180° adjustment. Diffuser vanes of single slot shall be segmented on 2 ft or 3 ft centers.

B. Diffuser models, lengths and slot sizes shall be as shown on drawings and/or as scheduled. Unless otherwise indicated, frame face shall have baked enamel or powder coat finish with color selected by Architect. Diffuser vanes and frame interior shall be finished in flat black.

3.06 FIXED BLADE LINEAR DIFFUSERS AND GRILLES

A. Linear diffusers and grilles to be extruded aluminum with frame type appropriate to sidewall, sill or ceiling installation as indicated.

B. Diffuser and grille models, lengths, blade spacing and blankoff strips to be as shown on drawings and/or as scheduled.

C. Diffusers used for supply air to be furnished with straightening or equalizing vanes. Blades to be fixed at 0 or 15□ deflection as scheduled.

D. Unless otherwise indicated, diffusers and grilles shall have anodized aluminum finish with color selected by Architect.

PART 3 EXECUTION

4.01 INSTALLATION

A. Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.

B. Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar sizes.

C. Seal connections between ductwork drops and diffusers/registers/grilles air tight.

D. Support independently diffusers and grilles designed for T-bar mounting that exceed weight limit of ceiling suspension system in which they are to be installed.

E. Unless otherwise shown, provide wire mesh screen at end of each open ended duct (OED) that is exposed in occupied spaces.

F. Blank off unused portion of linear diffusers and grilles.

G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

H. Protect diffusers, registers and grilles from construction dirt. Clean or replace those soiled or stained prior to turnover to Client.

I. In clean rooms and animal holding rooms, caulk space between diffuser or grille and ceiling or wall to be air and water tight. Use clear, non-hardening silicone sealant compatible with ceiling or wall surface. Sealant shall be resistant to microbiological growth and shall meet CGMP requirements. Refer to Section 20 0000 – General Mechanical Requirements for sealant.

END OF SECTION 23 37 13

SECTION 23 41 14 - FILTERS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01 8113 – Certification Requirements

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 LEED PERFORMANCE REQUIREMENTS

A. Provide MERV 13 or greater filters on all equipment that supplies outdoor air. Refer to filter schedules on drawings for required MERV ratings.

1.04 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

(1) Manufacturer's name and model number
(2) Identification as referenced in the Documents
(3) Capacities/ratings; cfm, area, face velocity
(4) Efficiencies and initial/final pressure drop
(5) Materials of construction
(6) Dimensions
(7) Filter gauges data
(8) Manufacturer's installation instructions
(9) All other appropriate data
(10) LEED Submittals: Provide filter cut sheets highlighting MERV rating of 13 or higher. Refer to filter schedules on drawings for required MERV ratings.

1.05 DELIVERY, STORAGE AND HANDLING

A. Ship filters in original package to prevent damage or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer’s recommendations. Provide protective coverings during construction.

1.06 DESIGN CRITERIA

A. Filters shall have UL 900 Listing.

B. Holding frames or housings specified in this Section may be furnished by filter manufacturers listed below, or where applicable, as part of factory packaged air handling units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. American Air Filter/Flanders, Camfil, Flanders Precisionaire, Glasfloss, Airguard or Filtration Group unless otherwise noted under individual filter.

2.02 DISPOSABLE PANEL FILTERS

A. Similar to Camfil Farr 30/30 or Flanders Precisionaire PrePleat 40.

B. Media shall be non-woven, fine fibered material laminated to rigid backing to hold pleat formation, having minimum efficiency MERV 8 based on ASHRAE Test Standard 52.2 (average dust spot efficiency of 30 to 35% based on ASHRAE Test Standard 52.1).

C. Filter housing shall consist of air handling or cabinet fan unit manufacturer's low velocity filter section, or holding frame, as scheduled. When holding frame is indicated, it may be furnished by filter manufacturer or it may be contractor fabricated.

D. Filters shall be 2” thick of size and capacity as scheduled. Clean filter pressure drop shall not exceed 0.31” WG based on 500 fpm face velocity.

2.03 DISPOSABLE RIGID CARTRIDGE TYPE AIR FILTERS

A. Similar to Camfil Durafil ES RIGA-FLO or Flanders Precisionaire

B. High performance deep pleated, rigid, disposable type filters. Each filter shall consist of high efficiency media, enclosing frame, contour stabilizers on both air entering and exiting sides and support grilles. Filters shall be designed to withstand minimum differential pressure of 6” WG without structural damage to filter frame, seals or media.

C. Filter thickness, size and capacity shall be as scheduled.

D. Filters shall have minimum efficiency MERV 14 based on ASHRAE Test Standard 52.2 (average efficiency of 90-95% based on ASHRAE Test Standard 52.1). Initial resistance at 500 fpm face velocity shall not exceed 0.57" WG.

2.04 SIDE ACCESS FILTER HOUSINGS

A. Provide for all prefilter and afterfilter banks as scheduled.

B. Construct housings with galvanized steel with aluminum or galvanized steel filter mounting tracks. Mounting tracks shall have gaskets to minimize air bypass around filters.

C. Each housing shall have door on both sides to facilitate changing filters. Doors shall have perimeter gaskets to minimize air leakage, shall be hinged, and shall have cam-lock or lever handle latches to secure the door. Doors shall not be secured with nuts and bolts or sheet metal screws.

D. Each prefilter housing in 2 filter bank air handling unit or each filter housing in single filter bank air handling unit shall include integral prefilter track for 2" prefilters.

E. Each prefilter housing in 2 filter bank air handling unit shall be internally insulated by manufacturer or externally insulated in the field. Factory applied internal insulation shall have thermal resistance equivalent to that specified for duct in which housing is located, shall have internal vapor barrier, and shall have flame spread and smoke developed ratings as specified in Section 20 0700 - Mechanical Systems Insulation. Afterfilter housings in air handling units shall be externally insulated in the field.

2.05 FILTER HOLDING FRAMES

A. Frames shall be minimum 16 ga galvanized steel construction with provisions for assembly in a bank. Frames shall be suitable for filters scheduled and incorporate replaceable gaskets. Filter frames for all AHU filters shall be similar to Camfill Fast frame or approved equal.

2.06 LOW VELOCITY FILTER SECTIONS

A. Provide for factory packaged, air handling units and cabinet fans as indicated.

B. Housing shall consist of modular steel section with hinged access doors for filter replacement. Each housing shall be internally insulated by manufacturer or externally insulated in the field. Factory applied internal insulation shall have thermal resistance equivalent to that specified for duct in which housing is located, shall have internal vapor barrier, and shall have flame spread and smoke developed ratings as specified in Section 20 0700 - Mechanical Systems Insulation.

2.07 FILTER PRESSURE DROP GAUGES

A. Dwyer Series 3000 MRS Photohelic pressure switch/gauge. Differential pressure switch shall be SPST (NO) solid state relay and will be used by BAS contractor for dirty filter alarm. Switch setting shall be externally adjustable.

B. Unless otherwise indicated below, select scale range to be most appropriate to clean and dirty filter pressure drops.

Filter Type	Scale Range (" WG)
Throwaway filters	0-0.5
Filters with 25 to 30% efficiency based on atmospheric dust spot test	0-1.0
Filters with 31 to 99% efficiency based on atmospheric dust spot	0-2.0

C. Provide gauges for each filter bank, including gauges across each individual filter bank in built-up rack assemblies, suitable for flush mounting in a panel, including air filter gauge accessory package for use with 1/4" OD copper tubing.

D. Provide 3/4" spacer at one 2' x 2' filter section between filter elements in built-up rack, adjacent to unit wall for placement of intermediate pressure probe.

2.08 ADDITIONAL FILTER MEDIA

A. For disposable panel filters, enough media for 3 filter changes, shall be provided for each air handler. Media used during construction shall be replaced when system is air balanced. Third set of media not used shall be turned over to Owner as spare.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install filters as shown on drawings and according to manufacturer's instructions.

B. Provide supports as required and necessary clearance for changing filters.

C. Provide structural supports, outside casing and blank-off materials for all field assembled filter banks, and filter banks where housings are not furnished by filter manufacturer.

3.02 FILTER PRESSURE DROP GAUGES

A. Mount gauge near each filter bank and install static pressure sensors according to manufacturer's instructions.

B. Mount gauge on control panel.

3.03 FILTER HOLDING FRAMES

A. Provide frames for all filter banks as required. Install built-up filter banks in accordance with manufacturer's installation instructions.

END OF SECTION 23 41 14

SECTION 23 72 14 - HEAT RECOVERY EQUIPMENT

PART 1 GENERAL

1.01 RELATED WORK

A. Section 23 33 14 Ductwork Specialties

B. Section 23 73 28 Factory Fabricated Custom Air Handling Units

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

(1) Manufacturer's name and model number

(2) Capacities/ratings/efficiencies

(3) Pressure/temperature rating

(4) Materials of construction

(5) Dimensions and weights

(6) All other appropriate data

1.04 CHECK, TEST AND START

A. Heat recovery equipment installed within air handling unit shall be inspected and verified by heat recovery equipment manufacturer’s representative to ensure installation in accordance with manufacturer’s recommendation.

B. AHU manufacturer shall provide cost for commissioning field testing and certification of heat recovery equipment.

1.05 WARRANTY

A. Standard 5 year material and labor warranty shall be provided for heat pipe heat exchanger. Components such as valves and dampers shall have 12 month warranty.

PART 2 PRODUCTS

2.01 AIR-TO-AIR HEAT EXCHANGERS (HEAT PIPE TYPE)

A. General:

(1) Manufacturers: Heat Pipe Technology, Carolina Heat Pipe, or approved equal

(a) Heat pipes serving DOAS-1 shall be similar to Innerygy Tec with refrigerant modulating control valves for capacity control. Ducted exhaust air bypass with modulating damper shall be provided for each energy recovery unit as shown on mechanical drawings.

B. Unit’s capacity, efficiency and operating characteristics to be as scheduled.

C. Units shall be capable of operating at temperatures from minimum of -60ºF up to maximum of 125ºF.

D. Entire unit must be capable of withstanding entrained moisture from outside air.

E. Casings:

(1) Construct casings from minimum #16 ga galvanized steel, of design proven to mount and support such coils in ductwork or in a piece of apparatus. Furnish all casings with minimum of 1-1/2” wide flange on each of 4 sides, both front and back for mounting. Punch both slots for mounting on 3” centers throughout. Furnish intermediate core supports to prevent sagging or bowing when mounted in recommended manner.

(2) Furnish protective end covers to protect tube ends, which extend through casing. End covers to be constructed of #20 ga galvanized steel and will be factory sealed.

(3) Furnish units with condensate drain pans.

F. Coils:

(1) Construct tubes of 1/2” OD copper. Construct fins of continuous aluminum plate, 0.006” thick, and of corrugated design of product maximum heat transfer efficiency.

(2) Use refrigerants classified as Group I in ASHRAE/ANSI Standard for Mechanical Refrigeration.

(3) Furnish vertical partition to completely isolate exhaust and supply airstreams from each other so that there will be no cross contamination.

G. Special Requirements:

(1) Finish units exposed to exhaust airstream with baked phenolic coating for corrosion protection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install units as shown on drawings, and in accordance with manufacturer's installation instruction.

B. Install Dwyer Series 2000 magnehelic pressure gauge across unit in supply air stream.

C. Install thermometer at each side of unit in both supply and exhaust.

3.02 AIR-TO-AIR HEAT EXCHANGERS (HEAT PIPE TYPE)

A. Provide filter racks upstream of supply and exhaust air as scheduled.

B. Pipe condensate drain pan to nearest floor drain.

END OF SECTION 23 72 14

SECTION 23 73 25 - FACTORY FABRICATED HEAT RECOVERY UNITS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Product Data for all equipment including, but not limited to, the following:

(1) Appropriate identification
(2) Complete drawings showing plans and sections including details of construction
(3) Overall unit dimensions and individual components and sections dimensions
(4) Shipping and operating weight of unit and/or sections
(5) Structural design load
(6) Details of component support
(7) Capacities/ratings
(8) Materials of construction
(9) Thermal and acoustical performance of wall, roof and floor panels
(10) Pressure ratings and leakage ratings
(11) Thermal break construction details and performance calculations or test data
(12) Each component manufacturer's name, model number and data.
(13) Air leakage rates and test data
(14) Fan balance report
(15) Wiring diagrams and terminal points for control panels provided with units
(16) Manufacturer’s installation instructions
(17) Unit manufacturer’s local representative and phone number

B. All submitted PDF documents shall have electronic bookmarks. Bookmarks shall be set up as follows:

(1) Shop Drawings:
(a) Each major system shall have a master bookmark programmed with all documentation for the system grouped in order under a single bookmark for that system. Subgroups under the main bookmark should be divided in a minimum of: flow diagram/bill of material, wiring detail, control sequence, point list.
(2) Device Data Sheets:
(a) Device Data Sheets for all equipment specified.
(3) Hyperlinks:
(a) Hyperlinks can be used to enhance the bookmark tools but are not an acceptable substitute for electronic bookmarks.
(b) If hyperlinks are used, they should be clearly identifiable as a hyperlink but using a different color text similar to how MS Office documents identify hyperlinks.

1.02 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish one spare set of MERV 8 filters per unit.

1.03 DESIGN CRITERIA

A. Manufacturer shall provide equipment as specified and install equipment furnished by others to result in complete and operational unit. Manufacturer shall assume single source responsibility for all components and accessories.

B. Furnish units complete with fans, piping, valves, piping specialties, motors, coils, drain pans, filter sections, damper sections and interior lighting, meeting configuration and as shown on drawings, specified and as scheduled.

C. Unit performance shall be in accordance with AHRI 430 (I-P)and shall be Third Party certified and labeled.

D. All systems shall meet NFPA 90A flame and smoke generation requirements.

E. Unless otherwise indicated, galvanized steel shall be G90 according to ASTM A924/A924M (formerly ASTM A525), ASTM A653/A653M and ASTM A90 and aluminum sheet shall be 3003-H14 alloy, conforming ASTM B209/B209M.

F. Fan(s) shall comply with AMCA Publication 11 and bear the AMCA Certified Ratings Program seal for air performance and sound performance according to AMCA 211 and AMCA 311.

G. Damper(s) shall be licensed to bear the AMCA Certified Ratings Program seal for air performance, air leakage and efficiency in accordance with AMCA 511.

H. Motor furnished with fan shall not operate into motor service factor in any cases.

I. Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of the change and system effect factor calculations, indicating increased static pressure requirement as described in AMCA 201. This Contractor shall be responsible for any motor drive and/or wiring changes required as result of duct configuration changes at fan.

J. Unit static pressure to take into consideration actual static pressure loss of components furnished within unit and average pressure drop of the installed filters.

K. Wire brush all welds with solvent and wipe clean all bare metal before painting.

L. Units shall be constructed for ____ application and shall be designed for roof mounting on ____. For outdoor applications, allow for and wind loading in accordance with the governing building code when calculating allowable deflections.

(1) For outdoor applications, allow for and wind loading in accordance with the governing building code when calculating allowable deflections.

M. Units shall have a method of fan motor removal. Method shall allow for motors to be disconnected, handled and placed in an area that fully support the weight of the motor. Provide method of fan removal in shop drawings.

1.04 DELIVERY, STORAGE AND HANDLING

A. Delivery: The Contractor upon receipt of the equipment shall immediately verify that the equipment has not received damage during shipping and that all items listed on the bill of lading and the equipment manufacturer Shipping Documents are included in the shipment. If damage has occurred or if items are missing, the Contractor must note this on the equipment manufacturer Shipping List before accepting delivery of the equipment.

B. Storage and Protection: Store equipment and protect it from exposure to harmful weather conditions and at temperature conditions as recommended by equipment manufacturer. See the equipment manufacturer Equipment Storage Instructions included in the Operations and Maintenance Manual, and raw material and component manufacturer’s instructions and Operations and Maintenance Manuals.

C. The equipment manufacturer shall seal fluid and air openings prior to shipment. Blow all coils free of water. Coils damaged by freezing to be replaced not repaired.

D. The equipment manufacturer shall protect coils with sheet metal blank-offs secured to both upstream and downstream faces of coils.

E. The equipment manufacturer shall deliver products to site with protective coverings and factory installed lifting lugs.

1.05 DOCUMENTATION

A. Provide the following information within the unit as it ships for Contractor use:

(1) As Built Electrical Drawings
(2) All O&M Information including coils, fans, damper actuators, pressure gauges, etc.
(3) Factory test results
(4) Control Points List
(5) Unit Submittal

1.06 MANUFACTURER QUALIFICATIONS

A. Unit manufacturer shall be held responsible for specified performance of units.

B. Each unit shall bear a third party label indicating the complete unit is listed as an assembly. Third party listing of individual components, or control panels only, is not acceptable.

(1) Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. TMI, CAHS, Haakon or Buffalo with operating characteristics as scheduled and physical dimensions as shown on drawings and/or detailed.

2.02 UNIT CONFIGURATION

A. Exhaust Inlet with Isolation Damper

B. Coil Bypass with Isolation Damper

C. MERV 8 Filter Rack

D. Heat Recovery Coil

E. Discharge Plenum with OA Make-Up Damper

F. Piping Vestibule

2.03 LABELING

A. Label all coil connections (e.g. “Heat Recovery Supply”, “Heat Recovery Return”, etc.).
   (1) Phenolic Nameplates:
      (a) ASTM D709, Type I, cellulose, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore.
      (b) Nameplates shall be approximately 1-1/2” x 4”, 1/16” thick, and have 1/2” high lettering. Face of plastic shall be black with white letters.
      (c) Fasteners shall be self-tapping, stainless steel screws.

B. Heat recovery unit access doors shall have warning label stating “Do not enter without appropriate training and PPE.”

2.04 UNIT BASE

A. Unit base shall be fabricated of structural steel around unit perimeter and all section splits with additional structural members to support installed equipment. Breakformed shapes or channels in base will not be accepted.
   (1) Base shall be 6"(min).

B. Weld bases solid at connection points to assure rigidity. Size perimeter members to allow for rigging and handling.

C. Locate and size base cross supports to support internal components. Breakformed cross supports will not be acceptable.

D. Each section shall be equipped with a minimum of four permanently welded lifting lugs attached to perimeter base steel. Incorporate means of attaching cable or chain into each lug.

E. Base shall be split in maximum size pieces to allow for economical shipment to jobsite and placement within building. Provide bolting members on both sides of split for field joining. Welding of sections for reassembly will not be permitted.

2.05 UNIT FLOOR

A. Unit floor shall be constructed to meet the maximum allowable deflection, and constructed of no lighter than:
   (1) 3/16” (min) aluminum checker plate

B. Floor joints and seams shall be continuously welded water tight. Each section shall have turned up lip on the inside of the panels around section perimeter with welded corner to form drain pan type floor capable of retaining minimum 1-1/2” of water without leakage.

C. Locate 1-1/2” aluminum floor drain with aluminum or stainless steel strainer in each pan type floor section. 1-1/2” aluminum or stainless steel pipe shall extend through perimeter base channel and be welded water tight. Provide threaded end and removable cap on each drain connection.

D. Weld flooring material to structural members below. Drive screw attachment is not acceptable.

E. Entire floor including floor drain piping and drain pans shall be insulated on underside to have same thermal and acoustical performance specified for unit housing. Insulation shall be supported by minimum 20 ga aluminum liner with joints sealed to provide continuous vapor barrier.

F. Base Drain Pans:
   (1) Provide recessed drain pans as integral part of unit floor under all coils.
   (2) Drain pans shall be constructed from 16 ga (min) Type 304 SS sheet, all seams continuously welded.
   (3) Drain pan shall be triple sloped to drain connection.
   (4) Locate drain connections at lowest point of pan. Connections shall extend through perimeter base channel and be continuously welded to insure air-tight seal as well as eliminate requirement for backup wrench during field piping. Provide removable cap on each drain connection.
   (5) Total drain pan height shall be 3” (min).
   (6) Provide walk on aluminum bar grating over base drain pan(s). Bar grating to be attached via bolt on clips to allow removal for cleaning and unit maintenance.

2.06 UNIT HOUSING

A. Unit housing shall be constructed of 4" (min) thick double wall, insulated panels meeting thermal, acoustical and structural requirements specified.

B. Panels shall utilize modular panel type construction. Panels may be self-supporting with internal support structure or supported by structural frame work. Structural frame work to be fully insulated and thermally broken from unit exterior.

C. Panel joints and seams shall be sealed with proper gasket and caulking to meet maximum allowable housing leakage rate specified.

D. Panel system shall incorporate thermal break design at panel frames, joining mullions, supporting base, or corners. Thermal break is defined as prevention of condensation on outside surface of unit casing with 95°F dry bulb and 85°F wet bulb temperature in adjacent space and 65°F dry bulb temperature inside unit.

E. Unit manufacturer shall submit, as part of shop drawings, details of thermal break construction and calculations or test data indicating that thermal break design will prevent condensation on outside surface of unit casing with specified air temperatures at outside of unit and specified air temperature at inside of unit.

F. Outer face of unit housings shall be constructed of no lighter than:

(1) 0.050" stucco embossed aluminum.

G. Solid inner face of panels shall be constructed of no lighter than:

(1) 0.050" flat aluminum.

H. Insulation

(1) Composite panel shall have heat transfer factor not greater than 0.055 Btu/hr/sq ft/°F. All products as applied shall meet NFPA 90A possessing flame spread rating of not over 25, fuel contributed rating of not over 50 and smoke developed rating of not over 50.

(2) Insulation: Closed Cell Foam.

I. Provide vertical partition to divide units into modules, as detailed on drawings. Partition panels shall be same construction as housing wall panels.

J. Provide blank-off panels with proper gaskets and sealants to prevent air bypass around equipment such as filters and coils. Blank-off panels shall be constructed of galvanized steel no lighter than 16 ga unless otherwise noted. Blank-off panels at coil sections shall be 16 gauge, Type 304 stainless steel construction with 1” closed cell insulation to prevent condensation.

K. Manufacturer shall have published literature available describing load-carrying capabilities and thermal characteristics of the panel system.

L. Roof of outdoor units shall be constructed with standing seam, water-tight joints and sloped 1/8” per foot (min).

2.07 PIPING VESTIBULE

A. Piping vestibule shall be constructed using the same materials as the unit housing and unit floor.

B. Provide _____.

C. Provide (2) LED marine lights in the section.

(1) Install lights on sidewalls of piping vestibule.

(2) Lights shall be controlled by a dedicated mechanical timed light switch.

2.08 ACCESS DOORS

A. Each unit section shall have 24” x 72” (min) access door. When the unit plenum height is less than 72”, the door shall be no shorter than the plenum height less 12” with the shortest door acceptable being 30” in height.

B. Access doors and door frames shall have same thermal break construction as specified under Unit Housing.

C. Access doors and door frames shall have same thermal break construction as specified under Unit Housing.

D. Access doors shall be same construction as housing panels.

E. Access doors shall be guaranteed tight closing through use of seals around entire periphery. Provide replaceable gasket between door frame and housing for air tight seal.

F. Each access door shall contain 1/4” thick wire glass or double glazed tempered glass window minimum size of 12” x 12” or equivalent round with centerline of window at 5’-6” from adjacent walking surface. Window shall be double paned with vapor seal construction.

(1) Piping vestibule doors do not require view windows.

G. Each access door shall be furnished with stainless steel metal hinges or stainless steel continuous piano hinge and shall have at least three handles per door operable from either side. Provide locking capability at each access door either integrated into door hardware or provide hardware for padlock by others.

(1) Door handles shall be Allegis 2650-304 pad lockable with handles on both sides of door.

(2) Where a single door has multiple handles, they shall be interconnected via a handle rod such that a single handle turns all handles simultaneously.

H. Doors shall open against higher air pressure.

I. Provide all access doors with door tie-backs.

J. Provide access doors of pressurized sections with test ports.

2.09 ACCESS SECTIONS

A. Access sections shall allow minimum of 30” between adjoining equipment. Provide access doors as indicated on the plans.

2.10 REMOVABLE ACCESS PANELS

A. Removable access panels shall be provided for removal of coils and fans or as indicated on drawings and where equipment removal is not possible through access door. Removable panels shall be same construction as housing panels.

B. Removable access panels shall be screwed in place on 6” centers.

2.11 PRESSURE RELIEF DOORS

A. Provide (_____) 18x18 negative pressure relief door. Door and frame shall be 12 ga (min) galvanized steel with seal around door perimeter.

B. Doors shall open automatically to relieve excess pressure above 6” WG set point (FA) and to close when pressure is reduced to less than 3” WG. Setting shall be adjustable from 3” to 8” WG with 1” WG increments in between.

2.12 FILTER SECTIONS

A. Holding frames shall be installed by unit manufacturer to raise filters off floor and to prevent leakage as specified by unit manufacturer.

B. Frames shall be minimum 16 ga galvanized steel construction with provisions for assembly in a bank. Frames shall be suitable for filters scheduled and incorporate gaskets and spring clips to prevent air bypass.

C. All filter frames shall be designed for face loading of filters.

D. MERV 8 Filters:

(1) Provide AAF MEGApleat M8 or Farr 30/30.

(2) Filters shall be 24x24x2.

(3) Furnish three full sets for each unit.

(a) Install one set during construction.

(b) Install one set prior to TAB.

(c) Deliver one set to the Owner for stock.

2.13 DIFFERENTIAL AIR PRESSURE INDICATORS

A. Provide _____ Differential Pressure Transmitter.

B. Range shall be 0 - 3" WG.

C. Provide gauges across each individual filter bank in built-up rack assemblies, suitable for surface mounting, including air filter gauge accessory package for use with 1/4” OD copper tubing.

D. Provide 2” spacer at one 2' x 2' filter section between filter elements in built-up rack, adjacent to unit wall for placement of intermediate pressure probe.

E. Mount gauges on side of casing at ±5’-6” above adjacent walking surface.

2.14 COIL SECTION

A. Provide coils, piping and internal piping as specified and indicated on drawings.

B. Install coils, internal piping, and specialties not to block face area of coils. Where coils are required to be dual-width coils due to length limitation, provide header connection piping to unit exterior and coil removal track assemblies to guide dual-width coils within the unit to unit exterior. Terminate piping 3” outside of unit casing for connection by Contractor. Provide necessary pipe supports and hangers. All piping specialties, valves, insulation, etc. to be provided by Contractor and installed in piping exterior to unit.

C. Provide for individual coil removal using stainless steel slide racks and/or I-beam immediately downstream of coil section. Coils shall be removable through unit access doors or removable access panels.

D. Tubes: Copper, 5/8 inch O.D., 0.035-inch wall thickness. Return bends shall be 0.049-inch wall thickness before bending.

E. Fin Thickness: Aluminum, 0.010 inch minimum.

F. Fin Spacing: 10 per inch maximum (continuous plate fins).

G. Maximum Fin Length: 10 feet per section. Die formed intermediate tube supports with oversized I.D. tube collars or with brass or nylon grommets shall be used when finned tube lengths equal or exceed 60 inches.

H. Maximum Fin Height: 54 inches.

I. Maximum Rows: 8 rows.

J. Minimum Tube Velocity: 6 ft/s.

K. Headers: Copper or Red Brass. Each header shall have a vent and a drain. Each vent and drain shall be individually extended through the unit-housing wall and constructed complete with shut-off valve and cap.

L. Channel frame casing, frame structure, slide rack and fasteners shall be constructed of 16 gauge (min), Type 304 stainless steel.

M. Mount coils in a channel frame casing designed for bolting to other sections of equipment.

N. Provide bolted frame structure to support and allow for individual coil removal.

O. All water coils shall be fully drainable incorporating vents and drains on all headers, including intermediate headers.

P. Coils shall be tested at 315 psig under water.

Q. Corrosion Protection Coating

(1) Provide _____ on coils.

2.15 DISCHARGE AIR SECTION

A. Provide all air discharge connections with spun bellmouth discharge opening conforming to size and configuration of the ductwork. Abrupt 90 degree duct discharge connections are not acceptable.

2.16 CONTROL DAMPERS (BYPASS DAMPERS)

A. Acceptable Manufacturers: TAMCO Series 1000 or Ruskin Model CD50.

B. Control dampers shall be installed by unit manufacturer at factory. Coordinate electric actuator requirements with Controls Contractor.

C. Bypass control dampers shall be parallel blade type.

D. Dampers shall be AMCA rated for Leakage Class 1A at 1 in w.g. static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.

2.17 INSULATED CONTROL DAMPERS (MAKEUP AIR)

A. Acceptable Manufacturers: TAMCO Series 9000 or Ruskin TED50XT.

B. Control dampers shall be installed by unit manufacturer at factory. Coordinate electric actuator requirements with Controls Contractor.

C. Modulating control dampers shall be opposed blade.

D. Dampers shall be AMCA rated for Leakage Class 1A at 1 in w.g. static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.

2.18 STATIONARY LOUVER

A. Provide extruded aluminum stationary drainable louver with drain gutters in each blade and head with downspouts in jambs and mullions with all welded construction.

(1) Color to match unit housing.

B. Frame Depth shall be 6 inches.

C. Provide aluminum bird screen behind louver.

D. Provide rain hood.

(1) Color to match unit housing.

2.19 ROOF CURB

A. Roof curb shall be _____ high and constructed from minimum 12ga galvanized steel. At each of 4 corners, curb shall be joined together with corner post that is welded to one section of curb and then field bolted to adjacent section. Wood nailer shall be attached to inside flange of curb for field attachment of flashing and roof membranes.

2.20 CONTROLS

A. Control devices shall be by same manufacturer providing control devices for the remainder of the building.

B. Control devices will be furnished by Contractor and shall be field installed as shown on plans and as described in control section of specifications.

C. Seal all conduit penetrations with neoprene grommets or other professional method. Sealing conduit penetrations with caulk alone is not acceptable. Fill inside of conduit with silicone sealant to prevent air leakage.

D. All wiring penetrations through the casing shall be protected in ‘RIGID’ type metal conduit.

2.21 FACTORY TESTING

A. Notify Owner, Designer and Contractor of factory test date at least 30 days in advance. Submit certified test data to Designer for approval.

B. Manufacturer shall provide factory tests to verify casing deflection and leakage after units are assembled.

C. Pay for all expenses for _____ representative, designated by Owner, to travel to the factory to witness casing deflection and leakage tests. Construction of units shall be coordinated such that testing of the following equipment can be accomplished in a single factory trip. All other equipment specified in this section that is not selected for witness testing shall be tested without Owner representative witnessing the testing.

D. Casing leakage tests shall verify that unit casing leakage is less than of _____ design air flow at _____ WG.

(1) Seal all unit openings. Connect unit to fan developing _____ WG and read air flow of this fan using approved air flow measuring device. Fan air flow measurement shall be considered casing leakage.

(2) Conduct leakage test for both positive and negative pressure. In either case, the casing leakage shall not exceed maximum allowable rate specified above.

E. Unit manufacturer shall provide factory panel deflection test. Conduct this test in conjunction with casing leakage testing.

(1) Panel deflection test for panels shall verify that unit casing deflection is less than _____ of the longest plane being measured at _____ WG negative.

(2) Deflection shall be measured at 8 total points at mid-point of panel height around unit.

2.22 FIELD TESTING

A. Notify Owner, Designer and Contractor of factory test date at least 30 days in advance. Submit certified test data to Designer for approval.

B. Contractor shall provide field tests to verify casing leakage after units are assembled on site.

C. Casing leakage tests shall verify that unit casing leakage is less than _____ of design air flow at _____ WG.

(1) Seal all unit openings. Connect unit to fan developing _____ WG and read air flow of this fan using approved air flow measuring device. Fan air flow measurement shall be considered casing leakage.

(2) Conduct leakage test for both positive and negative pressure. In either case, the casing leakage shall not exceed maximum allowable rate specified above.

D. Owner hall provide field panel deflection test. Conduct this test in conjunction with casing leakage testing.

(1) Panel deflection test for panels shall verify that unit casing deflection is less than _____ of the longest plane being measured at _____ WG negative.

(2) Deflection shall be measured at 8 total points at mid-point of panel height around unit.

2.23 ELECTRICAL SERVICE

A. The unit shall be power wired for independent power source for lights and GFCI receptacles on one switch, separate from the motor power source entrance. Lighting/convenience outlet circuit shall receive power from a dedicated 20 amp, 120 volt circuit.

B. Lights, switches, GFCI receptacles, wiring and conduit shall meet requirements of appropriate specification sections of Division 26.

(1) Provide one mechanical timed light switches to automatically turn off all lights after preset time. Timer shall be similar to Intermatic Model FF32HH with 0-2 hour range and hold feature to override automatic shut-off function.

(2) Provide one GFCI duplex receptacle on the pipe connection side of the unit and one GFCI duplex receptacle within the pipe vestibule.

(3) All wiring penetrations through the casing shall be protected in ‘RIGID’ type metal conduit.

C. LED Marine Lights:

(1) Provide two (min) per access section

(2) UL listed for wet locations, IP66 rated

(3) Housing: marine-grade or painted cast aluminum housing with guards and gasketed seal

(4) Lens: glass globe

(5) Lamps: light emitting diode with 50,000 hr (min) life at L70

(6) Light Output: 600 lumens (min); 60 lumens/W (min)

(7) Color Temperature: 4000K

D. Wiring and conduit inside of unit shall be provided by unit manufacturer meeting requirements of appropriate specification sections of Division 26. Conduit within unit shall be EMT, with 12” (min) to 24”(max) of flexible metal conduit for final motor connections. Conduit on exterior of unit shall be galvanized Rigid Metal Conduit. Wiring shall be stranded copper THHN/THWN.

E. Seal all conduit penetrations with neoprene grommets or other professional method. Sealing conduit penetrations with caulk alone is not acceptable. Fill inside of conduit with silicone sealant to prevent air leakage.

F. Provide laminated as built electrical wiring diagrams affixed to the backside of high voltage electrical panel door.

2.24 PIPED SERVICE

A. Interior piping and equipment installation shall be complete. Piping shall be installed and tested per appropriate specification section. Unit manufacturer shall be responsible for any leaks in factory installed piping, which occur in unit during system testing which occurs before system startup.

B. Extend piping for each coil through panel casing. Terminate piping 3” into piping vestibule with flange for pipe 2-1/2” and larger or threaded connection for pipe 2” and smaller with caps.

C. Seal all piping penetrations with neoprene grommets or other professional method. Sealing piping penetrations with caulk alone is not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Units shall be assembled in modules in unit manufacturer's plant to allow for testing of complete unit.

B. Unit manufacturer shall supervise and be responsible for all field joining of the modules, including sheet metal, electrical and piping. Local trades may provide labor for unit assembly and installation.

C. Joints in floor between modules shall be air and water tight.

D. Unit manufacturer shall furnish and install all equipment within unit as specified including fans, motors, coils, dampers, sound attenuating devices, piping, piping specialties, ductwork specialties, lights, switches and all equipment necessary to complete equipment contained within housings. Mechanical and electrical connections (i.e., piping and conduit) shall be stubbed through housing so that appropriate contractor may provide service to unit. Electrical wiring and control wiring shall terminate in junction boxes on accessible side of unit.

E. Field mounting of any equipment on housing walls or roof is not allowed without prior approval of Designer.

F. Unit manufacturer and Contractor shall coordinate all necessary requirements to assure proper unit installation.

3.02 PROTECTION OF OPENINGS

A. Protect openings on housings during construction against entry of foreign matter and construction dirt.

3.03 ON-SITE STORAGE

A. The Contractor shall either place the units in a controlled indoor environment or shall loosely but securely cover the units with protective coverings and place them in a covered and well-drained area so that they can breathe. Covering units with shrink wrap shall not be acceptable.

B. Under no circumstance shall the units be left in a state that water can enter the unit.

C. Provide a desiccant media in a plastic pan/bucket in each access section to prevent moisture build up in the unit. Change out desiccant media monthly or as needed until the unit is operational.

D. Provide a dehumidifier in each section to prevent moisture build up in the unit.

3.04 PRESSURE RELIEF DOORS

A. Install _____pressure relief door in the fan section dividing wall in accordance with the manufacturer's instructions.

B. Pressure relief door shall have an end switch that sends an alarm to the BAS when it is tripped.

3.05 DIFFERENTIAL AIR PRESSURE INDICATORS

A. Install static pressure sensors according to manufacturer's instructions.

3.06 MANUFACTURER'S FIELD SERVICES

A. Installation Supervision: Provide services of factory authorized service representative to provide installation supervision. Installation supervision is included for three eight-hour weekdays unless additional days are included in the purchase agreement. The Contractor is to notify the Manufacturer 30 days in advance of the installation.

B. Startup Supervision: Provide services of factory authorized service representative to provide start-up supervision. Start-up supervision is included for three eight-hour weekdays unless additional days are included in the purchase agreement. The Contractor is to notify Manufacturer 30 days in advance of the Start-up.

3.07 FIELD QUALITY CONTROL

A. Provide field test to verify casing leakage after units are installed at jobsite with supervision of test by Manufacturer. Coordinate power to unit test fan. Notify Owner, Designer, CM and Manufacturer of test date at least 2 weeks in advance. Submit certified test data to Designer for approval.

B. Perform casing leakage tests to verify integrity of the unit casing.

(1) Seal all unit openings. Connect unit to fan developing specified pressure and read air flow of this fan using approved air flow measuring device. Fan air flow measurement shall be considered casing leakage.

(2) Conduct leakage test for both positive and negative pressure. In either case, the casing leakage shall not exceed maximum allowable rate specified above.

C. Contractor shall be responsible for repair of any deficiencies found during field testing. Submit proposed corrections and certified test data to Designer for approval.

3.08 FINAL CLEANING

A. Outside and inside casings and all interior and exterior components of each unit shall be thoroughly cleaned. Use industrial grade cleaners to remove construction dust, sheet metal mil finish or grease. All proposed cleaning materials shall have contents identified and approved prior to use. Cover unit openings with sheet metal or other proper material until ductwork is connected to maintain unit cleanliness.

3.09 CLOSEOUT ACTIVITIES

A. Training:

(1) Provide services of factory authorized service representative to instruct Owner's personnel in operation and maintenance of units. Instruction includes 4 hours of training. Unless otherwise defined in the purchase agreement, the Owner's Instruction is to occur concurrent with the Installation Supervision or Start-Up Supervision.

END OF SECTION 23 73 25

SECTION 23 73 28 - FACTORY FABRICATED CUSTOM AIR HANDLING UNITS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 20 05 13 - Motors
B. Section 20 05 14 - Variable Frequency Drive (VFD) System
C. Section 20 05 29 - Piping and Equipment Supporting Devices
D. Section 20 07 00 - Mechanical Systems Insulation
E. Section 23 05 50 - Vibration Isolation
F. Section 23 09 01 - Control Systems Integration
G. Section 23 09 02 - Control Valves and Dampers
H. Section 23 09 03 - Control Instrumentation
I. Section 23 09 23 - Direct Digital Controllers and Networks
J. Section 23 09 93 - Control Sequences
K. Section 23 21 16 - Pipe and Pipe Fittings
L. Section 23 21 18 - Valves
M. Section 23 21 20 - Piping Specialties
N. Section 23 33 14 - Ductwork Specialties
O. Section 23 34 00 - Fans
P. Section 23 41 14 – Filters
Q. Section 23 72 14 – Heat Recovery Equipment
R. Section 23 82 16 - Coils
S. Section 23 84 13 - Humidification Equipment
T. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
U. Section 26 05 33 - Raceway and Boxes for Electrical Systems
V. Section 26 27 26 - Wiring Devices
W. Section 26 28 16 - Enclosed Switches and Circuit Breakers
X. Section 26 29 13 - Enclosed Controllers

1.02 SUBMITTALS

A. Shop Drawings (Product Data) for all equipment including, but not limited to, the following:
   (1) Appropriate identification
   (2) Complete drawings showing plans and sections including details of construction
   (3) Overall unit dimensions and individual components and sections dimensions
   (4) Shipping and operating weight of unit and/or sections
   (5) Structural design load
   (6) Details of component support
   (7) Capacities/ratings
   (8) Materials of construction
   (9) Thermal and acoustical performance of wall, roof and floor panels
   (10) Pressure ratings and leakage ratings
   (11) Thermal break construction details and performance calculations or test data
   (12) Each component manufacturer's name, model number and data (Refer to each component section for submittal requirements.)
   (13) Air leakage rates and test data
   (14) Wiring diagrams and terminal points for control panels provided with units
   (15) Manufacturer’s installation instructions
   (16) Air handling unit manufacturer’s local representative and phone number

1.03 DESIGN CRITERIA

A. For housings and floors operating under positive pressure (fan discharge side), maximum allowable deflection at panel midpoint shall not exceed 1/240th of any span in any direction at +10” WG.

B. For housings and floors operating under negative pressure (fan inlet side), maximum allowable deflections at panel midpoint shall not exceed 1/240th of any span in any direction at -10″ WG.

C. Furnish units complete with fans, piping, valves, piping specialties, actuators, motors, coils, humidifiers, drain pans, filter sections, damper sections and interior lighting, meeting configuration and as shown on drawings, specified and as scheduled. All unit components shall meet this Section of specification and all requirements specified in each section and division listed under Related Work. Control dampers shall be provided by unit manufacturer. Control dampers actuators will be furnished by Control Contractor for factory mounting by unit manufacturer.

D. All materials shall meet NFPA 90A Flame and Smoke Generation Requirements.

E. Units shall be UL or ETL listed in accordance with UL Standard 1995.

F. Unless otherwise indicated, galvanized steel shall be G90 according to ASTM A924 (formerly ASTM A525), A653 and ASTM A-90 and aluminum sheet shall be 3003-H14 alloy, conforming ASTM B209.

G. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled total static pressure without operating into motor service factor.

H. Motor furnished with fan shall not operate into motor service factor in any cases.

I. Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of the change and system effect factor calculations, indicating increased static pressure requirement as described in AMCA Publication 201. This Contractor shall be responsible for any motor drive and/or wiring changes required as result of duct configuration changes at fan.

J. Air handling unit static pressure to take into consideration actual static pressure loss of components furnished within unit.

K. Structural integrity of unit's casing shall be sufficient to support piping and ductwork that are mounted above unit as shown on drawings.

1.04 FINAL CLEANING

A. Outside and inside of each air handling unit shall be thoroughly cleaned. Use industrial grade cleaners to remove construction dust, sheet metal mill finish or grease. All proposed cleaning materials shall have contents identified and approved prior to use. Cover unit openings with sheetmetal or other proper material until ductwork is connected to maintain unit cleanliness.

1.05 MANUFACTURER QUALIFICATIONS

A. Air handling units shall be manufactured by qualified unit manufacturer that has been making custom units for at least 10 yrs and shall carry manufacturer's nameplate. Unit manufacturer shall be held responsible for specified performance of units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Alliance, Climate Craft, Engineered Air, Haakon, Nortek, Scott Springfield or approved equal with operating characteristics as scheduled and physical dimensions as shown on drawings and/or detailed.

2.02 UNIT BASE

A. Unit base shall be fabricated from structural or welded tubular steel.

B. Base shall be sized to provide sufficient height above floor to accommodate cooling coil gravity drain. Provide waterless trap similar to Des Champs Technologies N-Series HVAC Air-Trap at each cooling coil condensate drain.

C. Weld steel solid at connection points to assure rigidity. Size perimeter steel to allow for rigging and handling.

D. Locate and size base cross supports to support internal components.

E. Provide lifting lugs to perimeter base steel. Incorporate means of attaching cable or chain into each lug.

F. Base shall be split in maximum size pieces to allow for economical shipment to jobsite and placement within building. Provide bolting structural steel on both sides of split for field joining.

G. Unit base shall be primed and finished with rust inhibiting epoxy paint.

2.03 UNIT FLOOR

A. Unit floor shall be constructed to meet the maximum allowable deflection, and constructed of no lighter than:

(1) Floor plate shall be all welded 1/8" aluminum with diamond-tread.

B. Floor joints and seams shall be continuously welded water tight. Each section shall have turned up lip around section perimeter with welded corner to form drain pan type floor capable of retaining minimum 1-1/2" of water without leakage. Locate drain connection at lowest point of each pan type floor section. Connections shall extend through perimeter base channel and be welded water tight. Provide removable cap on each drain connection.

C. Entire floor including base drain pans shall be insulated on underside to have same thermal and acoustical performance specified for unit housing. Insulation shall be supported by minimum 22 ga galvanized steel liner with joints sealed to provide continuous vapor barrier.

D. Base Drain Pans:

(1) Provide recessed drain pans as integral part of unit floor in pre-heating coils, outside air sections and humidifier sections.

(2) Drain pans shall be constructed from minimum 1/8" aluminum with diamond tread or 16 ga 304 SS sheet, all seams continuously welded with minimum 2" turned up.

(3) Drain pan shall be double sloped; pitched down in direction of air flow and pitched sideways to drain connection.

(4) Locate drain connections at lowest point of pan, one on either end. Connections shall extend through perimeter base channel and be continuously welded to insure air-tight seal as well as eliminate requirement for backup wrench during field piping. Provide removable cap on each drain connection.

(5) Refer to Cooling Coil Section for cooling coil drain pan requirements.

2.04 UNIT HOUSING

A. Unit housing shall be constructed of minimum 4" thick double wall panels meeting thermal, acoustical and structural requirements specified.

B. Panels shall utilize modular panel type construction. Panels may be self-supporting with internal support structure or supported by structural frame work.

C. Panel joints and seams shall be sealed with proper gasket and caulking to meet maximum allowable housing leakage rate specified.

D. Panel system shall incorporate thermal break design at panel frames, joining mullions, supporting base, or corners. Thermal break is defined as prevention of condensation on outside surface of unit casing with 95.9ºF dry bulb and 74.3ºF wet bulb temperature in adjacent space and 50°F dry bulb temperature inside air handling unit.

E. Unit manufacturer shall submit, as part of Shop Drawings, details of thermal break construction and calculations or test data indicating that thermal break design will prevent condensation on outside surface of unit casing with specified air temperatures at outside of unit and specified air temperature at inside of unit.

F. Manufacturer's standard wash down liner is considered acceptable in lieu of thermally broken panel system as specified above.

G. Outer face of panels for indoor units shall be constructed of no lighter than:

(1) 16 ga galvanized steel.

H. Solid inner face of panels shall be constructed of no lighter than:

(1) 20 ga galvanized steel

(2) Unit casing shall be insulated with minimum 3 pcf density glass fiber, or 3 pcf density polyurethane foam insulation. Composite panel shall have heat transfer factor not greater than R-16 or 0.06 Btu/(h·ft2·°F.All products as applied shall meet NFPA 90A possessing flame spread rating of not over 25 and smoke developed rating of not over 50.

I. Use solid inner surface for all sections

J. Provide blank-off panels with proper gaskets and sealants to prevent air bypass around equipment such as filters, coils, and humidifiers. Blank-off panels shall be constructed of galvanized steel no lighter than 16 ga unless otherwise noted. Blank-off panels at cooling coil sections shall be insulated with 3/4" thick insulation similar to AP Armaflex SA Duct Liner. Do not insulate blank-off panels between cooling coils located above drain pans.

K. Panel manufacturer shall have published literature available stating sound absorption coefficient of panel system obtained using ASTM Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms (ASTM Designation C423-66), and sound transmission loss obtained using procedures conforming to ASTM Designation E90-70, E413-70T and other pertinent standards.

(1) Sound Transmission Loss in accordance with ASTM E90 shall equal or exceed the following:

	Octave Band Center Frequency (Hz)					
	125	250	500	1000	2000	4000
Transmission Loss (dB) of 4" Panels	21	24	34	44	51	53

(2) Sound performance tests must be documented by independent laboratory (ETL, Riverbank Laboratories, Kideras Labs, etc.).

L. Manufacturer shall also have published literature available describing load-carrying capabilities and thermal characteristics of the panel system.

2.05 ACCESS DOORS

A. Each unit section shall have 24” x 72” access door, unless shown differently on drawings.

B. Fan section access door shall be sized to allow removal of fan wheel and motor through door, but not smaller than 30” x 72”. If access door needs to be wider than 36”, removable access panel may be provided.

C. Access doors and door frames shall have similar thermal break construction as specified under Unit Housing.

D. Access doors shall be same construction as housing panels.

E. Access doors located downstream of cooling coils shall be true thermal break design with no metal to metal contact.

F. Access doors shall be guaranteed tight closing through use of seals around entire periphery. Provide neoprene gasket between door frame and housing for air tight seal.

G. Each access door shall contain 1/4” thick wire glass or double glazed tempered glass window minimum size of 10" x 12" or 12" round. Window shall be double paned with vapor seal construction.

H. Each access door shall be furnished with corrosion resistant metal hinges or continuous piano hinge and shall have at least 2 stainless steel or aluminum alloy handles operable from both sides.

I. Doors shall open against higher air pressure to affect seal.

2.06 ACCESS SECTIONS

A. Access sections shall allow minimum of 30” between adjoining equipment. Provide access doors as indicated on the plans.

2.07 REMOVABLE ACCESS PANELS

A. Removable access panels shall be provided as indicated on drawings and where equipment removal is not possible through access door. Removable panels shall be same construction as housing panels.

2.08 FILTER SECTIONS

A. Filters shall be provided as specified and scheduled. Holding frames shall be installed by unit manufacturer to raise filters off floor and to prevent leakage in accordance with filter manufacturer’s installation recommendation by unit manufacturer. Filters shall be equipped with sensing tubes and differential pressure gauges to monitor filter loading. Filters shall be furnished with magnehelic differential pressure gauges to monitor filter pressure drop and loading. Frame shall be similar to Camfill Fast frame or approved equal.

2.09 HEAT RECOVERY SECTION

A. Provide heat recovery equipment and exhaust energy recovery section integral to air handling unit as shown on drawings and as specified in Specification 23 7214. Vertical sheet metal partition shall be provided between supply and exhaust tunnels and shall be completely sealed to prevent cross contamination between supply and exhaust airstreams.

2.10 PREHEAT COIL SECTION

A. Provide preheat coils, piping and internal piping as specified and indicated on drawings.

B. Install coils, piping, and specialties not to block face area of coils. Terminate piping outside of unit casing for connection by Mechanical Contractor. Provide necessary pipe supports and hangers.

C. Each coil shall be supported by galvanized steel frame which is independent of unit casing. Support frame shall allow individual coil removal. Coils shall be removable through unit access doors. Blank-off panels shall be galvanized steel sheets.

2.11 COOLING COIL SECTIONS

A. Provide cooling coils, piping and piping specialties specified, and indicated on drawings.

B. Install coils, internal piping, and specialties not to block face area of coils. Terminate piping outside of unit casing for connection by Mechanical Contractor. Provide necessary pipe supports and hangers.

C. Each coil shall be supported by 304 stainless steel frame which is independent of unit casing. Support frame shall allow individual coil removal. Coils shall be removable through unit access doors or removable access panels. Blank-off panels shall be 304 stainless steel sheet with insulation as specified.

D. Each coil shall be provided with minimum 16 ga 304 stainless steel all welded condensate drain pan extending min. 6", but no more than 12" downstream of coil face. Each drain pan shall have sufficient depth to hold condensate water but not less than 2". Bottom drain pan shall extend min 18". Drain pans shall cover U bends of coil and any other pipes and components that form condensation. Drain pan shall be sloped in 2 directions (pitched down in direction of airflow and pitched sideways to drain connection) for self-drainage at minimum 1/4" per foot. Drain pan shall be individually piped down to drain pan located below, and bottom drain pan to be piped to hub drain at exterior of unit. Drain connection opening shall be flush with bottom of pan. Side pan connection located at lowest point of pan may be used only where bottom pan connection cannot be used. Drain pipes of intermediate and main drain pans shall be 304 stainless steel with sufficient size, but not less than 1-1/2"

E. Instead of drain pan under bottom coil, recessed pan, integral with unit floor may be used. It shall be constructed as specified above including thermal insulation and drain lines, and shall incorporate required drain trap height.

2.12 FAN SECTION

A. Fan and motor shall be provided as scheduled and meet requirements of appropriate Specification Sections.

B. Fan and motor shall be factory mounted on vibration isolation equipment meeting requirements of Section 23 05 50 - Vibration Isolation. Vibration base shall include integral adjustable motor base. If inertia bases are required, provide required concrete in factory.

C. Vibration isolation base shall have seismic restraints capable of containing fan in all directions with up to 1G of force applied.

D. Unit manufacturer shall provide flexible connection between fan and discharge wall.

E. Motor Removal:

(1) Provide motor removable winches per fan array.

(2) For motors 15 hp and larger, provide motor removal rail sized for L/400 deflection when fully extended and subjected to weight of motor at furthest extreme position.

(3) Removal rail shall be mounted in fan section, directly over motor, perpendicular to side of AHU.

(4) Removal rail shall be designed with roller so motor can be fully removed from unit to distance motor diameter plus minimum of 6", and lowered onto dolly with traversing arm able to freely move while carrying motor weight.

(5) Motor shall be able to be removed through access door or access panel.

F. Fan Array:

(1) Fan array system shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for duty specified. Fans shall be selected to deliver scheduled airflow quantity at scheduled operating total static pressure and scheduled fan/motor speed. Fan array shall be selected to operate at system total static pressure that does not exceed 90% of scheduled fan's peak static pressure producing capability at scheduled fan/motor speed. Each fan/motor cube shall include 11 ga, A60 Galvanized steel intake wall, 14 ga spun steel fan inlet funnel, and 11 ga G90 Galvanized steel motor support plate and structure. Motors shall be standard pedestal mounted type, T-frame motors selected at specified operating voltage, rpm, and efficiency as needed to meet performance requirements. Motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.

(2) Fan array shall provide uniform air flow and velocity profile across entire air way tunnel cross section. Airflow and velocity shall not exceed scheduled cooling coil and/or filter bank face velocity when measured at a point 12" from intake side of fan wall array intake plenum wall, and distance of 48" from discharge side of fan wall intake plenum wall.

(3) Fan array includes manufacturer-provided individual air flow meters for each fan with totalization display panel mounted to unit. Refer to Section 23 09 03 Control Instrumentation.

(4) Provide partition between fans to minimize system effect.

(5) Provide structural frame to support upper fans with solid floor panel partition between fans as shown on drawings to minimize system effect.

(6) Each fan/motor cube shall be equipped with metal grating fan outlet guard.

(7) Each fan in array shall be provided with back flow prevention means that produces less than 0.10" of static pressure drop and/or system effect when that fan is enabled. Any such system effects and/or pressure drops shall be submitted and included as component in determining fan system total static pressure as submitted. Manufacturer's pressure drop ratings of any such equipment, developed from straight run test conditions will not be accepted.

(8) Provide one VFD per fan.

(9) Provide local electrical disconnect for each fan.

(10) Contractor shall provide all wiring to air handling unit components that require power.

(11) Static regain diffuser

(a) For each fan in array provide static regain diffuser similar to Aero Acoustic Diffuser or approved equal. If static regain diffuser is not provided, fan manufacturer shall provide selections to show efficiencies are equivalent to fans provided with static regain diffuser.

(b) Fully galvanized construction features two diffuser sections mounted at the front and back of the fan wheel. Acoustic attenuating material inserted within a solid housing and perforated frontplate directs airflow across the diffuser to reduce discharge sound power levels and increase static efficiency.

G. Fan Array Airflow Measuring Station:

(1) Unit manufacturer shall provide airflow measurement pressure taps for each individual fan in array and shall provide the factory determined flow coefficient for the fans being furnished. If pressure taps are not available for the fans being supplied, the use of Pitot-type fan inlet airflow sensors is acceptable. Airflow meter shall not create system effect that adversely affects fan performance.

(2) Furnish and install fan array airflow totalizing system which monitors the airflow capacity of each individual fan based on the differential pressure and flow coefficient, and shall provide a totalized airflow rate to the BAS for control and monitoring purposes.

(a) Fan array airflow totalizing system

1) Manufacturers: Ebtron, Paragon Controls Inc., Model FAATS-1000 or equal as approved by the Engineer.

2) Accuracy: ±0.25 percent of full scale including non-linearity, hysteresis, deadband and non-repeatability for each fan in the array.

3) Signal Conversion Resolution: 16-bit A/D and 12 bit D/A.

4) Outputs:

1. Analog total CFM output: 0 – 5 VCD, 0 – 10 VDC, or 4 – 20 mA (Field selectable)

2. Digital alarm output: single dry contact rated for 5 amps @ 30 VAC/VDC & 10 amps @120 VAC/VDC

5) Human-Machine-Interface (HMI) Panel: For air volume indication and configuration of the fan array airflow totalizing system. The HMI shall provide continuous on screen indication of each individual fan's airflow rate and operational status, and shall display the totalized airflow rates for each fan array numerically and graphically as a percent of total design flow. The graphic screen shall be configured to match the fan array layout. Individual fan diagnostics via the HMI panel to indicate the measured differential pressure being reported by each individual fan as well as transducer output. Automatic zero and span calibration for each individual differential pressure transducer performed via the HMI.

6) Alarms: Individual fan failure alarms and warning alarms for when an individual fan's airflow rate is either above or below the average for all fans by a programmable percentage value. A failed fan alarm initiated when the airflow rate for an individual fan goes to zero. The fan (or fans) that are in an alarm state shall be shown on the HMI graphics screen in flashing yellow for warning and red for failed.

7) Network Communication: For monitoring and control purposes via BACnet®-MS/TP Master Communication network to the BAS. The network information shall provide individual fan information and remote configuration of all programmable values.

8) Enclosure: NEMA 4 Steel

9) Remote Panel: For fan array monitoring systems measuring both supply and return fan arrays in a single air handling unit, provide a remote transducer panel to minimize the pneumatic tubing.

2.13 HUMIDIFIER AND EVAPORATIVE PRECOOLING SECTIONS

A. Provide humidifiers, piping and supports as specified, and indicated on drawings.

B. Provide required absorption distance between humidifier and downstream equipment or housing wall.

2.14 DISCHARGE AIR SECTION

A. Provide with framed discharge opening or spun bellmouth fitting conforming to size and configuration of the ductwork.

2.15 CONTROL DAMPERS

A. Refer to Section 23 09 02 - Control Valves and Dampers, for control dampers.

B. Outside air dampers shall be similar to Tamco Series 9000 BF or Ruskin TED.

(1) Bearings shall be composed of Celcon inner bearing fixed to 7/16" aluminum hexagon blade pin, rotating within polycarbonate outer bearing inserted in frame, resulting in no metal-to-metal or metal-to-plastic contact.

(2) Linkage hardware shall be installed in frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for slip-proof grip.

(3) Dampers shall be designed for operation in temperatures ranging between -40°F and 212°F.

(4) Air leakage through 48" x 48" damper shall not exceed 4.12 cfm/ft2 against 4" WG differential static pressure at standard air.

(5) Pressure drop of fully open 48" x 48" damper shall not exceed .03" WG at 1000 fpm.

2.16 SMOKE ISOLATION DAMPERS

A. Refer to Section 23 33 14 – Ductwork Specialties for Smoke Damper specification

B. All Air Handling Units to be provided with discharge smoke/isolation dampers.

2.17 CONTROLS

A. Control devices, will be furnished by Control Contractor and shall be factory installed by unit manufacturer as shown on plans and as described in control section of Specifications. Control devices may be field installed by the Controls Contractor as long as all necessary conduit and sleeved openings for control devices are coordinated between AHU manufacturer and Controls Contractor.

B. Control devices will be provided by Control Contractor. Unit manufacturer shall coordinate with Control Contractor and provide sleeved openings on unit housing for control devices as required and as shown on submittal drawings.

C. Control devices shall be provided by equipment manufacturer. Control devices shall meet quantities, specifications and requirements as indicated in Sections 23 09 01, 23 09 02, 23 09 05, 23 09 23, and 23 09 93.

(1) For new construction where new control system is specified, unit controllers shall be by same manufacturer/control contractor providing control devices for remainder of building.

2.18 TESTING

A. Owner and/or Owner's representative may elect to witness tests. Notify Owner and/or Owner's representative of test date at least 2 weeks in advance. Submit certified test data to Engineer for approval.

B. Unit manufacturer shall provide factory tests to verify casing leakage after units are assembled.

C. Unit manufacturer and installing contractor shall jointly provide field tests to verify casing leakage after units are installed at jobsite. Coordinate with Electrical Contractor for power to unit test fan.

D. Casing leakage tests shall verify that unit casing leakage is less than 0.5% of design air flow at specified static pressure. Supply and exhaust sections of AHU shall be tested separately.

(1) Seal duct openings in positive pressure section. Connect this section to fan developing 10"WG positive static pressure, and read air flow of this fan using approved air flow measuring device. Fan air flow measurement shall be considered casing leakage of this section.

(2) Seal duct openings in suction side of unit. Connect this section to fan developing 10" WG in negative static pressure, and read fan air flow of this fan using approved air flow measuring device. Fan air flow shall be considered casing leakage of this section.

(3) Conduct casing leakage test individually for each air handling unit. Total casing leakage shall be calculated as sum of positive pressure section leakage and negative pressure sections leakage. Total casing leakage shall not exceed the allowable rate specified above.

(4) Blank off panels required for testing to be provided by unit manufacturer.

2.19 ELECTRICAL SERVICE

A. Provide adequate lighting and switching so equipment can be observed and maintained in safe manner. Combination lighting and convenience outlet circuit is required for each section of unit. Each access section shall contain a minimum of one light fixture. Sections wider than 12 ft shall have multiple light fixtures with maximum spacing of 6 feet (182.88 cm)

(1) Provide two light switches with pilot light. Locate switch near supply fan and return fan section.

(2) Wire all lights to single junction box with single switch with pilot light.

(3) Provide timer for light switch to automatically turn off lights after preset time. Timer shall be similar to Intermatic Model FF2H with 0-2 h range and hold feature to override automatic shut-off function.

(4) Light fixtures shall be: LED type. Provide bulbs for each fixture.

B. Lights, switches, convenience outlets, wiring and conduit shall meet requirements of appropriate Specification Sections of Division 26.

C. Wiring inside of unit shall be provided by unit manufacturer meeting requirements of NEC and appropriate Specification Sections of Division 26. In addition, wiring shall be in metallic conduits.

(1) Provide junction box for each fan motor at outside of unit wall for 3 Ph, 480 V power connection and separate junction box for 1 Ph, 120 V power connection.

(2) Provide two points of power connection, one for 3 Ph, 480 V and one for 1 Ph, 120 V power connection.

D. Seal electrical penetrations into unit air-tight.

2.20 PIPED SERVICE

A. Interior piping and equipment installation shall be complete. Piping shall be installed and tested per appropriate specification section. Unit manufacturer shall be responsible for any leaks, which occur in unit during system testing which occurs before system startup.

B. Extend piping for each coil and humidifier if used through panel casing. Terminate piping with flange for pipe 2-1/2" and larger or threaded connection for pipe 2" and smaller with caps.

PART 3 EXECUTION

3.01 INSTALLATION

A. Units shall be assembled in unit manufacturer's plant to allow for testing of complete unit.

B. Unit manufacturer shall supervise and be responsible for all field joining of the modules, including sheet metal, electrical and piping. Local trades may provide labor for unit assembly and installation.

C. Joints in floor between modules shall be air and water tight.

D. Unit manufacturer shall provide and install all equipment within unit as specified including fans, motors, coils, humidifiers, dampers, sound attenuating devices, piping, piping specialties, ductwork specialties, lights, switches and all equipment necessary to complete air handling equipment contained within housings. Mechanical and electrical connections (i.e., piping and conduit) shall be stubbed through housing so that appropriate Contractor may provide service to air handling unit. Electrical wiring and control wiring shall terminate in junction boxes on accessible side of unit.

E. Provide structural steel sub-base as required. Refer to Unit Base in Part 2.

F. Field mounting of any equipment on housing walls or roof is not allowed without prior approval of Engineer.

G. Unit manufacturer and installing contractor shall coordinate with other trade Contractors, all necessary requirements to assure proper air handling unit installation.

3.02 INSTRUMENT TEST HOLES

A. Provide instrument test holes at air entering and air leaving side of all internal air handling unit components for static pressure differential or temperature measurements. Refer to Section 23 33 14 - Ductwork Specialties, for instrument test holes.

3.03 PROTECTION OF OPENINGS

A. Protect openings on housings during construction against entry of foreign matter and construction dirt.

3.04 FIELD TESTING

A. Unit manufacturer and installing contractor shall jointly perform field casing leakage test on each completed housing assembly as previously specified and shall be responsible for repair of all leaks. Submit certified test data to Engineer for approval.

B. Temporary sealing of access doors, condensate drains, etc. is not allowed during field testing except to troubleshoot leakage points.

END OF SECTION 23 73 28

SECTION 23 81 26 - SPLIT-SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 23 05 50 - Vibration Isolation

1.02 SUBMITTALS

A. Shop Drawings including the following:

(1) Manufacturer's name and model number
(2) Identification as referenced in the Documents
(3) Capacities/ratings
(4) Materials of construction
(5) Dimensions and weights
(6) Wiring diagrams
(7) Manufacturer’s installation instructions
(8) All other appropriate data

B. LEED Submittals:

(1) Product Data for IEQ Prerequisite 1: Documentation indicating that units comply with ASHRAE 62.1 -2007, Section 5 – “Systems and Equipment.”
(2) Product Data for EA Credit 4: Documentation required by EA Credit 4 indicating that equipment and refrigerants comply.

1.03 OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide for services of factory trained service engineer to supervise and approve installation; start-up, test and adjust unit for proper operation; and instruct Owner's representative in operation and maintenance of machine. This shall include furnishing start-up and test log showing all initial settings and readings; signed by manufacturer's service representative. Before acceptance by Owner, unit manufacturer shall approve, in writing, complete installation including piping and wiring connections, and proper functioning of all operational and safety controls.

B. Manufacturer shall include additional 4-yr compressor warranty.

PART 2 - PRODUCTS

2.01 MINI-SPLIT SYSTEM

A. Manufacturers: Mitsubishi, Toshiba, Carrier, Daikin or LG. Manufacturer shall be responsible for entire system consisting of direct expansion cooling fan coil unit and condensing unit.

B. Unit data shall be certified in accordance with AHRI 210/240.

C. Provide factory assembled and tested, outdoor mounted, air-cooled condensing unit suitable for installation on grade. Include compressor, air cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls, motor starting components and additional features as specified herein or required for safe, automatic operation. Capacity and operating characteristics as indicated in the equipment schedule. Coil performance data shall be in accordance with AHRI 410. Refrigerant shall be R-32.

D. Condensing unit cabinet shall be constructed of heavy gauge, galvanized steel coated with weather resistant paint. Provide removable access panels to facilitate full access to the compressor, fan and control components.

E. Furnish head pressure control to operate compressor satisfactorily at ambient temperature to -20ºF (-29ºC) at minimum compressor load.

F. Provide factory assembled indoor fan coil unit. Cabinet shall be impact resistant and fully insulated. Supply fan shall be direct drive tangential blower. Motor shall be multi-speed, ODP with permanently lubricated bearings. Cooling coil shall be copper tube with aluminum fin and galvanized steel tube sheets. Drip pan under coil shall have drain connection with internal trap. Unit shall have filter rack with factory supplied cleanable filters. Unit shall be furnished with integral wall mounting bracket and mounting hardware.

G. Indoor fan coil unit shall be powered by outdoor condensing unit.

H. Provide with complete electronic microprocessor control system that shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature shall be controlled by a programmable wired remote thermostat with integral temperature sensor and wall mounting bracket.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install units as shown on Drawings and according to manufacturer's instructions.

B. Start-up units in accordance with manufacturer’s start-up instructions. Test controls and demonstrate compliance with requirements.

C. Extend cooling coil condensate drain to nearest code approved drain location; provide trap at drain pan.

END OF SECTION 23 81 26

SECTION 23 82 14 - HEATING AND COOLING TERMINAL DEVICES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 20 0513 - Motors

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

A. Shop Drawings for all items in this Section including, but not limited to, the following:

(1) Manufacturer's name and model number
(2) Identification as referenced in the documents
(3) Capacities/ratings
(4) Materials of construction
(5) Dimensions and weights
(6) Color selection chart where applicable
(7) Wiring diagrams
(8) Motor data (refer to Section 20 0513 - Motors)
(9) For chilled beams, submit performance data from independent testing agency. Performance data to include cooling capacity at supply water temperatures scheduled, air pressure drop, sound data, and water pressure drop for each beam length.
(10) All other appropriate data

1.04 REFERENCE STANDARDS AND DESIGN CRITERIA

A. Duct Reheat Coils: Ratings shall be certified in accordance with AHRI Standard 410.

B. Finned-Tube Radiation: Ratings shall be IBR Certified.

C. Units including electrical work shall be UL Listed.

1.05 ELECTRICALLY COMMUTATED (EC) MOTORS

A. Where EC motors are indicated in Part 2 of this Section, such motors shall comply with Section 20 0513 – Motors.

PART 2 PRODUCTS

2.01 DUCT REHEAT COILS (HOT WATER)

A. Manufacturers: Carrier, Trane, Greenheck, Aerofin, RAE, Temtrol, or Heatcraft

B. Reheat coils furnished with air terminal devices will be acceptable, provided coils are meeting requirements specified in this section.

C. Coils shall be constructed of 0.016” minimum tube wall, 1/2" or 5/8" OD copper tubes with aluminum fins suitable for minimum working pressure to 200 psig (1378.95 kPa) and temperatures to 220°F.

D. Coils having steel nipples for connection are not allowed.

E. Coil fins shall be continuous serpentine or plate fin type.

F. Coil headers shall be heavy seamless copper with all tubes brazed to header.

G. Casing shall have G90 galvanized steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section.

H. Coil frame shall be suitable for drive slip or flange and gasket connection to ductwork.

2.02 UNIT HEATERS

A. Manufacturers: Modine, McQuay, Sterling, Vulcan, Sigma, Rittling or Trane

B. Heating elements shall be constructed of copper tubing with aluminum fins and tested at 250 psig (1723.69 kPa) air under water.

C. Casings shall be steel phosphatized and finished in baked enamel.

D. Furnish directional louvers for horizontal units and louver cone diffuser for projection units.

E. Fans shall have aluminum blades, factory balanced and quiet in operation and furnished with safety guard.

F. Electrical

(1) Unit shall have junction box for motor terminals factory mounted on unit or integral to motor.

(2) Provide unit mounted non-fused electrical disconnect switch.

G. Motors:

(1) Motors shall be TEFC.

(2) Single phase motors shall have built-in thermal overload.

2.03 CABINET UNIT HEATERS

A. Manufacturers: Vulcan, McQuay, Sigma, Rittling, Sterling or Trane

B. Water coils shall be constructed of 3/8", 1/2", or 5/8" OD seamless copper tubes with aluminum fins suitable for maximum working pressure to 300 psig (2068.43 kPa) and temperature to 200°F.

C. Cabinet front panels shall be 18 ga steel for horizontal units and 16 ga steel for vertical units.

D. Exposed ceiling type units shall be furnished with hinged access panels to provide complete access to entire unit.

E. Units shall be furnished with filter rack and 2 sets of 1/2" or 1" thick glass fiber or aluminum filter.

F. Cabinets shall have baked enamel finish, colors to be selected by Architect.

G. Fan wheels shall be centrifugal forward-curved and double-width type, statically and dynamically balanced.

H. Units shall be furnished with 3-speed direct drive motor(s) and 3-speed manual switch settings.

I. Disconnect switches shall be factory-mounted at units.

2.04 FAN COIL UNITS

A. Manufacturers: Enviro-Tec, York, JCI, Carrier, Trane, McQuay, Rittling, International Environmental Corporation (IEC), Greenheck, or Modine

B. Unit data shall be certified in accordance with AHRI Standard 430 or 440.

C. Coils shall be constructed of 3/8", 1/2" or 5/8" OD seamless copper tubes with aluminum fins suitable for maximum working pressure to 300 psig (2068.43 kPa) and temperatures to 200ºF. Coil stub outs shall be 5/8" OD copper tubing. Furnish coils with manual air vents. Coil performance data shall be in accordance with AHRI Standard 410.

D. Units shall be furnished with centrifugal fans, separate hot and chilled water coils as scheduled, speed selection switches, condensate drain pans, and galvanized steel casings.

E. Drain Pans

(1) Primary condensate drain pans shall be single wall; heavy gauge galvanized steel for corrosion resistance and extend under the entire cooling coil. Drain pans shall be of one-piece construction and be positively sloped for condensate removal.

(2) Drain pans shall be field reversible for right-hand or left-hand connections.

(3) Drain pan shall be externally insulated with fire retardant, closed cell foam insulation. Insulation shall carry no more than 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.

(4) Furnish drain pan with condensate overflow switch conforming to UL 508 for condensate overflow unit fan shut off. Locate switch just below secondary drain connection. Pipe secondary drain to primary drain line before p-trap.

(5) Pipe drain line to nearest floor drain where shown on drawings. Fan coil units served by elevated temperature chilled water loop do not require condensate drain lines.

(6) Provide waterless trap similar to Des Champs Technologies N-Series HVAC Air-Trap at each cooling coil condensate drain.

(7) Where required to lift condensate, furnish condensate pump for removal of accumulated condensate in drain pan. Condensate pump shall have capability to lift produced condensate minimum of 15 feet (457.2 cm)

F. Units shall be furnished with 18 ga steel cabinet and access to all internal mechanical and electrical devices. Cabinets of exposed units shall have baked enamel finish in one of manufacturer's standard colors, selected by Architect. Cabinets of concealed units may be prime coated or galvanized steel. Ducted units shall be furnished with supply and return duct collars.

G. Fan wheels shall be aluminum or galvanized steel construction, centrifugal forward-curved and double-width type, statically and dynamically balanced.

H. Units shall be acoustically and thermally insulated with minimum 1/2" glass fiber insulation. Drain pans shall be constructed of galvanized steel insulated with minimum 1/4" fire retardant closed cell foam. Drain pan shall be constructed in compliance with ASHRAE 62.1-2010 and insulation shall meet requirements of NFPA 90A.

I. Each unit shall include readily accessible filter rack. Furnish 2 sets of 2" thick minimum efficiency MERV-8, based on ASHRAE Test Standard 52.2, throwaway glass fiber filter for each unit.

J. Motors:

(1) Unless otherwise indicated, furnish units with 3-speed permanent split capacitor motors with thermal overload protection with automatic reset.

K. Electrical:

(1) Provide factory mounted non-fused disconnect switch.

2.05 ACTIVE CHILLED BEAMS

A. Manufacturers: Dadanco, Semco, Price, or approved equal.

B. Units shall be induction type with primary air connection(s), induction nozzles, chilled water coil(s), heating hot water coil(s) (where scheduled), integral air diffuser(s) and removable induction inlet grille for access to coil face(s). Units shall be designed for 2-pipe, cooling only duty or 4-pipe heating and cooling duty as scheduled.

C. All components of chilled beam shall meet NFPA 90A requirements for flame spread and smoke developed.

D. Housing shall be formed/stamped aluminum or galvanized steel.

E. Units shall be complete with flush mounted, removable induction grille for access to coil(s), supply air plenum with inlet duct collars, induction nozzles, and slotted supply diffusers in 1-way or 2-way throw configuration as scheduled.

F. Induction inlet grille shall be removable for coil access. Grilles shall have safety cables or chains to support grille core during coil access or grilles shall be hinged along one side, allowing grille core to swing down 90 degrees minimum for coil access.

G. Provide minimum of 4 adjustable support tabs/brackets per unit, for hanger support from building structure Each beam shall be individually supported to building structure as recommended by manufacturer. Installation hardware shall be in accordance with manufacturer's recommendations and any local codes that dictate hanging requirements.

H. Units shall have removable and interchangeable plastic induction nozzles.

I. Diffuser and induction grille face shall be constructed of aluminum or pressed steel components. Induction grille shall be perforated steel or aluminum, of sufficient gauge to avoid sagging. Air plenum shall be constructed of minimum 22 ga galvanized steel. Interior of plenum shall be painted black if visible from room side.

J. Diffuser and induction grille face shall be powder coat or baked enamel finish with color selected by architect.

K. Units shall be designed with standard US (IP) dimensions and NPT pipe connections.

L. Units shall be of nominal length and width scheduled and shall be compatible with ceiling type scheduled or specified by Architect.

M. Units for installation without a ceiling, shall be provided with diffuser extension (Coanda) wings to assist horizontal throw.

N. Unit face shall be drop-face or flat-face as scheduled.

O. Water coils shall be constructed of 1/2" or 5/8" OD seamless copper tubes with minimum wall thickness of 0.016" with aluminum fins suitable for minimum working pressure to 300 psig (2068.43 kPa) at 75ºF temperature. Coil connections shall be NPT threaded.

P. Coils shall be rated according to AHRI Standard 410. Coils shall be delivered factory clean, flushed and capped. Water pipes shall be factory fitted with one vent and one drain valve.

Q. Coil shall be factory painted flat black.

R. Where dual coils are used to meet scheduled capacity, provide dual coils with factory pre-piped single point supply and return connections.

S. Accessories:

(1) Provide flexible metal hose assemblies for cooling and heating water connections for each chilled beam. Minimum length of metal hose assembly shall be 18" and maximum length shall be 24".

(a) Flexible Hose:

1) Stainless Steel (Corrugated) Core:

1. Flexible hose shall be constructed of corrugated 300 series stainless steel core, 300 series stainless steel braided cover, stainless steel ferrules, and 304 stainless steel end connections. Maximum Allowable Operating Pressure (MAOP) shall be not less than 400 psi (2757.90 kPa) at 600°F.

T. Submittals shall include performance data from independent testing agency. Performance data to include cooling/heating capacity at supply water temperatures scheduled, air pressure drop, supply air throw performance, sound data and water pressure drop for each chilled beam length and throw configuration.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install units as indicated on drawings, and according to manufacturer's installation instructions.

B. Install branch piping to each unit with minimum of 3 elbows to allow for expansion and contraction.

C. Protect units during construction against entry of foreign matter and construction dirt.

D. Unless otherwise shown on drawings, mount vertical type wall mounted heating units 12" above finished floor.

3.02 DUCT REHEAT COILS

A. Comb out fins when bent or crushed before enclosing coils in ductwork. Clean dust and debris from each coil to ensure its cleanliness.

B. Seal or gasket coil connection to ductwork to meet maximum allowable leakage rate specified in Section 23 3114 - Ductwork, Part 3.

C. Protect units during construction against entry of foreign matter and construction dirt.

D. Unless otherwise specified, connect piping to coils with multiple rows for counter-flow arrangement.

3.03 FIN TUBE RADIATION

A. Unless otherwise shown on drawings, mount units with manufacturer's recommended minimum height above finished floor to provide capacities scheduled.

3.04 FAN COIL UNITS

A. Mount units above concealed ceilings or as shown on drawings with ample clearances for coil pull and filter service.

B. Provide vibration isolation hangers for support of each unit.

C. Duct connections to fan coil units shall use flexible duct connections.

3.05 ACTIVE CHILLED BEAMS

A. Mount units in ceilings as shown on drawings and on reflected ceiling plans.

B. Support units independently of ceiling grid and directly from building structure, with minimum of 4 supports per chilled beam, using threaded rod or approved cable supported system. Wire supports are not allowed.

C. Where necessary, provide strut supports spanning under wide obstructions (ducts) to allow for proper alignment of chilled beam to ceiling grid.

D. Install manual air vents for complete venting of air from system. Provide drain valves at low points of main or branch main piping.

E. Multiple chilled beams may be zoned to match associated supply air terminals and controlled through single control valve. Refer to chilled beam schedule and/or drawings for chilled beams served by common control valve.

END OF SECTION 23 82 14

SECTION 23 82 16 - COILS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 23 8214 - Heating and Cooling Terminal Devices (Reheat Coils)

1.02 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

(1) Manufacturer's name and model number
(2) Identification as referenced in the documents
(3) Capacities/ratings
(4) Flow rate and pressure drop
(5) Materials of construction
(6) Dimensions and weights
(7) Manufacturer's installation instructions
(8) All other appropriate data

1.04 DESIGN CRITERIA

A. This Section covers coils in factory-packaged air handling unit, custom air handling units and field-erected air handling units.

B. Coil sizes, capacities, configuration and operating characteristics to be as shown on plans and/or as scheduled. Coil performance data shall be certified in accordance with AHRI Standard 410, unless scheduled coil performance is outside range of standard rating conditions.

C. Coils shall be counter flow design, air to water.

D. Unless otherwise specified, temperature profile of discharge air from entire coil face shall be uniform within 12" of coil face.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Carrier, McQuay, Trane, Marlo, Heatcraft, Aerofin, RAE, Temtrol, Cancoil or Precision Coils

2.02 HOT WATER COILS

A. Coils shall be constructed of 0.024" tube wall, 1/2" or 5/8" OD seamless copper tubes with aluminum fins suitable for working pressures to 200 psig (1378.95 kPa) and temperatures to 220°F. Coils shall be tested at 250 psig (1723.69 kPa) under water.

B. Coil fins shall be continuous serpentine or plate fin type.

C. Coil headers shall be Type L seamless copper conforming to ASTM B88, with tubes brazed to header.

D. Coil connections shall be Schedule 40 seamless red brass conforming to ASTM B43, threaded end for 2" and smaller and flanged end for 2-1/2" and larger.

E. Casings shall be minimum 16 ga galvanized steel having galvanized steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section.

F. Coils shall be equipped with bronze spring turbulators where required to provide capacities indicated.

2.03 CHILLED WATER COILS

A. Coils shall be constructed of 0.035” tube wall, 5/8”OD seamless copper tubes with 0.0095” aluminum fins suitable for working pressures to 200 psig (1378.95 kPa). Coils shall be tested at 250 psig (1723.69 kPa) under water.

B. Coil fins shall be continuous plate fin type.

C. Coil headers shall be constructed of Type L seamless copper conforming to ASTM B88, with tubes brazed to header.

D. Coil connections shall be Schedule 40 seamless red brass conforming to ASTM B43, threaded end for 2" and smaller and flanged end for 2-1/2" and larger.

E. Casings shall be minimum 16 ga 304 stainless steel having steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section. Support and channels shall be same metal as casing.

F. Select coils for tube velocity not less than 3.0 fps.

G. Maximum allowable fin spacing shall be 10 fins per inch. Coil depth shall not exceed 8 rows.

H. If more than two cooling coils are stacked due to casing height, each coil shall be fitted with a condensate pan in order to prevent flooding the bottom coil with condensate. Coat condensate pans with ½" thick foamed-in-place, cellular insulation.

PART 3 EXECUTION

3.01 GENERAL

A. Install coils as indicated on drawings and/or as detailed. Pitch coils for proper drainage according to manufacturer's installation instructions. Install shims as required.

B. Clean oil film from coil fins with hot water/detergent as recommended by coil manufacturer.

C. Comb out fins when bent or crushed before enclosing coils in housing. Clean dust and debris from each coil to ensure its cleanliness.

D. Provide offsets in piping to facilitate coil removal. Unless otherwise specified, pipe coils for counter flow arrangement.

E. Install piping flexible connections and/or piping vibration isolation supports as specified in Section 23 0550 - Vibration Isolation.

F. Provide piping flexible connections for floor-mounted coils.

G. Provide air vent and drain valve at each water coil.

H. Provide shut-off valves, balancing valve, drain valve and air vent for each coil for air handling unit with multiple coils as shown on drawings.

I. Pipe condensate drain pan to the nearest drain with trap.

END OF SECTION 23 82 16

SECTION 23 82 39 - UNIT HEATERS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 23 05 13 - Motors for Mechanical Equipment

1.02 SUBMITTALS

A. Shop Drawings for all items in this Section including the following:
   (1) Manufacturer's name and model number
   (2) Identification as referenced in the documents
   (3) Capacities/ratings
   (4) Materials of construction
   (5) Dimensions and weights
   (6) Color selection chart where applicable
   (7) Wiring diagrams
   (8) Motor data (refer to Section 23 05 13 - Motors for Mechanical Equipment)
   (9) All other appropriate data

B. LEED Submittal:
   (1) Product Data for IEQ Prerequisite 1: Documentation indicating that units comply with ASHRAE 62.1 -2007, Section 5 – “Systems and Equipment.”

1.03 REFERENCE STANDARDS AND DESIGN CRITERIA

A. AHRI 1240 Standard for Performance Rating of Active Chilled Beams.

B. Units including electrical work shall be UL Listed.

C. Electric Heaters: Shall be listed by UL, bear appropriate UL Label, contain the latest devices for protection of installation, and shall be installed in strict accordance with the latest revision of National Electric Code and other applicable State and Local Codes. Provide grounding lugs on all apparatus.

1.04 ELECTRICALLY COMMUTATED (EC) MOTORS

A. Where EC motors are indicated in Part 2 of this Section, such motors shall comply with Section 23 05 13 - Motors for Mechanical Equipment.

PART 2 - PRODUCTS

2.01 HYDRONIC UNIT HEATERS

A. Manufacturers: Vulcan, Daikin, Sigma, Rittling, Sterling, Modine or Jaga

B. Heating elements shall be constructed of copper tubing with aluminum fins and tested at 250 psig (1720 kPa) air under water.

C. Casings shall be minimum 20 ga (0.912 mm) steel with epoxy or polyester powder coat finish, or baked enamel finish

D. Furnish adjustable horizontal and vertical discharge louvers for horizontal units and adjustable cone diffuser for projection units.

E. Fans shall have aluminum blades, factory balanced and quiet in operation and furnished with finger-proof safety guard.

F. Electrical
   (1) Unit shall have junction box for motor terminals factory mounted on unit or integral to motor.
   (2) Provide unit mounted fused electrical disconnect switch.
   (3) Provide (unit-mounted) line voltage thermostat (suitable for wall mounting).

G. Motors:
   (1) Motors shall be TEFC with characteristics as scheduled.
   (2) Single phase motors shall be permanently lubricated and have built-in thermal overload.

2.02 CABINET UNIT HEATERS

A. Manufacturers: Vulcan, Daikin, Sigma, Rittling, Sterling, Modine or Trane

B. Water coils shall be constructed of 3/8” (9 mm), 1/2" (13 mm), or 5/8" (16 mm) OD seamless copper tubes with aluminum fins suitable for maximum working pressure to 300 psig (2070 kPa) and temperature to 200°F (93°C).

C. Steam coils shall be constructed of 1“ (25 mm) OD seamless copper tubes with aluminum fins suitable for maximum working pressure to 100 psig (689 kPa) and temperature to 325°F (162°C). Coil stub outs shall be 5/8" (16 mm) OD copper tubing.

D. Cabinet front panels shall be 18 ga (1.214 mm) steel for horizontal units and 16 ga (1.519 mm) steel for vertical units.

E. Exposed ceiling type units shall be furnished with hinged access panels to provide complete access to entire unit.

F. Ducted units shall be furnished with supply and return duct collars.

G. Units shall be furnished with filter rack and 2 sets of 1/2” (12 mm) or 1" (25 mm) thick glass fiber or aluminum filter.

H. Cabinets of exposed units shall have epoxy or polyester powder coat finish, or baked enamel finish in one of manufacturer's standard colors to be selected by Architect.

I. Cabinets of exposed units shall have epoxy or polyester powder coat finish, or baked enamel finish, colors to be selected by Architect.

J. Cabinets of concealed units shall be prime coated or galvanized steel.

K. Fan wheels shall be aluminum or galvanized steel construction, centrifugal forward-curved and double-width type, statically and dynamically balanced.

L. Units shall be furnished with 3-speed direct drive motor(s) and 3-speed manual switch settings.

M. Furnish units with direct-drive variable speed electrically commutated (EC) motor with manual speed control. Refer to Section 23 05 13 - Motors for Mechanical Equipment. Number and horsepower of motor(s) shall be as scheduled.

N. Disconnect switches shall be factory-mounted at units.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install units as indicated on Drawings, and according to manufacturer's installation instructions.

B. Install branch piping to each unit with minimum of 3 elbows to allow for expansion and contraction.

C. Protect units during construction against entry of foreign matter and construction dirt.

END OF SECTION 23 82 39

END OF DIVISION 23

DIVISION 26 - ELECTRICAL

SECTION 26 00 00 GENERAL ELECTRICAL REQUIREMENTS

SECTION 26 01 26 MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

SECTION 26 04 77 POWER MODULE SWITCH-ELEVATOR DISCONNECT

SECTION 26 05 13.16 MEDIUM-VOLTAGE, SINGLE, AND MULTI-CONDUCTOR CABLES

SECTION 26 05 19 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

SECTION 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

SECTION 26 05 33 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

SECTION 26 05 33 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

SECTION 26 05 43.13 EXCAVATION AND BACKFILL

SECTION 26 05 43.19 MANHOLES AND HARDWARE

SECTION 26 0543.23 UNDERGROUND ELECTRICAL SERVICE

SECTION 26 05 53 ELECTRICAL SYSTEMS IDENTIFICATION

SECTION 26 05 73 POWER SYSTEM STUDIES

SECTION 26 05 93 ELECTRICAL SYSTEMS FIRESTOPPING

SECTION 26 08 00 COMMISSIONING OF ELECTRICAL SYSTEMS

SECTION 26 08 12 POWER DISTRIBUTION ACCEPTANCE TESTS

SECTION 26 08 13 POWER DISTRIBUTION ACCEPTANCE TEST TABLES

SECTION 26 09 23 LIGHTING CONTROL DEVICES

SECTION 26 09 43 NETWORK LIGHTING CONTROLS

SECTION 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

SECTION 26 13 23 MEDIUM VOLTAGE PAD MOUNTED SWITCHGEAR

SECTION 26 22 00 LOW-VOLTAGE TRANSFORMERS

SECTION 26 23 00 LOW-VOLTAGE SWITCHGEAR

SECTION 26 24 13 SWITCHBOARDS

SECTION 26 2416.13 LIGHTING AND APPLIANCE PANELBOARDS

SECTION 26 2416.16 DISTRIBUTION PANELBOARDS

SECTION 26 27 13 ELECTRICAL METERING

SECTION 26 27 26 WIRING DEVICES

SECTION 26 28 13 FUSES

SECTION 26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

SECTION 26 29 13 ENCLOSED CONTROLLERS

SECTION 26 32 13 ENGINE GENERATORS

SECTION 26 36 23 AUTOMATIC TRANSFER SWITCHES

SECTION 26 41 13 LIGHTNING PROTECTION FOR STRUCTURES

SECTION 26 43 00 SURGE PROTECTIVE DEVICES (SPD)

SECTION 26 50 00 LIGHTING

SECTION 26 00 00 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Intent of drawings and Specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, the terms “provide”, “furnish” and “install” as used in Division 26 Contract Documents shall have the following meanings:

(1) “Provide” or “provided” shall mean “furnish and install”.

(2) “Furnish” or “furnished” does not include installation.

(3) “Install” or “installed” does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this Contract are electrical connections to equipment provided by others. Refer to Architectural, Mechanical, Plumbing, and final shop drawings for equipment being furnished under other sections for exact locations of electrical outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for dimensions.

G. Where architectural features govern location of work, refer to Architectural Drawings.

H. Perform work in “neat and workmanlike” manner as defined in ANSI/NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

1.02 RELATED WORK

A. Utility Services:

(1) Include costs for temporary service, temporary routing of service or other requirements of a temporary nature associated with utility service.

B. Temporary Services:

(1) Division 01 - Temporary Facilities and Controls.

C. Continuity of Service:

(1) No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.

(2) When interruption of services is required, Architect, Owner and other concerned parties shall be notified and shall determine a time.

D. Demolition:

(1) Division 02 - Selective Demolition

(2) Division 02 - Building Demolition

(3) Perform required demolition to accomplish new work.

(a) Remove abandoned wiring to source of supply.

(b) Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

(c) Disconnect abandoned outlets and remove devices.

(d) Remove abandoned outlets if conduit servicing them is abandoned and removed.

(e) Provide blank cover for abandoned outlets that are not removed.

(f) Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

(g) Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

(h) Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

(4) Accomplish work in neat workmanlike manner to minimize interference; annoyance or inconvenience such work might impose on Owner or other Contractors.

(5) Unless otherwise noted, remove from premises materials and equipment removed in demolition work.

(6) Equipment noted to be removed and turned over to Owner, shall be delivered to Owner at place and time Owner designates.

(7) Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.

(8) Where demolition work interferes with Owner's use of premises, schedule work through Architect, Owner and with other Contractors to minimize inconvenience to Owner. Architect must approve schedule before Contractor begins such work.

E. Concrete Work:

(1) Provide cast-in-place concrete as required by Contract Documents unless otherwise noted.

(2) Concrete shall comply with Division 03 - Concrete.

(3) Provide anchor bolts, metal shapes and templates to be cast in concrete or used to form concrete as required for anchoring and supporting electrical equipment.

F. Painting:

(1) Furnish equipment with factory-applied finish coats or paint equipment per Division 09 – Finishes unless specified otherwise.

(2) Furnish equipment with factory applied prime finish unless otherwise specified.

(3) If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect.

(4) Furnish one can of touch up paint for each final factory-applied finish coat of product.

G. Sustainable Architecture and LEED Requirements:

(1) Provide services, documentation, and product data required to meet LEED credits involving an electrical component such as:

(a) Prerequisite SS – Construction Activity Pollution Prevention

(b) Credit SS – Light Pollution Reduction

(c) Credit WE – Water Metering

(d) Prerequisite EA – Fundamental Commissioning of the Building Energy Systems

(e) Prerequisite EA – Minimum Energy Performance

(f) Prerequisite EA – Building-Level Energy Metering

(g) Credit EA – Enhanced Commissioning

(h) Credit EA – Optimize Energy Performance

(i) Prerequisite MR – Construction and Demolition Waste Management Planning

(j) Credit MR – Building Product Disclosure and Optimization – Environmental Product Declarations

(k) Credit MR – Building Product Disclosure and Optimization – Sourcing of Raw Materials

(l) Credit MR – Building Product Disclosure and Optimization – Material Ingredients

(m) Credit MR – Construction and Demolition Waste Management

(n) Credit MR 4 – Recycled Content

(o) Credit MR 5 – Regional Materials

(p) Credit EQ – Low Emitting Materials

(q) Credit EQ – Construction Indoor Air Quality Management Plan

(r) Credit EQ – Interior Lighting

(s) Credit EQ – Daylighting

(t) Credit EQ – Acoustic Performance

(u) Credit ID – Innovation

1.03 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.04 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:

(1) Association of Edison Illuminating Companies

(2) American National Standards Institute

(3) American Society of Mechanical Engineers

(4) American Society for Testing and Materials

(5) Building Industry Consulting Services International

(6) Electronic Industries Association

(7) Federal Information Processing Standards

(8) Federal Communications Commission

(9) Insulated Cable Engineers Association

(10) Institute of Electrical & Electronics Engineers

(11) Illuminating Engineering Society of North America
(12) National Electrical Code
(13) National Electrical Contractors Association
(14) National Electrical Manufacturers Association
(15) National Electrical Safety Code
(16) National Electrical Testing Association
(17) National Fire Protection Association
(18) National Institute of Standards & Technology
(19) Telecommunications Industries Association
(20) Underwriters Laboratories, Inc.

B. Work shall be in accordance with latest edition of codes, standards or specifications unless otherwise noted.

1.05 LISTING

A. Install materials bearing UL label or UL listing, unless UL label or listing is not available for that type of material.
B. Other nationally recognized testing agencies, acceptable to AHJ, are approved.

1.06 ENCLOSURES

A. Typical NEMA Enclosures and Usage
(1) NEMA 1 - Indoors. Falling dirt.
(2) NEMA 2 - Indoors. Falling dirt. Falling liquids. Light splashing.
(3) NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust.
(4) NEMA 3X - Same as NEMA 3 plus corrosion resistant.
(5) NEMA 3S - Same as NEMA 3 plus mechanism operable when ice covered.
(6) NEMA 3SX - Same as NEMA 3S plus corrosion resistant.
(7) NEMA 3R - Outdoors. Rain, snow, sleet.
(8) NEMA 3RX - Same as NEMA 3R plus corrosion resistant.
(9) NEMA 4 - Indoors: Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down. Outdoors: Rain, sleet, snow. Windblown dust. Hose down.
(10) NEMA 4X - Same as NEMA 4 - Indoors / Outdoor plus corrosion resistant.
(11) NEMA 5 - Indoors. Falling Dirt. Falling Liquids. Settling dust, lint and fibers.
(12) NEMA 6 - Indoors: Falling dirt. Falling and light splashing liquids. Flying dust, ling and fibers. Hose down. Temporary submersion. Outdoors: Rain, snow, sleet. Windblown dust. Hose down. Temporary
(13) NEMA 6P - Same as NEMA 6 - Indoors plus corrosion resistant. Prolonged submersion.
(14) NEMA 6P - Same as NEMA 6 - Outdoors plus corrosion resistant. Prolonged Submersion.
(15) NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).
(16) NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).
(17) NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.
(18) NEMA 13 - Same as NEMA 12 plus oil or coolant spraying or splashing.

1.07 SUBMITTALS

A. Shop Drawings (Product Data):
(1) Refer to Division 01 - Submittal Procedures.
(2) Note that for satisfying submittal requirements for Division 26, “Product Data” is usually more appropriate than true “Shop Drawings” as defined in Division 01. However, the expression “Shop Drawings” is generally used throughout Specification.
(3) Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.
(4) Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
(5) Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
(6) When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Clearly mark and note submittal accordingly.
(7) Submit complete record of required components when luminaires, equipment and items specified include accessories, parts and additional items under one designation.
(8) Include wiring diagrams for electrically powered or controlled equipment.

(9) Submit electrical equipment room layouts drawn to scale, including equipment, raceways, accessories and required working clearances. Submit electrical equipment room layouts concurrently with electrical distribution equipment submittals.

(10) Where submittals cover products containing non-metallic materials, include “Material Safety Data Sheet” (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.

(11) Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.

(12) Submittals that are not complete, not permanent, or not properly checked by Contractor, will be returned without review.

(13) Bidders shall provide a full compliance review of specifications. Compliance review shall accompany submittals. Compliance review shall include paragraph-by-paragraph review of specifications with the following information “C”, “D”, “E” marked in the margin of the specification section. Unless a deviation or exception is specifically noted in the compliance review, it is assumed that Bidder is in complete compliance with plans and specifications. Lack of these requirements in the submittal shall result in rejection of submittal. Text shall be provided accompanying compliance review as follows:

(a) “C” – Comply with no exceptions

(b) “D” – Comply with deviations. For each of the deviations, provide numbered footnote with reasons for proposed deviation

(c) “E” – Exceptions; do not comply

B. Bookmarks:

(1) Submitted documents greater than 50 pages in length shall include electronic bookmarks setup to quickly navigate and easily locate submitted information. Each major series of equipment shall have a bookmark.

(2) Hyperlinks can be used to enhance bookmark tools but are not an acceptable substitute for electronic bookmarks. If hyperlinks are used, they should be clearly identifiable as a hyperlink by using a different color text similar to how MS Office identifies hyperlinks.

C. Certificates and Inspections:

(1) Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

D. Operation and Maintenance Manuals:

(1) Refer to Division 01 - Operation and Maintenance Data.

(2) Upon completion of work but before final acceptance of system, submit electronic copy to Architect for approval. After securing approval, submit 3 copies to Owner.

(3) Organize manuals by specification section number and furnish table of contents and tabs for each piece of equipment or system.

(4) Manuals shall include the following:

(a) Copies of shop drawings

(b) Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment, with component exploded views and part numbers. Where manufacturer's data includes several types or models, designate applicable type or model.

(c) Flash/thumb drives of O&M data with exploded parts lists where available

(d) Phone numbers and addresses of local parts suppliers and service companies

(e) Internet/WEB page addresses where applicable

(f) Wiring diagrams

(g) Start up and shut down procedure

(h) Factory and field test records

(i) Additional information, diagrams or explanations as designated under respective equipment or systems specification section

(5) Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.

(6) Furnish O&M manuals and instructions to Owner prior to request for final payment.

(7) Include bookmarks as indicated above.

E. Record Documents:

(1) Refer to General Conditions of Contract and Division 01 - Project Record Documents. Prepare complete set of record drawings in accordance with Division 01.

(2) Use designated set of prints of Contract Documents as prepared by Architect to mark-up for record drawing purposes.

1.08 JOB CONDITIONS

A. Building Access:

(1) Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Coordination:

(1) Equipment provided under other Divisions of these specifications.

(a) Motors

(b) Electrically powered equipment

(c) Electrically controlled equipment

(d) Starters, where specified

(e) Variable frequency drives, where specified

(f) Control devices, where specified

(2) Provide the following devices required for control of motors or electrical equipment, unless otherwise noted:

(a) Starters

(b) Disconnect devices

(c) Control devices:

1) Pushbuttons

2) Pilot lights

3) Contacts

(d) Conduit, boxes and wiring for Power wiring

(e) Conduit, boxes and wiring for Control wiring, except for control wiring systems as defined in Section 23 09 01 - Control Systems Integration.

(3) Connect and wire equipment complete and ready to operate according to wiring diagrams furnished by various trades.

(4) Wire starters or other similar control devices furnished by others.

(5) This Contractor's drawings and/or specifications show number and hp (kW) rating of motors furnished by others, together with their actuating devices. Should any change in size, hp (kW) rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, Contractor responsible for change shall immediately notify this Contractor. Additional costs due to these changes shall be responsibility of Contractor initiating change.

(6) Equipment and wiring shall be selected and installed for conditions in which it will be required to perform. (i.e., general purpose, weatherproof, rain tight, explosion proof, dust tight, or any other special type as required.)

(7) Comply with local utility motor starting requirements and provide starters for motors furnished by others as specified herein or under various trade sections of those specifications.

C. Housekeeping and Cleanup:

(1) Refer to Division 01 - Closeout Procedures.

(2) As work progresses or as directed by Architect, periodically remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.09 WARRANTY

A. Refer to Division 01 for general warranty requirements.

B. Refer to technical sections for warranty requirement for each system.

(1) Where no warranty requirements are called out, warrant as called out in Division 01 equipment, materials, and workmanship to be free from defect. _____ Warranty period shall begin on date of substantial completion.

C. Repair, replace, or alter systems or parts of systems found defective at no extra cost to Owner.

D. In any case, wherein fulfilling requirements of any guarantee, if this Contractor disturbs any work guaranteed under another contract, this Contractor shall restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Warranty shall include labor, material, and travel time.

PART 2 - PRODUCTS

2.01 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.01 GENERAL

A. Verify elevations and dimensions prior to installation of materials.

B. Where conduits are shown on plans, they are shown for reference only. Conduit routes shown on plans may not show all required junction boxes, pull boxes, control conduits, or coordination with other trades. Contractor is responsible for coordination of all conduit routes with other trades and providing junction boxes and pull boxes as required by code.

3.02 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

G. Provide supplemental heat if required to prevent moisture contamination. Provide temporary circuits as required.

3.03 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide sleeves and inserts that are to be built into structure during progress of construction.

B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 ga (0.71 mm) galvanized sheet metal for permanent sleeves unless otherwise noted.

C. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required below grade or to exterior.

D. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.

E. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials, (steel conduit, PVC conduit, cables, cable tray, etc.), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in 26 05 93 - Electrical Systems Firestopping.

G. Adhesives and sealants used on the interior of the building shall comply with VOC limits per section 01352 LEED requirements.

H. Provide 2" (50 mm) clearance around penetration openings intended for raceways and cables. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.

I. Seal non-fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

J. Seal non-rated wall openings with urethane caulk.

K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation or sealing system by another manufacturer approved as equal by Engineer. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

L. Finish and trim penetrations as shown on details and as specified.

M. Provide chrome or nickel-plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.

3.04 EQUIPMENT ACCESS

A. Install raceways, cable tray, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocate raceways or accessories to provide maintenance access at no additional cost to Owner.

B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other future or installed equipment.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors for equipment shall provide access for servicing, repairs and/or maintenance.

D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions.

E. Provide access doors in walls, chases or inaccessible ceilings for equipment requiring access for servicing, repairs and maintenance, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Provide access doors used in fire-rated construction with UL label. Provide steel, prime-coated access doors in dry locations. Provide stainless steel access doors for use in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Provide access doors of sufficient size to allow complete maintenance. Coordinate location of access doors with General Contractor and rough-in equipment accordingly.

F. Locate electrical outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.

G. Verify door swings before installing room light switch boxes. Install boxes on latch side of door unless otherwise noted

3.05 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

B. Provide steel shell with plug type concrete anchors for attaching equipment to concrete. Plastic, rawhide or anchors using lead are not allowed.

C. Do not support equipment or luminaires from metal roof decking.

3.06 SUPPORT PROTECTION

A. In occupied areas, mechanical and electrical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.

B. Provide minimum 1/2” (13 mm) thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft (2.13 m) above floors, platforms or catwalks in these areas.

C. Protect threaded rods or bolts at supporting elements as described above. Trim threaded rods or bolts such that they do not extend beyond supporting element.

3.07 ELECTRICAL SYSTEMS IDENTIFICATION

A. Refer to Section 26 05 53 - Identification for Electrical Systems

3.08 ACCEPTANCE TESTING

A. When testing is to be witnessed by Architect/Engineer or Inspector, notify them at least 10 days prior to testing date.

B. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials.

C. Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

D. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.09 START-UP

A. Systems and equipment shall be started, tested, adjusted, and turned over to Owner ready for operation. This includes “Owner-Furnished, Contractor-Installed” (OFCI) and “Contractor-Furnished, Contractor-Installed” (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with all trades.

3.10 CLEANING

A. Clean systems after installation is complete.

B. Vacuum debris from panelboards, switchboards, motor starter and disconnect switch enclosures, junction boxes and pull boxes two weeks before energization and again prior to completion.

C. Where louvers are provided in switchgear or transformer enclosures, vacuum louvers free of dust and dirt.

D. Clean luminaire lenses and lamps at time of installation and clean lens exteriors just prior to final inspection.

E. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

F. During construction, maintain indoor air quality per general contractors IAQ plan for LEED credit.

END OF SECTION 26 00 00

SECTION 26 01 26 - MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 00 00 - General Electrical Requirements

1.02 DESCRIPTION

A. Test the following systems:

(1) Medium voltage distribution equipment from point of service
(2) 480Y/277 V substations
(3) 208Y/120 V substations
(4) Power distribution monitoring, control and relay equipment
(5) Overcurrent protection device settings
(6) Starters feeding motors 40 hp (30 kW) or greater
(7) Motors 40 hp (30 kW) or greater
(8) Feeders from service point through feeders serving panelboards of 400 A or greater
(9) Emergency or standby generators
(10) Grounding system from service point through branch panelboard feeders
(11) Computer room grounding system

1.03 INITIAL ACCEPTANCE TEST AND INSPECTION

A. Perform acceptance test per NETA ATS - 1987 except as modified herein.

B. Perform on-site testing after equipment installation, unless otherwise noted.

C. Provide material, equipment, labor, and technical supervision to perform such tests and inspections.

D. Provide test power required.

E. Coordinate testing schedule and equipment availability with Owner.

F. Notify Owner 1 week before testing.

G. Prepare test results with comparison to industry and manufacturer's values and tolerances.

H. Assure electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with Contract Documents.

I. Provide recommendations for suitability of continued energization.

1.04 WORK NOT INCLUDED

A. Prime mover testing (turbines or engines) will be performed by others.

B. Uninterruptible Power Systems

1.05 APPLICABLE CODES, STANDARDS AND REFERENCES

A. Perform inspections and tests in accordance with the following Codes and Standards:

(1) National Electrical Code - NEC
(2) National Electrical Manufacturer's Association - NEMA
(3) American Society for Testing and Materials - ASTM
(4) American National Standards Institute - ANSI
(5) Institute of Electrical and Electronic Engineers - IEEE
(6) National Electrical Testing Association - NETA
(7) State and Local Codes and Ordinances
(8) Insulated Cable Engineers Association - ICEA
(9) Association of Edison Illuminating Companies - AEIC
(10) OSHA - Part 1910: Subpart S - 1910.308

B. Perform inspections and tests in accordance with the following references.

(1) Project Design Specifications
(2) Project Design Drawings
(3) Manufacturer's instruction manuals
(4) Manufacturer's shop drawings

C. Qualifications of Testing Agency

(1) Member of NETA.

(2) Meet Federal Department of Commerce requirements for independent testing laboratory accreditation.

(3) Submit proof of above qualifications to Engineer.

1.06 SUBMITTALS

A. Provide 5 copies of complete testing report using NETA printed forms. Test report includes the following: summary of project, description of equipment tested, description of test, test results, conclusion and recommendation, and signature of responsible test organization authority.

B. Submit completed report to Engineer no later than 30 days after completion of testing, unless directed otherwise.

PART 2 - PRODUCTS

2.01 NOT APPLICABLE TO THIS SECTION

PART 3 - EXECUTION

3.01 THE FOLLOWING INDICATES APPLICABLE NETA STANDARD ATS - 1987 SECTIONS FOR THIS PROJECT.

ELECTRICAL ACCEPTANCE TESTS

5. GENERAL
   - 5.1 Test Instrument Calibration
   - 5.2 Test Report
     - 5.2.2.: 5 copies of Test Report
   - 5.3 Safety & Precautions

8. INSPECTION AND TEST PROCEDURES:
   - 8.1 Metal Enclosed Switchgear and Switchboard Assemblies
   - 8.2 Transformers
     - 8.2.1 Transformers - Dry Type
     - 8.2.3 Small Transformers - Dry Type, Air Cooled (600V and Below)
   - 8.3 Cables
     - 8.3.1 Cables - Low Voltage - 600 Maximum
     - 8.3.2 Cables - Medium and High Voltage - 69 kV Maximum
   - 8.4 Metal Enclosed Busways
     - 8.4.1 Visual and Mechanical Inspection
     - 8.4.2 Electrical Tests
     - 8.4.3 Test Values
   - 8.5 Switches
     - 8.5.1 Air Switches
     - 8.5.2 Air Switches - Medium Voltage - Metal Enclosed
   - 8.6 Circuit Breakers
     - 8.6.1 Circuit Breakers - Low Voltage
       - 8.6.1.1 Circuit Breakers - Low Voltage - Insulated Case
       - 8.6.1.2 Circuit Breakers - Low Voltage Power (600V Service Class)
     - 8.6.2 Circuit Breakers - Medium Voltage
       - 8.6.2.3 Circuit Breakers - Medium Voltage - Vacuum
   - 8.9 Protective Relays
     - 8.9.1 Visual and Mechanical Inspection
     - 8.9.2 Electrical Tests
   - 8.10 Instrument Transformers
     - 8.10.1 Visual and Mechanical Inspection
     - 8.10.2 Electrical Tests - Current Transformers
     - 8.10.3 Electrical Tests - Voltage Transformers
     - 8.10.4 Test Values
   - 8.11 Metering and Instrumentation
     - 8.11.1 Visual and Mechanical Inspection
     - 8.11.2 Electrical Tests
   - 8.13 Grounding Systems
     - 8.13.1 Visual and Mechanical Inspection

8.13.2 Electrical Tests
8.13.3 Test Values
8.14 Ground Fault System
8.14.1 Visual and Mechanical Inspection
8.14.2 Electrical Tests
8.14.3 Test Parameters
8.15 Rotating Machinery
8.15.1 AC Motors 40 hp (30 kW) or Greater)
8.16 Motor Control
8.16.2 Motor Control Centers (VFD's)
8.19 Surge Arrestors
8.19.1 Low Voltage Surge Protection Devices
8.19.2 Medium and High Voltage Surge Protection Devices
8.20 Capacitors
8.20.1 Visual and Mechanical Inspection
8.20.2 Electrical Tests
8.20.3 Test Values
8.22 Emergency Systems
8.22.1 Engine Generator
8.22.4 Automatic Transfer Switches
9. SYSTEM FUNCTION TESTS
10. THERMOGRAPHIC SURVEY
11. TABLES

END OF SECTION 26 01 26

SECTION 26 04 77 - POWER MODULE SWITCH-ELEVATOR DISCONNECT

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 00 00 - General Electrical Requirements
B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems
D. Section 26 05 29 - Hangers and Supports for Electrical Systems
E. Section 26 05 33 - Raceway and Boxes for Electrical Systems
F. Section 26 05 53 - Electrical Systems Identification
G. Section 26 05 73 - Power System Studies
H. Section 26 08 12 - Power Distribution Acceptance Tests
I. Section 26 24 16.13 - Lighting and Appliance Panelboards
J. Section 26 24 16.16 - Distribution Panelboards
K. Section 26 27 26 - Wiring Devices
L. Section 26 28 13 - Fuses
M. Section 26 28 16 - Enclosed Switches and Circuit Breakers

1.02 DESCRIPTION

A. This Section includes Power Module Switch(es), and accessories required to distribute electrical power to elevators.

1.03 REFERENCE STANDARDS

A. ANSI/ASME A17.1, 102.2(4)
B. NETA ATS
C. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures
D. NEMA FU 1 – Low Voltage Cartridge Fuses
E. NEMA BS 31047 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
F. NFPA 70 – National Electrical Code
G. UL 98 – Enclosed and Dead Front Switches
H. UL 486A-486B – Wire Connectors
I. UL 512 - Fuseholders

1.04 SUBMITTALS

A. Product Data:
   (1) Include catalog cutsheet information showing voltage, amperage, short circuit current ampere rating, enclosure type and dimensions, configurations, and methods of mounting and installation. Submit listing of all types, sizes and quantity of fuses which will be installed including the location of each.
B. Manufacturer's Installation Instructions:
   (1) Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation and starting of product.
C. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience.
D. Closeout Submittals:
   (1) Project Record Documents:
      (a) Record actual locations with ratings of installed Power Modules Switches .
   (2) Operation and Maintenance Data:
      (a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      (b) Include spare parts data listing, source, and current prices of replacement parts and supplies.
      (c) Include Manufacturer Seismic Qualification Certification and Installation Seismic Qualification Certification.
E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section –Quality Control, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the InterNational Electrical Testing Association (NETA).

(1) Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Obtain all elevator power module switch(es) from a single manufacturer.

C. Comply with NFPA 70 for components and installation.

D. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.

(1) Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Bussmann

B. Eaton

C. Littelfuse

2.02 POWER MODULE SWITCH

A. Provide Power Module Switch in a single NEMA Type 1 enclosure with necessary relay(s), control transformer and other options as required and as shown on drawings.

B. Power Module Switch shall have an ampere rating as shown on drawings and shall include horsepower rated switch with shunt trip capabilities.

C. Power Module Switch shall include as an accessory, a control power transformer with primary voltage rating of 480 volts and 120 volt secondary.

D. Module shall have been successfully tested to a short circuit rating with Low-Peak Class J fuses at 200,000 amps RMS Symmetrical.

E. Switches shall have shunt trip capabilities at 120V AC for remote fire safety signal. Since fire safety control voltage is normally 24 V DC, include for each shunt trip one control power transformer and relay to activate shunt trip solenoid.

F. Switches shall include a key to test switch red "ON" pilot light and 2 normally open and 2 normally closed mechanical interlock auxiliary contacts.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install power module switches in locations as indicated, according to manufacturer's written instructions.

B. Install switches level and plumb.

C. Install wiring between switches and any control, and indication devices.

D. Connect switches and components to wiring system as indicated and instructed by manufacturer.

(1) Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. Identify each power module switch according to requirements specified in Division 26 Section 26 05 53 - Electrical Systems Identification. Attach nameplate to exterior of each switch using small corrosion-resistant metal screws or rivets. Do not use contact adhesive.

F. Install the top of the switch handle a minimum of 3'-6" (1 m) and maximum of 6' 6" (2 m) above finished floor.

3.02 CONNECTIONS

A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening valves. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A-486B.

B. Provide equipment grounding connections for individually mounted overcurrent protective devices as indicated, as required by the NEC and per section 26 05 26 - Grounding and Bonding for Electrical Systems. Tighten connectors to comply with tightening torques specific in UL 486A-486B to assure permanent and effective grounding.

3.03 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment connections, anchorage, and grounding.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

C. Test disconnect switches and/or enclosed circuit breakers per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.

D. Interpret test results in writing and submit to Engineer.

3.04 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, vacuum dirt and construction debris, and repair damaged finish including chips, scratches, and abrasions to match original finish, using manufacturer-supplied paint kit. Do not use compressed air to assist in cleaning.

END OF SECTION 26 04 77

SECTION 26 05 13.16 - MEDIUM-VOLTAGE, SINGLE- AND MULTI-CONDUCTOR CABLES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems

B. Section 26 05 43 - Underground Ducts And Raceways For Electrical Systems

C. Section 26 05 53 - Electrical Systems Identification

D. Section 26 05 93 - Electrical Systems Firestopping

E. Section 26 08 12 - Power Distribution Acceptance Tests

F. Section 26 08 13 - Power Distribution Acceptance Test Tables

1.02 DESCRIPTION

A. Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

B. Cables are for use in wet or dry locations applications.

C. Conductors shall be rated to operate at conductor temperature of 105°C for continuous normal operation, 140°C for emergency overload conditions, and 250°C for short circuit conditions, based on 40°C maximum ambient temperature.

D. Conductor sizes in Section are based on copper wire, and only copper wire shall be used.

1.03 REFERENCE STANDARDS

A. AEIC CS8 – Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46kV.

B. IEEE 48 – Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5kV through 765kV.

C. IEEE 386 – Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600 V (ANSI).

D. IEEE 404 – Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 – 500000 V (ANSI)

E. IEEE 576 – Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications (ANSI)

F. ICEA S-93-639 – 5-46kV Shielded Power Cables for the Distribution and Transmission of Electrical Energy

G. ICEA S-94-649 – 5-46kV Concentric Neutral Cables Rated 5000 to 46000 Volts

H. ICEA S-97-682 – Utility Shielded Power Cables Rated 5000 to 46000 Volts

I. NFPA 70 – National Electrical Code

J. UL 1072 – Medium-Voltage Power Cable

1.04 SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cable and cable accessories.

(1) Include cable drawings with the following data:

(a) Longitudinal cutback and cross-sectional view of cable.

(b) Identification and structure of cable components.

(c) Dimensions of cable components in English and SI units.

B. Material Certificates: For each cable and accessory type, signed by manufacturer.

C. Manufacturer Testing Certificate: For each type and voltage class of cable indicated.

D. Certified Field Quality Control Test Reports per requirements in Section 26 08 12 - Power Distribution Acceptance Tests and Section 26 08 13 - Power Distribution Acceptance Test Tables for each type and voltage class of cable indicated. Indicate applicable standards compliance. Interpret test results and corrective action taken for compliance with specification requirements.

E. Qualification Data: For 15 KV.

F. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

G. Installation Guide: Include the following:

(1) Maximum allowable pulling tension (in pounds and newtons)

(2) Minimum allowable bending radius

(3) Recommended pulling compounds

(4) Splicing and termination instructions with diagrams, dimensions, and material lists

(5) Weight per 1,000 ft (305 m)

(6) Standard “packaging” of reels (i.e., lengths, lagging, banding, etc.)

(7) Reactance and AC resistance (ohms to neutral) of each size and voltage class of cable, both in magnetic and non-magnetic duct, based on 3-1/C cables or 1-3/C cable in one duct.

H. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual locations of cables, splices, and terminations.

(2) Operation and Maintenance Data:

(a) Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.05 QUALITY ASSURANCE

A. Installer: Engage cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable, having not less than 3 yrs experience as licensed electrician.

B. Regulatory Requirements:

(1) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Source Limitations: Obtain cables and accessories through one source from single manufacturer.

D. All cables shall be of a single type and configuration. Date of manufacture shall not precede contract date by more than one year.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Coordinate with manufacturer to provide protective covering over cable and reel to prevent damage during shipping, storage, or handling.

B. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Cables:

(1) Okonite Company

B. Cable Splicing and Terminating Products and Accessories:

(1) Raychem Corporation

(2) RTE Components; Cooper Power Systems, Inc.

(3) Prysmian Group

(4) Thomas & Betts Corporation/Elastimold

(5) 3M; Electrical Products Division

(6) Approved equal

2.02 CABLES

A. Cable Type: MV105

B. Comply with UL 1072, AEIC CS8, ICEA S-93-639 and ICEA S-97-682

C. Conductor: Copper

D. Conductor Stranding: Compact round, concentric lay, Class B

E. Strand Filling: Conductor interstices are filled with impermeable compound

F. Conductor Insulation: Ethylene-propylene-rubber

G. Voltage Rating: 15 kV

H. Insulation Thickness: 133 percent insulation level

I. Shielding: Copper tape, helically applied over semiconducting insulation shield. 25% overlap.

J. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors

K. Circuit Identification: color-coded tape (black, red, blue) under the metallic shielding

L. Cable Armor: Interlocked aluminum applied over cable

M. Cable Jacket: Sunlight-resistant PVC. Color: red, unless otherwise designated

N. Cable lengths shall be supplied with factory-installed, moisture-proof end seals on conductors on each end. Cable seals shall be rubber or plastic caps and shall prevent moisture from seeping into cable ends.

O. Each cable reel shall be tagged with the following:

(1) Manufacturer
(2) Cable Size
(3) Cable Type
(4) Voltage Class
(5) Manufacture Date
(6) Cable Length
(7) Tolerances
(8) Reel Number
(9) Customer Order No.
(10) Customer Name

P. Surface Marking:

(1) Cables shall be permanently printed (or imprinted) on jacket surface at regular intervals over entire length of cable with the following:
(a) Manufacturer’s name
(b) Conductor size
(c) Voltage class
(d) Insulation type
(e) UL designation

Q. Cables shall be constructed and rated for continuous and intermittent submersion in water and shall be suitable for installation in conduit and underground duct.

R. Cable shield shall be capable of withstanding fault current indicated on drawings for 1/10 second.

2.03 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include components required for complete splice, with detailed instructions.

(1) Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
(2) Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
(3) Premolded, cold-shrink-rubber, in-line splicing kit.
(4) Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.04 SOLID TERMINATIONS

A. Multi-conductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

(1) Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable with external plastic jacket.
(2) Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
(3) Heat-shrink sheath seal kit with phase- and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
(4) Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.

B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

(1) Class 1 Terminations: Modular type, furnished as kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
(2) Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer non-tracking tubes; multiple, molded, non-tracking skirt modules; and compression-type connector.

(3) Class 1 Terminations: Modular type, furnished as kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules, shield ground strap; and compression-type connector.

(4) Class 1 Terminations, Indoors: Kit with stress-relief tube, non-tracking insulator tube, shield ground strap, compression-type connector, and end seal.

(5) Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

(6) Class 3 Terminations: Kit with stress cone and compression-type connector.

C. Non-shielded Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

D. Cable Terminations:

(1) Product of one manufacturer and furnished in kit form compatible with insulation and conductor material for cable terminated.

E. Connecting Lugs:

(1) Connectors and terminals: Copper with uniform compression over entire contact surface.

(2) Terminals on conductors: Solderless terminal lugs.

2.05 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200A, 15 KV class, 95 KV BIL load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated, with steel-reinforced hook-stick eye, grounding eye, and arc-quenching material. Include capacitance coupled test point on terminator body. Include cold shrinkable metallic shield adapter kit to ground metallic shielded cable. Include connection bus with parking stand for wall mounting.

D. Dead-Break Cable Terminators: Elbow-type unit with 600A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: 200A, 15 KV class, modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

(1) Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.

(2) Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.

(3) Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.

(4) Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Test-Pont Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.06 SOURCE QUALITY CONTROL

A. Test and inspect cables according to Section 26 08 12 - Power Distribution Acceptance Tests and Section 26 08 13 - Power Distribution Acceptance Test Tables.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended minimum installation temperature, maximum pulling tensions, and sidewall pressure values.

(1) Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.

(2) Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

(3) Cut off cable damaged by cable grips or pulling make-ups so as to provide clean, undamaged cable for termination. Continuously record pulling tension during installation.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

(1) Support cables and conductors in vertical raceways per requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Support cables in handholes and manholes from walls on heavy-duty, non-metallic cable rack arms, at least 3” (80 mm) above the floor. Support cables with reinforced nylon cradles. Anchor to wall with stainless steel anchor bolts.

(1) Install compression connectors with hydraulic compression tool on 600V neutral/ground conductor.

E. Install direct-buried cables on leveled and tamped bed of 3” (80 mm) thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4" (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install “buried-cable” warning tape per requirements in Section 26 05 53 - Identification for Electrical Systems.

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by longest route from entry to exit and support cables at intervals adequate to prevent sag. Fill lowest ducts first, avoid covering or blocking duct entrances and allow space for future cable installation.

H. Cut cable in clean, dry environment. Seal cut ends with waterproof seal immediately after cutting. Maintain a seal during and after pulling.

I. Install cable splices at pull points (accessible locations) and elsewhere as indicated; use standard kits.

J. Install terminations at ends of conductors and seal multi-conductor cable ends with standard kits. Do not install exterior terminations during inclement weather or damp atmospheric conditions.

K. Install stress cones at cable splices and terminations, grounded per cable and connector manufacturer recommendations.

L. Check phase rotation before connections are made to existing circuits. Clearly letter cable terminations. Identify phases with phase designations lettered on terminal boxes and other terminations throughout the system.

M. Install separable insulated-connector components as follows:

(1) Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected

(2) Portable Feed-Through Accessory: Three

(3) Standoff Insulator: Three

N. Seal around cables passing through fire-rated elements according to Section 26 05 93 - Electrical Systems Firestopping.

O. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Shields shall be grounded at both ends of cable run. Single point grounding will not be accepted. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware. For grounding requirements, refer to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

P. Identify cables according to Section 26 05 53 - Electrical Systems Identification.

3.02 FIELD QUALITY CONTROL

A. Perform cable acceptance tests on cable circuits after installing cables and before electrical circuitry has been energized. Splices and terminations required as part of this project are to be completed and acceptance tested as part of cable tests. For cables not spliced or terminated as part of project, ends should be clean, dry and long enough to eliminate leakage from conductor to ground along outer surface of cable.

B. Perform acceptance tests and damage investigations under constant supervision of Owner’s representative. Contractor shall coordinate and provide labor, material, equipment, and services necessary to test each completed cable circuit.

C. Remove and replace defective cables and retest as required.

D. Refer to Section 26 08 12 - Power Distribution Acceptance Tests and Section 26 08 13 - Power Distribution Acceptance Test Tables for visual and mechanical inspection and electrical tests. Certify compliance with test parameters.

END OF SECTION 26 05 13.16

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 29 - Hangers and Supports for Electrical Systems

B. Section 26 05 33 - Raceway and Boxes for Electrical Systems

C. Section 26 05 43.16 - Cable In Duct System

D. Section 26 05 53 - Electrical Systems Identification

E. Section 26 05 93 - Electrical Systems Firestopping

F. Section 26 08 12 - Power Distribution Acceptance Tests

G. Section 26 08 13 - Power Distribution Acceptance Test Tables

1.02 DESCRIPTION

A. Section includes conductors and cables rated 600 V and less, connectors, splices, and terminations rated 600 V and less, sleeves and sleeve seals for cables.

B. Conductor and conduit sizes in these contract documents are based on copper wire, and only copper wire shall be used.

1.03 REFERENCE STANDARDS

A. ASTM B1 – Standard Specification for Hand-Drawn Copper Wire.

B. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. NEMA WC 70 – Non-Shielded Power Cable 2000 V or less for the Distribution of Electrical Energy (ICEA S-95-658).

D. NFPA 70 – National Electrical Code.

E. UL 44 – Thermoset-Insulated Wires and Cables.

F. UL 83 – Thermoplastic-Insulated Wires and Cables.

G. UL 486A-486B – Wire Connectors.

H. UL 486C – Splicing Wire Connectors.

I. UL 486D – Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.

J. UL 486E – Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.

K. UL 486G - Standard for Sealed Twist-On Connecting Devices.

L. UL 1569 – Standard for Metal-Clad Cables.

1.04 SUBMITTALS

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

B. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual locations of components and circuits.

(2) Operation and Maintenance Data:

(a) Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, test reports, and preventive maintenance instructions.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements:

(1) Comply with NFPA 70 for components and installation.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

B. Wire and cable boxes and reels shall bear the date of manufacture.

(1) Date of manufacture shall not precede contract date by more than one year.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General Cable Corporation

B. Cerrowire

C. Southwire Company

D. Encore Wire Corporation

2.02 DESCRIPTION

A. NEMA WC 70; single copper conductor insulated wire; 600 V rated insulation; 90°C maximum operating temperature for dry and wet or damp locations.

(1) Thermoplastic-insulated wires and cables: NEMA WC 70, UL 83; Type THHN, THWN, THHW, THW-2, and THWN-2.

(2) Thermoset-insulated wires and cables: NEMA WC 70, UL 44; Type XHHW, XHHW-2, USE, and SO.

B. Multi-conductor Cable: NEMA WC 70; for armored cable, Type AC, metal-clad cable, Type MC, Type SO, and Type USE with ground wire.

C. Metal-clad cable, Type MC; UL 1569:

(1) Impervious, corrugated, continuous, seam welded metal sheath.

(2) No grounding conductor.

(3) Single grounding conductor.

(4) Three grounding conductors for use as VFD to motor feeder.

(5) Overall PVC jacket for water resistance.

(6) Listed for cable tray use when cable trays are used for electrical conductor support

2.03 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Class 1

(1) Copper conductor, single insulated wire.

(2) Insulation type THHN rated 90°C, 600 V insulation class.

(3) Type XHHW for ambient temperature less than 32°F (0°C).

(4) UL 83 listed, ASTM B1 for solid conductors; ASTM B 8 for stranded conductors.

B. Classes 2 and 3

(1) Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted.

(2) Insulation type XLPE, rated 105°C, 300 V insulation class.

(3) UL listed for use in space in which circuits will be installed.

2.04 CONNECTORS, SPLICES, AND TERMINALS

A. Manufacturers:

(1) AFC Cable Systems, Inc.

(2) Hubbell Power Systems, Inc.

(3) O-Z/Gedney; EGS Electrical Group LLC.

(4) 3M; Electrical Products Division

(5) Tyco Electronics Corp.

(6) King Innovation

(7) Ideal Industries

(8) NSi Industries

(9) DryConn

(10) Approved equal

B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E, UL 486G; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.

2.05 TERMINATIONS

A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.

B. Waterproof.

(1) Connectors shall be UL 486G listed for use in wet, damp, direct burial, and above-grade applications.

(2) Connectors shall incorporate internal sealing materials, such as dielectric grease or silicone sealant, and be factory-sealed.

(3) Rated for 600 volts minimum, 1000 volts for fixtures or Class 2 circuits, suitable for lighting systems, irrigation, or branch circuit wiring.

(4) Connector body: UV-resistant, high-impact thermoplastic or equivalent.

(5) Sealant: pre-filled, non-hardening dielectric compond.Spring or twist-on design to mechanically secure wires.

(6) Temperature rating: -40° F to 105° F continuous.

(7) Wire compatibility: #22 AWG to #6 AWG, solid or stranded copper conductors.

(8) Moisture ingress protection: rated for direct burial and submersion in water when installed per manufacturer instructions.

(9) Clearly labeled with wire range, voltage rating, and UL listing.

(10) Marked with installation torque or twist-on guidelines as required.

2.06 PLASTIC CABLE TIES

A. Nylon or approved; locking type; metallic ties not permitted.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONDUCTORS AND CABLES

A. Install conductors in a raceway system, unless otherwise specified or indicated.

B. Install conductors only after:

(1) Building interior is enclosed and weather tight

(2) Mechanical work likely to damage conductors has been completed

(3) Raceway installation is complete and supported

C. Pull conductors into raceway at same time.

D. Neatly train and lace conductors inside boxes, equipment, and panelboards.

E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

F. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible. Protect exposed cables from damage.

I. Support cables above accessible ceiling using plastic cable ties to support cables from structure . Do not rest cable on ceiling panels.

J. Support cables and conductors in vertical raceways per requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.

K. Identify and color-code conductors and cables according to Section 26 05 53 - Electrical Systems Identification.

L. Wiring at Outlets: Install conductor at each outlet, with minimum 6" (150 mm) of slack.

M. Limit conduit fill to a maximum of 9 current-carrying conductors.

N. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.

O. Install VFD input wiring, output wiring and control wiring in their own separate conduit systems.

P. Provide dedicated neutrals for branch circuits unless otherwise noted on drawings.

3.02 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid or stranded for #10 AWG and smaller; stranded for #8 AWG and larger.

B. Branch Circuits: Copper. Solid or stranded for #10 AWG and smaller; stranded for #8 AWG and larger.

C. Minimum conductor sizes shall be as follows:

(1) #12 AWG – Branch circuits of any kind.

(2) #14 AWG – Fire alarm system.

(3) #16 AWG – Remote control and signal systems.

D. Branch wiring length limitations:

(1) Where wire sizes are shown on project drawings and do not indicate they have been adjusted for voltage drop based on circuit length, they shall be increased as noted below depending on Contractor routing.

(a) 208Y/120 V circuits over 75 ft (23 m) in length: Increase wire size one size for each 75 ft (23 m) in length. Increase conduit size as required.

(b) 480Y/277 V circuits over 150 ft (45 m) in length: Increase wire size one size for each150 ft (45 m) of length. Increase conduit size as required.

3.03 CONDUCTOR INSULATIONS AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, rated 90°C for wet locations, single conductors in raceway, Type XHHW-2, rated 90°C for wet locations, single conductors in raceway, Mineral-insulated, metal-sheathed cable, Type MI, or Type SE or USE multi-conductor cable.

B. Exposed Feeders: Type THHN/THWN-2, rated 90°C for wet locations, single conductors in raceway or Type XHHW-2, rated 90°C for wet locations, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, rated 90°C for wet locations, single conductors in raceway or Type XHHW-2, rated 90°C for wet locations, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, rated 90°C for wet locations, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, rated 90°C for wet locations, single conductors in raceway, Type XHHW-2, rated 90°C for wet locations, single conductors in raceway, or Metal-clad cable, Type MC.

F. Exposed Branch Circuits, Including in Crawl Spaces: Type THHN, rated 90°C for dry and wet or damp locations, single conductors in raceway, Type THW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway, Type THWN-2, rated 90°C for dry and wet or damp locations, single conductors in raceway, or Type XHHW-2. rated 90°C for dry and wet or damp locations, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN, rated 90°C for dry and wet or damp locations, single conductors in raceway, Type THW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway, Type THWN-2, rated 90°C for dry and wet or damp locations, single conductors in raceway, or Type XHHW-2 rated 90°C for dry and wet or damp locations, single conductors in raceway.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway, Type THWN-2, rated 90°C for dry and wet or damp locations, single conductors in raceway, or Type XHHW-2 rated 90°C for dry and wet or damp locations, single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Type THHN, rated 90°C for dry and wet or damp locations, single conductors in raceway, Type THW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway, Type THWN-2, rated 90°C for dry and wet or damp locations, single conductors in raceway, Type XHHW-2 rated 90°C for dry and wet or damp locations, single conductors in raceway, or Metal-clad cable, Type MC.

J. Motor Circuit Branch Wiring and Associated Control Wiring: Type THHN, rated 90°C for dry and wet or damp locations, single conductors in raceway, stranded.

K. Wiring in Light Fixture Channels: Type THHN/THWN-2, rated 90°C for dry and damp locations, single conductors.

L. Branch Circuits Single Conductors in Raceway: 90°C rated conductors sized at 75°C rating for connection to equipment and devices.

M. Circuits 100A and less, utilize 60C for ampacity (unless both sides of the circuit are listed for 75C). Circuits 100A and over use 75C for ampacity. If the wire insulation ratings are higher, they may be utilized for de-rating purposes only and wire size shall be increased if the de-rated insulation rating is less than the required load current.

N. Metal-clad cable, Type MC, use for the following:

(1) Interior use limited to recessed and semi-recessed lighting fixtures final connections from homerun junction box

O. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.04 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Sizing – #16 AWG minimum.

B. Installation:

(1) Install cables in cable tray and cable rings.

(2) Provide protection for exposed cables where subject to damage.

(3) Support cables above accessible ceilings; do not rest on ceiling tiles.

(4) Use suitable cable fittings and connectors.

3.05 CONNECTORS, SPLICES, AND TERMINALS

A. Connectors:

(1) Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with connectors being installed.

(2) Use bolt or compression-set type with application of insulating tape, pre-stretched or heat-shrinkable insulating tubing for splices and taps of #8 AWG conductors and larger. Install with hydraulic compression tool.

(3) Use pre-insulated “twist-on” connectors with integral spring for splices and taps of #10 AWG conductors and smaller and in quantities not to exceed manufacturer's recommendations.

(4) 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-486B.

B. Waterproof Connectors:

(1) Install sealed waterproof connectors in accordance with UL 486G, NEC, and manufacturer's instructions.

(2) Ensure conductors are clean and stripped to correct length. Do not pre-twist conductors unless specifically directed by the manufacturer.

(3) Insert conductors fully into connector and twist to engage spring and internal sealant.

(4) Verify sealant visibly encapsulates conductor ends.

(5) For underground or wet environments, confirm proper sealing and apply additional waterproofing (e.g., gel wrap or heat shrink) only if required.

C. Splices:

(1) Splice wires and cable only in accessible locations such as within junction boxes.

(2) Make splices to carry full capacity of conductors with no perceptible temperature rise.

(3) Make below-grade splices in manholes and handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.

(4) Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.

(5) Plastic snap-on splice insulators are not allowed.

(6) Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

(7) Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

D. Terminals:

(1) Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.

(2) Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.

(3) Train wires to eliminate fanning of stands, crimp with proper tool and die.

(4) Torque screw termination per manufacturer’s recommended values.

(5) Field installed lug terminals:

(a) Install mechanical lugs per manufacturer's instructions and UL 486A requirements.

(b) Clean conductor surfaces and apply antioxidant compound as required.

(c) Ensure proper conductor insertion depth before tightening.

(d) Use a calibrated torque wrench to achieve manufacturer-specified torque values.

(e) Protect connections exposed to moisture or corrosive environments with approved insulating or sealing materials.

3.06 CABLE TIES

A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.07 FIELD QUALITY CONTROL

A. Test 600 volt conductors and cables per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.

B. Interpret test results in writing and submit to Engineer.

C. Replace conductors and cables that are found defective, at no expense to Owner.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 04 77 - Power Module Switch-Elevator Disconnect
B. Section 26 05 13.16 - Medium-Voltage, Single- and Multi-Conductor Cables
C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
D. Section 26 05 33 - Raceway and Boxes for Electrical Systems
E. Section 26 05 43 - Underground Ducts And Raceways For Electrical Systems
F. Section 26 05 43.19 - Manholes and Hardware
G. Section 26 05 43.23 - Underground Electrical Service
H. Section 26 08 12 - Power Distribution Acceptance Tests
I. Section 26 08 13 - Power Distribution Acceptance Test Tables
J. Section 26 09 23 - Lighting Control Devices
K. Section 26 09 43 - Network Lighting Controls
L. Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
M. Section 26 22 00 - Low-Voltage Transformers
N. Section 26 23 00 - Low-Voltage Switchgear
O. Section 26 24 13 - Switchboards
P. Section 26 24 16.13 - Lighting and Appliance Panelboards
Q. Section 26 24 16.16 - Distribution Panelboards
R. Section 26 27 26 - Wiring Devices
S. Section 26 28 16 - Enclosed Switches and Circuit Breakers
T. Section 26 29 13 - Enclosed Controllers
U. Section 26 32 13 - Engine Generators
V. Section 26 36 23 - Automatic Transfer Switches
W. Section 26 41 13 - Lightning Protection for Structures
X. Section 26 43 00 - Surge Protective Devices (SPD)
Y. Section 26 50 00 - Lighting
Z. Section 27 05 26 - Grounding and Bonding for Communications Systems
AA. Section 27 05 28.33 - Raceway and Boxes for Communications Systems
BB. Section 27 05 28.36 - Cable Trays for Communications Systems
CC. Section 27 10 00 - Structured Cabling
DD. Section 27 11 00 - Communications Equipment Room Fittings
EE. Section 27 13 00 - Communications Backbone Cabling
FF. Section 27 15 00 - Communications Horizontal Cabling
GG. Section 27 51 29 - Two-way Communication System
HH. Section 27 53 19 - Emergency Responder Radio Reinforcement System

1.02 DESCRIPTION

A. Section includes methods and materials for grounding systems and equipment, as required by State Codes, NFPA 70, applicable portions of other NFPA codes, as indicated herein, plus the following special applications:
   (1) Overhead-lines grounding.
   (2) Underground distribution grounding.
   (3) Common ground bonding with lightning protection system.
B. Maximum resistance to ground shall be less than _____ ohms.
C. Refer to Grounding Riser Diagram.

1.03 REFERENCE STANDARDS

A. TIA-607 -_____ – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

B. ASTM B3 – Specification for Soft or Annealed Copper Wire
C. ASTM B8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
D. ASTM B33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
E. IACS - International Annealed Copper Standard
F. IEEE C2 – National Electrical Safety Code (ANSI)
G. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems
H. IEEE 837 - Standard for Qualifying Permanent Connections used on Substation Grounding
I. IEEE 857 – Standard for Qualifying Permanent Connections Used in Substation Grounding
J. NETA MTS – Maintenance Testing Specifications
K. NFPA 70 – National Electrical Code
L. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
M. NFPA 780 – Lightning Protection Systems
N. UL 96 – Lightning Protection Components
O. UL 467 – Grounding and Bonding Equipment

1.04 TELECOMMUNICATIONS GROUNDING SYSTEM DEFINITIONS

A. Grounding Equalizer (GE): Conductor that interconnects elements of telecommunications grounding infrastructure.
B. Telecommunications Bonding Backbone (TBB): Conductor that interconnects telecommunications main grounding busbar (TMGB) to telecommunications grounding busbar (TGB).
C. Telecommunications Bonding Conductor: Conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.
D. Telecommunications Grounding Busbar (TGB): Interface to building telecommunications grounding system, common point of connection for telecommunications system and equipment to ground, and located in telecommunications room or equipment room.
E. Telecommunications Main Grounding Busbar (TMGB): Busbar placed in convenient and accessible location and bonded by means of bonding conductor for telecommunications to building service equipment (power) ground.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Other Informational Submittals:
    (1) Plans showing dimensioned as-built locations of grounding features, including the following:
        (a) Test wells
        (b) Ground rods
        (c) Ground rings
        (d) Grounding arrangements and connections for separately derived systems
        (e) Grounding for sensitive electronic equipment
    (2) Photos of underground grounding and bonding
C. Field Quality-Control Test Reports:
    (1) Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
    (2) Test reports of resistance to earth. Each test report shall include:
        (a) Date of test, soil moisture content, and soil temperature
        (b) Test operator
        (c) Instrument or other test equipment used
        (d) Electrode designation or location
        (e) Ground impedance in ohms
        (f) Assumptions made - if required
D. Closeout Submittals:
    (1) Operation and Maintenance Manuals: Include the following:
        (a) Instructions for periodic testing and inspection of grounding features at _____ based on _____.
            1) Instructions to perform tests to determine if ground resistance or impedance values remain within specified maximums.

1.06 QUALITY ASSURANCE

A. Regulatory Requirements:

(1) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.

(2) Comply with UL 467 for grounding and bonding materials and equipment.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store products in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.08 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. Insulated Conductors: _____ wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction, insulation color: green.

(1) Grounding Conductor: Solid #12 & #10, stranded #8 and larger

(2) Bonding Cable: 28 kcmil, 14 strands of #17 AWG conductor, 1/4” (6 mm) in diameter.

(3) Bonding Conductor: #4 AWG or #6 AWG, stranded conductor.

B. Bare Copper Conductors:

(1) Solid Conductors: ASTM B3.

(2) Stranded Conductors: ASTM B8.

(3) Tinned Conductors: ASTM B33.

(4) Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8” (41 mm) wide and 1/16" (2 mm) thick.

(5) Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8” (41 mm) wide and 1/16" (2 mm) thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:

(1) #4 AWG minimum, soft drawn copper.

(2) Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

2.02 WALL MOUNTED GROUND BUS

A. Grounding Bus: Horizontal rectangular bars of annealed copper, _____.

2.03 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Electro-tin-plated copper or copper alloy, bolted pressure-type, with at least two bolts.

(1) Pipe connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Compression Connectors: Irreversible type.

2.04 GROUNDING ELECTRODES

A. Ground Rods: _____ steel_____; _____.

B. Chemical-Enhanced Grounding Electrodes: 300 series stainless steel tube, straight or L-shaped, charged with _____.

(1) Termination: Factory-attached #4/0 AWG bare conductor at least 48” (1219 mm) long.

(2) Backfill Material: Electrode manufacturer’s recommended material.

2.05 TELECOMMUNICATIONS BUSBARS

A. Material: Copper

(1) 1/4” (6 mm) thick

B. Pre-drilled

(1) 7/16” (11 mm) diameter

(2) Hole spacing per ANSI Joint Standard _____

(3) Hole pattern shall accommodate two-hole lugs

C. Insulators and stand-off brackets shall electrically isolate busbar from wall or other mounting surface.

D. Provide busbars listed by nationally recognized testing laboratory.

E. Size:

(1) Telecommunications Main Ground Busbar (TMGB) – 20” x 4” (500 mm x 100 mm) (minimum)

(2) Telecommunications Grounding Busbar (TGB) – 12” x 2” (300 mm x 50 mm) (minimum)

F. Size:

(1) Telecommunications Primary Bonding Busbar (PBB) – _____

(2) Telecommunications Secondary Bonding Busbar (SBB) – _____

2.06 TELECOMMUNICATIONS GROUNDING CONDUCTORS

A. Material: Stranded copper

B. Provide insulated bonding conductors.

(1) Green Jacket or Black Jacket marked with Green Tape or Green adhesive labels per NEC.

C. Size:

(1) Bonding Conductor for Telecommunications (BCT; TMGB to Grounding Electrode), Telecommunications Bonding Backbone (TBB; TMGB to TGB), Grounding Equalizer (GE; TBB to TBB): _____

(2) Telecommunications Bonding Backbone (TBB; TMGB to TGB) _____

D. Size:

(1) Telecommunications Bonding Conductor (TBC; PBB to Electrical Service Entrance main ground bar), Backbone Bonding Conductor (BBC; PBB to local steel structure): _____

(2) Telecommunications Bonding Backbone (TBB; PBB to SBB), Backbone Bonding Conductor (BBC; SBB to local steel structure): _____

2.07 TELECOMMUNICATIONS GROUNDING CONNECTIONS

A. Mechanical Connectors:

(1) Connector Body:

(a) High-strength, high-conductivity cast copper alloy

(b) 2-bolt type

(2) Bolts, nuts, washers, and lock-washers: 300 series stainless steel

(a) Supplied as part of connector body

(b) Split-bolt connector types are not allowed.

(3) Connector:

(a) Meet or exceed UL 467

(b) Clearly marked with catalog number, conductor size, and manufacturer

B. Irreversible Compression Connectors:

(1) Connector Body: Pure wrought copper.

(2) Conductivity shall be no less than 99%.

(3) Connector:

(a) Meet or exceed requirements of IEEE 837, latest revision.

(b) Filled with an oxide-inhibiting compound. _____

(c) Clearly marked with manufacturer, catalog number, conductor size, and required compression tool settings.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install solid conductor for. ____ and smaller, and stranded conductors for ____ and larger, unless otherwise indicated.

(1) Size conductors and jumpers as indicated on drawings, unless specifically noted otherwise.

B. Underground Grounding Conductors: Install bare _____ conductor. _____

(1) Bury at least 24” (600 mm) below grade.

(2) Ductbank Grounding Conductor: Bury 12” (300 mm) above ductbank when indicated as part of ductbank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Wall Mounted Grounding Bus: Install in electrical and communications rooms, in rooms housing service equipment.
   (1) _____
   (2) Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor, and connect to horizontal bus.

E. Conductor Terminations and Connections:
   (1) Pipe Terminations: Mechanical lugs
   (2) Equipment Grounding Conductor Terminations: Mechanical lugs
   (3) Underground Connections: Welded connectors
   (4) Connections to Ground Rods at Test Wells: Mechanical connectors
   (5) Connections to Structural Steel: _____

3.02 GROUNDING OVERHEAD LINES

A. Install _____ parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 ohms.

B. Drive ground rods until tops are 12” (300 mm) below finished grade in undisturbed earth.

C. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods only where located within test well.

D. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.

3.03 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4” (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide #1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof PVC sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2" (50 mm) above to 6" (150 mm) below concrete. Seal floor opening with waterproof, non-shrink grout.

B. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, catch basins, metallic cover frame and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with #4 AWG minimum, stranded, copper bonding 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, Unit Substations, and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with transformer and switches by connecting them to underground cable and grounding electrodes. Install _____ conductor not less than #2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 24” from the foundation. Install as indicated on drawings.

3.04 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   (1) Feeders and branch circuits
      (a) Install a single insulated equipment ground conductor for each branch circuit conduit originating from panelboards.
      (b) Install a single insulated equipment ground conductor for each branch circuit neutral originating from panelboards, including lighting circuits.
   (2) Flexible raceway runs
   (3) Armored and metal-clad cable runs

B. Air-Duct Equipment Circuits: Install a separate insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping. Ground ductwork of fans serving flammable liquid storage rooms or fume hoods. Install continuous ground around any flexible connections in this ductwork system. Bond lower end of exhaust ducts, vent stacks, etc., which pass through roof.

C. Raised Access Floor: _____.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Wiring devices, receptacles and light switches of any amperage: Install separate jumper between grounding terminal on device and metallic box.

F. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

H. Size of equipment grounding conductors for branch circuits: As indicated in NEC-70, except minimum size shall be #12 AWG.

I. Size of branch panel feeder originating at switchboards/switchgear: As indicated in NEC-70, except in no instance smaller than #8 AWG.

J. Signal and Communication Equipment: For alarm and other communication equipment (see Telecommunications Grounding System Installation section below for voice and data systems), install _____ from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

(1) Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor _____.

(2) Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

K. Install grounding conductor from each standby-emergency generator to grounding electrode system. Provide flexible jumper between base and isolated generator.

L. Install grounding electrode conductor from secondary side of each transformer to grounding electrode system as required for separately derived system.

M. Install supply side bonding jumper from secondary side of each transformer to downstream distribution equipment, as required for separately derived system.

N. Install grounding conductor to luminaires hanging from conduit swivel hangers.

O. Install grounding conductor across all flexible or isolated support systems to maintain effective ground fault path.

P. _____ Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors to pole base. Grounding Conductor: Same size as phase conductors, but not smaller than #10 AWG.

(1) Install at each pole or standard a concealed driven 1/2” x 8’-0” (13 mm x 2.44 m) ground rod, ground clamp and No. 3 stranded copper conductor concealed and attached to pole and base.

3.05 GROUNDING ELECTRODE SYSTEM

A. Install grounding for service entrance equipment room consisting of ground bus, ground conductors, and grounding rods arranged as indicated on drawings.

(1) Ground bus shall be horizontal _____, copper bar. Bolt to wall at 3 ft (1 m) intervals with 1 " (25 mm) stand-offs at each bus support.

(2) Install ground bus per details on drawings.

B. Install No. _____ copper grounding conductor from ground bus to each ground rod.

C. Install No. _____ copper grounding conductor from ground bus to buried ground loop.

D. Install No. _____ copper grounding conductor from ground bus to structural steel.

E. Install No. _____ copper grounding conductor from ground bus to cold water pipe where pipe enters the building.

F. Install No. _____ copper grounding conductor from ground bus to concrete encased electrode.

3.06 SEQUENCING, SCHEDULING

A. Permanently attach grounding conductors before permanent building service is energized.

B. Permanently attach equipment grounds prior to energizing equipment.

3.07 INSTALLATION

A. Contractor shall take photographs of all underground grounding and bonding connections prior to covering. Furthermore, Contractor shall coordinate with the Authority Having Jurisdiction to confirm approval of installation prior to covering.

B. Connections: Exposed and visible for inspection at all times. Do not install insulation over ground connections.

C. Identify all grounding conductors by system and room number of termination at building grounding electrode point.

D. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

E. Ground Rods: _____.

(1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

(2) For grounding electrode system, install at least _____ rods spaced at least one rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

F. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12” (300 mm) deep, with cover.

(1) Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

(1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

(2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

(3) Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

H. Grounding and Bonding for Piping:

(1) Metal Water Service Pipe: Install 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, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Water pipe, by itself, is not an adequate grounding electrode and must be supplemented by another electrode system. Bond system together.

(2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

(3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

(a) Confirm application with local gas and electric utility ordinances and notify the engineer if restrictions do not allow bonding as required by the project documents.

I. Grounding Electrode Conductor installed in metal conduit or sleeves, shall be bonded at each end using grounding hubs. The bonding conductor shall be the same size as the grounding electrode conductor. Conduits terminated to grounding enclosures, shall be secured to enclosure using grounding locknuts.

J. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned copper bonding jumper to bond across flexible duct connections to achieve continuity.

K. Grounding for Steel Building Structure: _____

L. Bond steel columns at bases using copper conductor to column footing rebar.

M. Make grounding connections on surface that has been cleaned of paint, dirt, oil, etc., so that connections are bare metal to bare metal contact.

N. Make grounding connections tight with UL listed grounding devices, fittings, bushings, etc.

O. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each _____, extending around the perimeter of _____.

(1) Install _____ conductor _____.

(2) Bury ground ring not less than _____ below grade.

P. Concrete-Encased Grounding Electrode: Fabricate according to NFPA 70, using a minimum of _____ of bare copper conductor not smaller than _____.

(1) If concrete foundation is less than _____ long, coil excess conductor within base of foundation.

(2) 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 grounding electrode external to concrete.

Q. Equipment Grounding Conductor: Terminate in panelboard at equipment ground bus.

R. Multiple Conductors on Single Lug: Not permitted. Terminate each grounding and grounded conductor on its own terminal lug.

S. Flexible Metallic Conduit, Non-Metallic Rigid Conduit, or Liquid Tight Flexible Conduit: Install equipment grounding conductor with phase conductors in conduit.

3.08 TELECOMMUNICATIONS BONDING AND GROUNDING SYSTEM INSTALLATION

A. Provide required elements and miscellaneous hardware necessary to establish Telecommunication Bonding and Grounding infrastructure as specified.

B. Install products in accordance with manufacturer's instructions. Install Compression Connectors with compression, tool-and-die system, as recommended by manufacturer of connectors.

C. Telecommunications Bonding Conductor, Telecommunications Bonding Backbone (TBB), and Grounding Equalizer (GE): Compression or Exothermic type connections.

D. Locate TGBs and TMGB per drawings.

E. Telecommunications Bonding Backbone (TBB) shall be continuous and not interrupted by Telecommunications Grounding Busbars (TGB).

(1) TGBs shall be bonded to TBB via tap off of TBB. Exception: "last" TGB on TBB (e.g., furthest from TMGB).

(2) Grounding Equalizer(s) (GE) shall connect to TGBs to be interconnected.

F. Insulate busbars from their support.

G. Coordinate with Sections 27 10 00 - Structured Cabling, 27 11 00 - Communications Equipment Room Fittings, 27 13 00 - Communications Backbone Cabling and 27 15 00 - Communications Horizontal Cabling.

3.09 FIELD QUALITY CONTROL

A. After installing grounding system but before permanent electrical circuits have been energized, test grounding system.

(1) Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal _____.

(2) Test grounding systems per requirements in Section 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.

B. Interpret test results in writing and submit to Engineer.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 33 - Raceway and Boxes for Electrical Systems
B. Section 26 05 36 - Cable Trays for Electrical Systems
C. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
D. Section 26 12 13 - Liquid-Filled, Medium-Voltage Transformers
E. Section 26 12 16 - Dry-Type, Medium-Voltage Transformers
F. Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
G. Section 26 13 16 - Medium-Voltage Fusible Interrupter Switchgear
H. Section 26 13 19 - Medium-Voltage Vacuum Interrupter Switchgear
I. Section 26 13 23 - Medium-Voltage Pad-Mounted Switchgear
J. Section 26 22 00 - Low-Voltage Transformers
K. Section 26 23 00 - Low-Voltage Switchgear
L. Section 26 24 13 - Switchboards
M. Section 26 24 16.13 - Lighting and Appliance Panelboards
N. Section 26 24 16.16 - Distribution Panelboards
O. Section 26 24 19 - Motor-Control Centers
P. Section 26 25 00 - Enclosed Bus Assemblies
Q. Section 26 26 00 - Power Distribution Units
R. Section 26 28 16 - Enclosed Switches and Circuit Breakers
S. Section 26 29 13 - Enclosed Controllers
T. Section 26 32 13 - Engine Generators
U. Section 26 33 53 - Static Uninterruptible Power Supply With Battery Energy Storage
V. Section 26 36 23 - Automatic Transfer Switches
W. Section 26 50 00 - Lighting

1.02 DESCRIPTION

A. Section includes the following:
   (1) Manufactured hangers and supports for individual raceways and cables, slotted channel and angle systems for multiple conduit runs, and most electrical equipment that is not floor mounted.
   (2) Construction requirements for concrete housekeeping pads for floor-mounted electrical equipment.

1.03 REFERENCE STANDARDS

A. AWS D1.1/D1.1M – Structural Welding Code-Steel.
B. ASTM A36/A36M – Carbon Structural Steel.
C. ASTM F3125/F3125M – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
D. ASTM A780/A780M – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
E. MSS SP-58 – Pipe Hangers and Supports - Materials, Design and Manufacture.
F. MSS SP-69 – Pipe Hangers and Supports - Selection and Application.
G. MFMA-4 – Metal Framing Standards Publication.
H. NECA 1 – Standard Practices for Good Workmanship in Electrical Construction.
I. NECA 101 – Standard for Installing Steel Conduits (Rigid, IMC, EMT).
J. NFPA 70 – National Electrical Code.
K. SSPC-PA 1 – Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.
L. ETL PVC-001 – PVC Coated Conduit

1.04 SUBMITTALS

A. Product Data: For the following:
   (1) Steel slotted support systems.
   (2) Nonmetallic slotted support systems.
   (3) Raceway and cable supports.
   (4) Support for conductors in vertical raceway.
   (5) Structural steel for fabricated supports and restraints.
   (6) Mounting, anchoring, and attachment components:
      (a) Powder-actuated fasteners.
      (b) Mechanical-expansion anchors.
      (c) Concrete inserts.
      (d) Clamps for attachment to structural steel.
      (e) Through bolts.
      (f) Toggle bolts.
      (g) Hanger rods.

B. Shop Drawings: _____. Include concrete anchors application, size, and placement. Include concrete inserts application, size, loading, and placement. Show fabrications and installation details and include calculations for the following:
   (1) Trapeze hangers. Include product data for components.
   (2) Steel slotted channel systems. Include product data for components.
   (3) Nonmetallic slotted channel systems. Include product data for components.
   (4) Fabricated metal equipment support assemblies.

C. Drawings showing specific locations of any suspended loads which exceed 100 lbs (45 kg) within joist chord panel, to be attached to open web steel joist structural members. Include weight supported by such attachments. (Panel is length of chord between two adjacent diagonal web members at points of connection to chord.)

D. Welding certificates and drawings showing specific locations of any weld attachments to structure including weight supported by such attachments.
   (1) Any proposed weld attachments to building structure shall be reviewed by Structural Engineer prior to execution of work. This review may result in use of other welding codes or standards, which may apply to “structural work”. Execution of this work may be assigned to General Trades responsible for building structural steel. Cost of this work, however, will remain the responsibility of this Contractor.

E. Schedule of hangers and support devices with support spacing.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code – Steel.”

B. Comply with NFPA 70.

C. Certification:
   (1) Installer of PVC-coated hangers and supports shall be certified by a PVC conduit manufacturer.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of _____ times the applied force.

B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   (1) Finishes
      (a) Metallic Coatings:
         1) Factory standard primed, galvanized or electroplated finish and applied according to MFMA-4, for indoor applications.
         2) Hot-dip galvanized after fabrication and applied according to MFMA-4, for outdoor applications.
      (b) Nonmetallic Coatings: Manufacturer’s standard PVC, polyurethane, or polyester coating applied according to MFMA-4, for corrosive environments.
      (c) Painted Coatings: Manufacturer’s standard painted coating applied according to MFMA-4.
   (2) Channel Dimensions: Selected for applicable load criteria.
   (3) Manufacturers:
      (a) Allied Support Systems; Power-Strut Unit.

(b) Cooper B-Line, Inc.; A division of Cooper Industries.
(c) ERICO International Corporation.
(d) GS Metals Corporation.
(e) Thomas & Betts Corporation.
(f) Unistrut; Tyco International, Ltd.
(g) Wesanco, Inc.
(h) National Pipe Hanger Corporation.
(i) Michigan Hanger Co., Inc.; O-Strut Division.
(j) Approved equal.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16” (14 mm) diameter holes at a maximum of 8" (200 mm) o.c., in at least one surface.
(1) Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
(2) Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
(3) Rated Strength: Selected to suit applicable load criteria.
(4) Manufacturers:
(a) Allied Support Systems; Power-Strut Unit
(b) Cooper B-Line, Inc.; A division of Cooper Industries
(c) Fabco Plastics Wholesale Limited
(d) Seasafe, Inc.
(e) Approved equal

D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

E. Raceway and Cable Support Devices: _____ hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

F. PVC Raceway Support Devices: ANSI C80.1, UL 6, ETL PVC-001.

G. Support for 600V and under Conductors in Vertical Raceway: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
(1) Manufacturers:
(a) O-Z/Gedney
(b) Approved equal

H. Support for Conductors 601V and greater in Vertical Raceway: Heavy duty strain relief grip consisting of solder protector, galvanized steel mesh, endless multi-weave style.
(1) Manufacturers:
(a) Hubbell-Kellems
(b) Approved equal

I. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

J. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
(1) Concrete Anchors
(a) Anchors shall be selected, sized, and detailed by Contractor’s structural engineer registered in project’s jurisdiction, based on project conditions and in accordance with project building code. Calculations and drawings shall be submitted.
(b) Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.
(c) Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.
(d) Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.

(e) Anchors for seismic load application shall be approved by ICC-ES Evaluation Reports to resist seismic loads and selected to meet project seismic design requirements. Refer to Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment and Structural drawings.

(f) Anchors shall be zinc plated in accordance with ASTM B633.

(g) Select anchors with load ratings based on cracked concrete conditions.

(h) Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

1) Manufacturers:

1. Hilti Inc.
2. ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
3. MKT Fastening, LLC.
4. Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit
5. Approved equal

(i) Mechanical-Expansion Anchors: Insert-wedge-type, _____ steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

1) Manufacturers:

1. Cooper B-Line, Inc.; A division of Cooper Industries
2. Empire Tool and Manufacturing Co., Inc.
3. Hilti Inc.
4. ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
5. MKT Fastening, LLC.
6. Approved equal

(2) Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

(3) Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

K. Beam Clamps: C-clamps are allowed 3/8” (9 mm) or smaller and only for static loading such conduits. Provide locknut for hanging rod at clamp. C-clamps are not allowed for open web steel joist applications nor seismic applications.

L. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

M. Toggle Bolts: All-steel springhead type.

N. Hanger Rods:

(1) MSS SP-58; threaded steel, with adjusting and lock nuts; _____ finish.

(2) MSS SP-58; nonmetallic, with adjusting and lock nuts.

2.02 FABRICATED METAL FRAMING EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section “Metal Fabrications” for steel shapes and plates; not be lighter than 12 ga (2.758 mm).

C. Finish: _____.

D. Manufacturers: Same as in paragraph 2.1.B.3 above.

2.03 CONTINUOUS INSERT CHANNELS

A. Length and support capabilities to be suitable for application.

B. Brackets, inserts and accessories suitable for channel insert selected.

C. Manufacturers:

(1) Unistrut; Tyco International, Ltd.

(2) Cooper B-Line, Inc.; A division of Cooper Industries

(3) Michigan Hanger Co., O-Strut Division

(4) Anvil International, Inc.

(5) Approved equal

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as _____ NFPA 70.

(1) Size steel hanger rods for individual hangers and trapeze supports as indicated in the following schedule. Total weight of equipment shall not exceed limits indicated.

Maximum Loads	Rod Diameter	Maximum Pipe Size with Single Rod
730lbs (331kg)	3/8" (9mm)	2" (50 mm)
1130lbs (513kg)	1/2" (13mm)	3" (80mm)
1818lbs (825kg)	5/8" (16mm)	5" (130mm)

(2) Size nonmetallic rods for individual hangers and trapeze supports as indicated in the following schedule. Total weight of equipment shall not exceed limits indicated.

Maximum Loads	Rod Diameter	Maximum Pipe Size with Single Rod
____lbs (____kg)	_____" (_____mm)	_____" (_____mm)

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least _____ in future without exceeding specified design load limits.

(1) Secure raceways and cables to these supports with _____.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 3/4” (21 mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

E. Install PVC-coated hangers and supports in areas with corrosive atmosphere as noted on plans.

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in paragraphs below.

B. Raceway Support Methods: In addition to methods described in NECA 1, _____ may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (91 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor application size and placement shall be reviewed and approved by Structural Engineer prior to installation. Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

(1) To Wood: Fasten with lag screws or through bolts.

(2) To New Concrete: Bolt to concrete inserts.

(3) To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

(4) To Existing Concrete: Expansion anchor fasteners.

(5) Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4” (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4” (100 mm) thick.

(6) To Steel: _____.

(7) To Light Steel: Sheet metal screws.

(8) Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Do not support raceway by other raceway.

G. Do not support equipment or raceway from metal roof decking or floor decking.

H. Do not impose weight of electrical equipment, raceways, or lighting fixtures on support provided for other trades or systems.

I. Top or bottom chords of open web steel joists may be used to support loads provided total load within panel does not exceed 100 lbs (45 kg) and load is placed concentric to joist (panel is length of chord between two adjacent diagonal web members at point of connection to chord).

(1) C-clamps are not permitted for use in open web steel joist applications.

J. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

K. Use conduit-mounting pedestals for piping on roof. Install bottom of pedestal flat on roof deck and insulate exterior of pedestal, flashing and counter flashing.

L. Minimize use of concrete anchors and inserts after concrete pour.

M. Punching, drilling, welding of building structural steel or welding attachment to building structural steel is not allowed, unless approved by structural engineer.

N. Use tools approved for use with PVC-coated conduits and fittings.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section “Metal Fabrications” for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE HOUSEKEEPING PADS

A. Construct concrete housekeeping pads for all floor-mounted electrical equipment.

B. Dimensions: _____ high and not less than _____ larger in both directions than supported equipment, so anchors will be a minimum of 10 bolt diameters from edge of the base.

C. Use _____, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section “Cast-in-Place Concrete.”

D. Anchor equipment to concrete housekeeping pad.

(1) Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

(2) Install anchor bolts to elevations required for proper attachment to supported equipment.

(3) Install anchor bolts according to anchor-bolt manufacturer’s written instructions.

E. Coordinate with Architect installation of housekeeping pads on roof.

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

(1) Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 _____ for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
E. Section 26 05 53 - Electrical Systems Identification
F. Section 26 05 93 - Electrical Systems Firestopping
G. Section 26 27 26 - Wiring Devices
H. Section 27 05 53 - Communications Systems Identification
I. Section 27 11 00 - Communications Equipment Room Fittings
J. Section 27 13 00 - Communications Backbone Cabling
K. Section 27 15 00 - Communications Horizontal Cabling

1.02 DESCRIPTION

A. Section includes raceways, fittings, wireways, wall ducts, indoor service poles, outlet boxes, pull and junction boxes, floor boxes, tap boxes and raceway seals.

1.03 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting
B. ANSI C80.1 – Rigid Steel Conduit-Zinc Coated (GRS)
C. ANSI C80.3 – Electrical Metallic Tubing-Zinc Coated (EMT)
D. ANSI C80.5 – Aluminum Rigid Conduit-Zinc Coated (ARC)
E. ANSI C80.6 – Intermediate Metal Conduit-Zinc Coated (IMC)
F. ASTM A53/A53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
G. BICSI TDMM – Telecommunications Distribution Methods Manual, Latest Edition
H. NEMA EN 10250 – Enclosures for Electrical Equipment (1000 V Maximum)
I. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
J. NEMA OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
K. NEMA OS 2 – Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports
L. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
M. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit
N. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing
O. NEMA BI 50058– Electrical Nonmetallic Tubing (ENT)
P. NFPA 70 – National Electrical Code
Q. TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
R. UL 1 – Flexible Metal Conduit
S. UL 6 – Electrical Rigid Metallic Conduit-Steel
T. UL 6A – Electrical Rigid Metallic Conduit-Aluminum and Stainless Steel
U. UL 360 – Liquid-Tight Flexible Steel Conduit
V. UL 514A – Metallic Outlet Boxes
W. UL 514B – Conduit, Tubing, and Cable Fittings
X. UL 514C – Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
Y. UL 651 – Schedule 40 and 80 Rigid PVC Conduit and Fittings
Z. UL 797 – Electrical Metallic Tubing-Steel
AA. UL 870 – Wireways, Auxiliary Gutters, and Associated Fittings
BB. UL 1242 – Electrical Intermediate Metal Conduit-Steel

CC. UL 1660– Liquid-Tight Flexible Nonmetallic Conduit

DD. UL 2024– Optical Fiber and Communication Cable Raceway

1.04 SUBMITTALS

A. Product Data:

(1) Raceways

(2) Fittings

(3) Wireways

(4) Outlet boxes

(5) Pull and junction boxes

(6) Floor boxes

(7) Tap boxes

(8) Raceway seals

B. Manufacturer's Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

C. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual routing of raceways larger than 2" (53 mm).

(b) Record actual location and mounting heights of wireways, wall ducts, indoor service poles, floor boxes, tap boxes, outlet, pull and junction boxes.

(2) Operation and Maintenance Data:

(a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements:

(1) Comply with NFPA 70.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Protect PVC conduit from sunlight.

C. Comply with manufacturer's written instructions.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

PART 2 - PRODUCTS

2.01 RIGID METAL CONDUIT (RMC)

A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6; heavy wall galvanized steel

B. Intermediate Metal Conduit (IMC): ANSI C80.6, UL 1242; thinner wall, galvanized steel

C. Rigid Aluminum Conduit (RAC): ANSI C80.5; heavy wall aluminum

D. Fittings (couplings, connectors and bushings): NEMA FB 1, UL 514B B; _____ (concrete-tight where applicable); threaded; connectors with double locknuts and steel insulating bushings.

E. Fittings (conduit bodies): NEMA FB 1, UL 514B; ____; cover: ____, ____ with stainless steel screws and neoprene gaskets _____.

F. Fittings Manufacturers: Cooper Crouse-Hinds; Carlon Electric Products/Prime Conduit Inc.; O-Z/Gedney; Appleton; Hubbell; Approved equal

2.02 ELECTRICAL METALLIC TUBING (EMT)

A. ANSI C80.3, UL 797; galvanized steel tubing

B. Fittings (couplings and connectors): NEMA FB 1, UL 514B; steel, ____ gland compression type ____ connectors with double locknuts and insulated throat. Indentor, drive-on, zinc die-cast or pressure cast not permitted.

C. Fittings (conduit bodies): NEMA FB 1, UL 514B: ____; cover: ____, with stainless steel screws and neoprene gaskets.

D. Fittings Manufacturers: Same as manufacturers listed in 2.1

2.03 FLEXIBLE METAL CONDUIT (FMC)

A. UL 1; interlocked steel ____

B. Fittings: NEMA FB 1, UL 514B; steel, die-cast fittings not permitted

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. UL 360; interlocked _____, with PVC jacket

B. Fittings: NEMA FB 1, UL 514B; steel

2.05 RIGID NONMETALLIC CONDUIT (RNC)

A. NEMA TC 2, UL 651; Schedule _____ PVC

B. Fittings: NEMA TC 3, UL 651

2.06 ELECTRICAL NONMETALLIC TUBING (ENT)

A. NEMA BI 50058; hand-bendable, corrugated PVC conduit

B. Fittings: NEMA TC 3

2.07 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. UL 1660; flexible conduit with a plastic sheath

B. Fittings: UL 514B

2.08 METAL WIREWAYS

A. NEMA EN 10250, UL 870; sheet metal troughs with hinged or removable cover, Type ____, unless otherwise indicated.

B. Size: ____.

C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mated with wireways as required for complete system.

D. Wireways Covers: ____

E. Knockouts: ____

F. Finish: Manufacturer’s standard

G. Manufacturers: Hoffman; Square D Co.; Approved equal

2.09 NONMETALLIC WIREWAYS

A. NEMA EN 10250, UL 870; flame-retardant, nonmetallic troughs with removable cover

B. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mated with wireways as required for complete system.

C. Manufacturers: Hoffman Engineering Co.; Lamson & Sessions; Carlon Electrical Products; Square D Co.; Approved equal

2.10 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, UL 514A galvanized steel with stamped knockouts.

(1) Luminaire and Equipment Supporting Boxes: Interior of box shall be marked by the manufacturer to indicate the maximum weight the box is permitted to support. Box shall be supported independently of the luminaire or equipment, if these exceed 50lbs.

(2) Where recessed in Concrete: Concrete Type, two-piece welded construction supplied with two rows of stamped knockouts.

B. Cast-Metal Outlet Boxes: NEMA FB 1, ____, Type FD, with gasketed cover and threaded hubs

(1) For applications requiring more than 2 gang boxes, provide stainless steel custom fabricated welded boxes with threaded hubs and coverplate. For applications including terminations and splicing of power conductors, a standard UL Listed box shall be used inside of the custom fabricated box.

C. Nonmetallic Outlet Boxes: NEMA OS 2

D. Gangable type boxes are not allowed.

E. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds; Approved equal

2.11 PULL AND JUNCTION BOXES

A. Sheet Metal Pull and Junction Boxes: NEMA OS 1; galvanized steel

B. Cast-Metal, Pull, and Junction Boxes: NEMA FB 1; ____ with ground flange, gasketed cover and stainless-steel cover screws

C. Minimum size: 4” (100 mm) square by 2-1/8" (54 mm) deep ____ for use with 1" (27 mm) conduit and smaller; 4-11/16” (118 mm) square by 2-1/8" (54 mm) deep ____ for use with 1-1/4” (35 mm) conduit and larger

D. Sheet Metal Boxes Larger Than 12” (300 mm) in any direction: Hinged cover or a chain installed between box and cover

E. Field-fabricated boxes not allowed without prior approval of local authority having jurisdiction.

F. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds; ; Approved equal

2.12 POKE-THROUGH FITTINGS

A. Poke-Through Fittings: Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.

(1) Fire Rating: ____ h

(2) Service Fitting Type: ____

(3) Housing: ____

(4) Configuration: ____

(5) Manufacturers: Hubbell, Legrand/Wiremold, FSR; Approved equal

2.13 FLOOR BOXES

A. Metal Floor Boxes: NEMA OS 1; ____; ____; ____; Moisture-proof, with forged brass blank cover with each box and close up covers and/or carpet flanges as required for finished floor.

B. Nonmetallic Floor Boxes: nonadjustable, round

2.14 MULTISERVICE FLOOR BOXES

A. Above Grade: Stamped steel, watertight design approved for use on above-grade concrete floor applications, with four independent wiring compartments and capacity for up to four duplex receptacles and/or communication services. The box: fully adjustable providing pre-pour and after-pour adjustment, tunnel compartment, and two receptacle brackets. Conduit knockouts per drawing requirements. Comply with UL 514A and UL 514C scrub water exclusion test for tile, terrazzo, carpet and wood floors.

B. On Grade: Cast iron or steel pour box, watertight design approved for use in on-grade and above-grade concrete floor applications, with four independent wiring compartments and capacity for up to four duplex receptacles and/or communication devices. The box: fully adjustable providing pre-pour and after-pour adjustment, tunnel compartment, and two receptacle brackets. Conduit knockouts per drawing requirements. Comply with UL 514A and UL 514C scrub water exclusion test for tile, terrazzo, carpet and wood floors.

C. Covers: Activation Covers – Die-cast aluminum with textured aluminum finish, and black or brass powder-coated paint finishes as selected by the Architect. Cover: flanged or flangeless, as required, with options for tile or carpet inserts, blank covers, or covers with one or two 1” (27 mm) liquid tight conduit openings for furniture feed applications.

D. Communication Modules Mounting Accessories: Complete line of faceplates and bezels provided by floor box manufacturer to facilitate mounting of fiber optic, coaxial, high-performance twisted-pair cabling, and communication devices. Cabling type and faceplate configurations per requirements in Section 27 15 00 - Communications Horizontal Cabling. The box shall accommodate workstation connectivity outlets and modular inserts and other system devices.

E. Manufacturers:

(1) Hubbell - HBLCFB Series

(2) Spider - AFB/CFB Series

(3) Legrand/Wiremold - Evolution Series

2.15 TAP BOXES

A. Multi-tap connectors as indicated on drawings.

B. Manufacturers: Ilsco; ____

2.16 EXPANSION FITTINGS

A. Malleable iron, hot dip galvanized allowing ____ raceway movement.

B. Manufacturers: OZ/Gedney AX Series; or equivalent by manufacturer listed in 2.1.

2.17 RACEWAY PENETRATION SEALS

A. Thruwall and Floor Seals.

B. Manufacturers: New construction – OZ/Gedney FSK Series; existing construction – OZ/Gedney CSM Series; or equivalent by manufacturer listed in 2.1.

2.18 RACEWAY SEALING FITTINGS

A. For one through four conductors: Manufacturers: OZ/Gedney CSB Series; ____

B. For greater than four conductors: Manufacturers: OZ/Gedney EYA Series with sealing compound; ____

C. Low-temperature or hazardous locations: Manufacturers: OZ/Gedney EYA Series with sealing compound; ____

2.19 CABLE SUPPORTS

A. Manufacturers: OZ/Gedney Type S; or equivalent by manufacturer listed in 2.1.

2.20 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends, with integral water stop.

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052” (1.321 mm) or 0.138" (3.505 mm) thickness and of length to suit application.

C. Integral Water Stop: Manufacturer: Thunderline Corporation; ____

(1) High density polyethylene (HDPE). Type Century-Line engineered sleeve with end caps.

(2) Steel. Type WS engineered sleeve.

2.21 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

(1) Sealing Elements: ____ interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

(2) Pressure Plates: ____. Include two for each sealing element.

(3) Connecting Bolts and Nuts: ____ of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.01 COORDINATION

A. Coordinate with Architect/Engineer size and location of required built-in openings in building structure, including those sleeved, formed or core drilled.

B. Coordinate with Architect/Engineer cutting, removing, or piercing general or mechanical insulation, fire-rated walls, ceilings or steelwork.

C. Verify with Architect/Engineer all surface raceway installations except in mechanical, electrical, and communications rooms.

D. Coordinate with Architect/Engineer exact locations of floor boxes, where shown on drawings, prior to rough-in.

E. Coordinate routing of through-roof conduits.

F. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 05 93 - Electrical Systems Firestopping.

G. Verify that exterior wall or wet location boxes are gasketed type cast boxes with matching cover.

H. Verify with manufacturer that “touch-up” paint kit and PVC-coating kit are available for use.

3.02 EXAMINATION

A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of raceway’s installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Raceways:

(1) Comply with ANSI/NECA 1 and NFPA 70 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this Section are stricter.

(2) Arrange raceways to maintain headroom and present neat appearance.

(3) Raceway routing is shown in approximate locations, unless dimensioned. Route to complete raceway installation before starting conductor installation.

(4) Keep raceways at least ____ away from parallel runs of flues, steam, hot-water pipes or ductwork. Install horizontal raceway runs above water and steam piping. Install raceways level and square and at proper elevations: 6’-6” (2 m) minimum headroom, except in exit pathways 7'0" (2.1 m) minimum headroom. Do not block access to junction boxes, mechanical equipment or prevent removal of ceiling panels, etc.

(5) Run raceways concealed in construction to avoid adverse conditions such as heat and moisture, to permit drainage, and to avoid materials and equipment of other trades, except where noted otherwise.

(6) Avoid exposed raceway runs. Run raceways exposed where impractical or impossible to conceal or where specific approval is obtained. Run exposed raceways grouped and parallel or perpendicular to construction. Do not route exposed raceways over boilers or other high-temperature machinery or in contact with such equipment. Offset exposed raceways at boxes.

(7) Route raceways installed above accessible ceilings parallel or perpendicular to construction.

(8) Do not install raceways in structural or topping floor slabs, except where noted on the plans. Install raceway in structural or topping floor slabs, where noted on plans, as follows:

- (a) Center raceways in structural slabs clear of reinforcing steel, except where crossing same, and spaced on centers equal or exceeding 3 times the raceway diameter. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in concrete.
- (b) Outside diameter of raceway shall not exceed 1/3 the structural slab thickness.
- (c) Obtain approval from Engineer for each run of raceway 1” (27 mm) or larger.
- (d) Do not install raceways in topping slabs of 2” (50 mm) or less.
- (e) Locate raceways to avoid conflict with equipment, door bucks, partitions and other equipment bolted to floor.
- (f) Arrange stub-ups so curved portions of bends are not visible above finished slab. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; use flexible metal conduit 6” above the floor. Install threaded plugs flush with floor for future equipment connections.
- (g) Change from nonmetallic raceway to RMC or IMC before rising above floor.

(9) Cut raceways square using saw or pipe cutter.

(10) Use hydraulic one-shot raceway bender or factory elbows for bends in raceway larger than 2” (53 mm), unless sweep elbows required. Bend raceways according to manufacturer’s recommendations. Do not use torches or open flame to aid in bend of PVC conduit.

(11) Use raceway fittings compatible with raceways and suitable for use and environment.

(12) Provide bushings on ____.

(13) Raceways minimum sizes:

- (a) Minimum raceway size ____, except as noted on drawings.
- (b) Minimum home run size: ____, except as noted on drawings.
- (c) Minimum size for flexible metal conduit is 1/2” (16 mm) except 3/8" (12 mm) for luminaires.
- (d) Minimum size for liquidtight flexible metal conduit is 1/2” (16 mm)

(14) Install empty raceways 2-1/2” (63 mm) and larger with 10 ga (2.5 mm) galvanized fish wire; install 200 lb (90.7 kg) nylon pull cord in raceways smaller than 2-1/2" (63 mm); leave at least 12" (300 mm) of slack at each end of pull wire. Cap raceways at both ends.

(15) Feed devices on same wall vertically from above or junction box in suspended ceiling.

- (a) Do not install horizontal bends in conduit around corners.
- (b) Feed devices in exterior or load-bearing walls by horizontal conduit runs.

(16) Raceways Supports:

- (a) Independently support or attach raceway system to structural parts of construction. Suspended ceiling systems shall not be considered as structural parts of construction for raceway support. Do not attach raceways to piping system.
- (b) Raceway supports for horizontal or vertical single runs:
  - 1) Hot dipped galvanized heavy-duty sheet steel straps, mineralac clamps or steel slotted support channel system with appropriate components.
  - 2) Spring steel type pressure clamps for raceways 3/4” (21 mm) and smaller.
- (c) Raceway supports for horizontal and vertical multiple runs:
  - 1) Trapeze-type supports fabricated with steel slotted channel systems with appropriate components.
  - 2) Support horizontal runs with appropriately sized rods.
  - 3) Anchor vertical runs to structure.
  - 4) Spring-steel type pressure clamps for raceways 3/4” (21 mm) and smaller.
- (d) Vertical raceway runs 1-1/4” (35 mm) and larger passing through floors: Support at each floor with pipe riser clamps.
- (e) Do not support raceways with wire, perforated pipe straps or plastic tie-wrap. Remove wires used for temporary support.
- (f) Secure raceways in metal stud walls to prevent rattling.
- (g) Arrange raceway supports to prevent misalignment during wiring installation.

(h) Do not fasten raceways to corrugated metal roof deck.

(i) For fasteners and supports, including steel slotted support systems, support devices, support spacing, support of conductors in vertical raceways, and hanger rod size, refer to Section 26 05 29 - Hangers and Supports for Electrical Systems and NFPA 70.

(17) Raceways Seismic Restraints:

(a) Avoid raceway runs crossing building seismic joints. Use flexible connections where crossings cannot be avoided.

(b) Install rigid bracing and lateral restraints for suspended raceway runs per requirements in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems.

(18) Identify raceways per requirements in Section 26 05 53 - Electrical Systems Identification.

(19) Ground raceways per requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

(20) Flexible Conduit Connections: Use maximum of 72” (1800 mm) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for motors.

(a) Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

B. Wireways and Wall Ducts:

(1) Install in accordance with manufacturer’s instructions.

(2) Use screws, clips and straps to fasten raceway channel to surfaces.

(3) Mount plumb and level.

(4) Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

(5) Supports: Per manufacturer’s recommendations.

(6) Close ends of raceway channel and unused conduit openings.

C. Boxes:

(1) Install boxes to accommodate device indicated by symbol, in conformance with code requirements, number and size of conductors and splices and consistent with type of construction.

(2) Install the appropriate cover on surface-mounted boxes:

(a) Raised device covers on 4” (100 mm) square and 4-11/16" (118 mm) boxes and handy box covers on handy boxes, etc.

(b) Device covers that are square drawn or square cut on boxes in block.

(c) Tile covers on boxes in tile.

(d) Round drawn device covers on boxes in lath and plaster walls or drywall only.

(e) Set front edge of device boxes flush with finished wall surfaces except on walls of non-combustible materials where boxes may have maximum set back of 1/4” (6 mm). Secure flush-mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

(3) Set outlet boxes parallel to construction and independently attached to same.

(4) Do not install back-to-back and through-the-wall boxes. Install with minimum 6” (150 mm) horizontal separation between closest edges of the boxes. Install with minimum 24" (600 mm) separation in acoustic-rated walls and fire-rated walls.

(5) Install multi-ganged boxes where 2 or more devices are in same location, unless otherwise noted.

(6) Box Support:

(a) Mount boxes straight.

(b) Install horizontal bracing at top or bottom of box for 3 or more gang device boxes in stud walls.

(c) Install stud support one side, with short piece of stud, for up to 2 gang device boxes.

(d) Do not support boxes with tie-wire.

(e) For one and two gang box support, manufactured bracket supports shall be accepted alternate.

(f) Support boxes independently of raceways.

(g) Install adjustable steel channel fasteners for hung ceiling outlet box.

(h) Install stamped steel bridges to fasten flush-mounted outlet box between studs.

(i) Do not install boxes to ceiling support wires or piping systems.

(7) Install partitions in multi-ganged boxes where different types of devices are installed, or devices installed operate at different voltages.

(8) Mount boxes in block walls at block joint nearest to indicated height.

(9) Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall.

(10) When boxes are installed in fire-resistive walls and partitions, provide 24” (600 mm) horizontal separation between boxes on opposite sides of a wall. In addition, limit penetrations to 16 sq in (650 sq mm) per penetration and not to exceed a total of 100 sq in per 100 sq ft (64500 sq mm per 9 sq m) of wall area. Apply fire stop putty pads acceptable to the fire marshal.

(11) Pull and junction boxes: Install as shown, or as necessary to facilitate pulling of wire and to limit number of bends within code requirements. Install above accessible ceilings and in unfinished areas.

(12) Install boxes to be permanently accessible.

(13) Do not intermix conductors from more than one system in same junction box or pull box, unless shown or specifically authorized otherwise.

(14) Adjust box location up to ____ prior to rough-in to accommodate intended purpose.

(15) Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26 - Wiring Devices.

(16) Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6” (150 mm) from ceiling access panel or from removable recessed luminaire.

(17) The drawings do not necessarily show every outlet, pull or junction box required. Add all required boxes as necessary.

D. Floor Boxes:

(1) Set metal floor boxes level and flush with finished floor surface.

(2) Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

(3) Use cast floor boxes for installations in slab on grade.

(4) Install floor boxes and fittings to preserve fire-resistant rating of slabs and other elements, using materials and methods specified in Section 26 05 93 - Electrical Systems Firestopping.

(5) Identify communication outlets per requirements in Section 27 05 53 - Communications Systems Identification.

(6) Power and IT or AV conduits require a minimum 12” separation where routed parallel including entry into floor boxes.

E. Expansion Fittings:

(1) Install raceway expansion and deflection fittings in all raceway runs embedded in or penetrating concrete where movement perpendicular to axis of the raceway may be encountered.

(2) Install raceway expansion fittings complete with bonding jumpers in raceway runs that cross expansion joints in structure and raceway runs mechanically attached to 2 separate structures.

(3) Use couplings and flexible connection made up of 24” (600 mm) length of flexible metal conduit, where EMT runs across expansion joints in ceiling spaces.

(4) Install fitting(s) that provide expansion and contraction for at least 0.0004” per ft (0.01 mm per m) of length of straight run per ____°F (____°C) of temperature change.

(5) Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer’s written instructions for conditions at specific location at time of installation.

F. Raceway Penetration Seals:

(1) Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

(2) Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section “Maintenance of Joint Protection” for materials and installation.

(3) Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Section 26 05 93 - Electrical Systems Firestopping.

(4) Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

(5) Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1” (25 mm) annual clear space between pipe and sleeve for installing mechanical sleeve seals.

(6) Underground, Exterior-Wall Penetrations: Install cast-iron “wall pipes” for sleeves. Size sleeves to allow for 1” (25 mm) annual clear space between raceway and sleeve for installing mechanical sleeve seals.

(7) Sleeve-Seal Installation: Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

(8) Remove temporary sleeves, if used for form wall openings, prior to installation of permanent materials.

G. Raceway Sealing Fittings:

(1) Install listed watertight seals to prevent the passage of moisture and water vapor through raceway, where raceway passes from interior to exterior of the building, where raceway passes between areas of different temperatures such as into or out of cold rooms or freezers, where raceway enters room which at any time is subject to low or high temperatures and where raceway enters a room which at any time is subject to internal air pressures above or below normal.

(2) Install watertight seals in interior of all raceways passing through building roof, ground floor slab (when the raceway does not extend beyond building footprint), or through outside walls of building above or below grade. Seal on the end inside building, using raceway sealing fittings manufactured for the purpose. Locate fittings at suitable accessible locations. For concealed raceways install each fitting in flush steel box with blank coverplate to match finish of adjacent plates or surfaces.

(3) Seal raceways entering or passing through “hazardous (classified) areas” as defined in NFPA 70.

H. Sleeve Installation for Electrical Penetrations:

(1) Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 05 93 - Electrical Systems Firestopping.

(2) Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

(3) Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

(4) Rectangular Sleeve Minimum Metal Thickness:

(a) For sleeve cross-section rectangle perimeter less than 50” (1270 mm) and no side greater than 16" (400 mm), thickness shall be 0.052" (1.321 mm).

(b) For sleeve cross-section rectangle perimeter equal to, or greater than, 50” (1250 mm) and 1 or more sides equal to, or greater than, 16" (400 mm), thickness shall be 0.138" (3.5 mm).

(5) Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies, unless openings compatible with firestop system used are fabricated during construction of floor or wall.

(6) Cut sleeves to length for mounting flush with both surfaces of walls.

(7) Extend sleeves installed in floors 2” (50 mm) above finished floor level.

(8) Size pipe sleeves to provide ____ annular clear space between sleeve and raceway, unless sleeve seal is to be installed or unless seismic criteria require different clearance.

3.04 APPLICATION

A. Provide raceways and boxes in accordance with the following table:

Application	Approved Raceways	Approved Boxes	Application Notes
Underground More than____ outside Foundation Walls	____, ____.	Cast Metal Boxes or Nonmetallic Handholes	
Underground More than ____ from Foundation Walls	____, ____.	Cast Metal Boxes or Nonmetallic Handholes	
In or Under Slab on Grade	____, ____	Cast or Nonmetallic Boxes	Use steel elbows with RNC when encased in concrete
Outdoor Locations, Above Grade	____	Cast Metal or Nonmetallic	
In Slab Above Grade	____, ____	____	
Wet and Damp Locations	____, ____	Cast Metal or Nonmetallic. Install flush mounting outlet boxes in finished areas.	
Concealed Dry Locations	____, ____	Sheet Metal Boxes; Install flush mounting outlet boxes in finished areas. Install hinged enclosure for large pull boxes.	
Exposed Dry Locations	____, Schedule 80 PVC	____ boxes; Install flush mounting outlet boxes in finished areas; Install hinged enclosure for large pull boxes.	
Exposed Subject to Damage	____	Cast Metal	
Hazardous Locations	____	Cast Metal	
Locations requiring Mechanical Protection	____		
Corrosive Atmospheres	____		Use PVC Coated Elbows with PVC Conduits
Vibrating equipment (including transformers &	Flexible Metal Conduits		Lengths for FMC & LFMC may range between 2 ft (0.6

Application	Approved Raceways	Approved Boxes	Application Notes
hydraulic, pneumatic, electric solenoid or motor-driven equipment)	(FMC) – Dry Locations Only Liquid Tight Flexible Metal Conduits (LFMC) – Wet Locations		m) to 4 ft (1.2 m)
Kitchen Equipment	Liquid Tight Flexible Metal Conduits		Lengths for LFMC may range between 2 ft (0.6 m) to 4 ft (1.2 m)
Instruments & control devices	Liquid Tight Flexible Metal Conduits		Lengths for LFMC may range between 2 ft (0.6 m) to 4 ft (1.2 m)

B. Special Conditions

(1) 1/2" raceway permitted:

(a) Between controller and its control or pilot device

(b) Between lighting switch and nearest outlet for luminaire

(c) Control wiring where mounted on equipment where conduit must follow contour of equipment

(d) Protective and signal systems where noted

(e) Where shown on plans

3.05 FIELD QUALITY CONTROL

A. Inspect raceway, boxes, indoor service poles, and wireways for physical damage, proper alignment, supports and seismic restraints, where applicable.

B. Replace any damaged component of the raceway system or install new raceway system.

C. Inspect components, wiring, connections and grounding.

3.06 REPAINTING

A. Repair damage to galvanized finishes with manufacturer-supplied zinc-rich paint kit. Leave remaining paint with Owner.

B. Repair damage to PVC or paint finishes with manufacturer-supplied touch-up coating. Leave remaining coating with Owner.

C. Wireways, indoor service poles: Remove paint splatters and other marks from surface; touch-up chips, scratches, or marred finished to match original finish using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.07 ADJUSTING

A. Adjust flush-mounted boxes pre-pour and after-pour to be flush with finished materials.

B. Install knockout closures in unused openings in boxes.

C. Align adjacent wall-mounted outlet boxes for switches and similar devices.

D. Adjust outlet boxes to allow luminaires to be positioned as indicated on ____.

3.08 CLEANING

A. Clean interior and exterior of boxes, wireways, and indoor poles to remove dust, debris and other material.

END OF SECTION 26 05 33

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 03 30 00 - Cast-In-Place Concrete

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems

C. Section 26 05 33 - Raceway and Boxes for Electrical Systems

D. Section 26 05 43.13 - Excavation and Backfill

E. Section 26 05 43.19 - Manholes and Hardware

F. Section 26 05 53 - Electrical Systems Identification

1.02 DESCRIPTION

A. Section includes conduits, ducts, and duct accessories for ____ for underground distribution for electrical power and communications.

B. The terms duct and ductbank, as used in this Section, are defined as follows:

(1) Duct: A single underground conduit, encased in concrete or direct buried.

(2) Duct Bank: Two or more ducts run together.

1.03 REFERENCE STANDARDS

A. ANSI C2 – National Electrical Safety Code

B. ANSI C80.1 – Rigid Steel Conduit-Zinc Coated (GRC)

C. ASTM F512 – Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduits and Fittings for Underground Installation

D. NEMA TC 2 – Electrical Polyvinylchloride (PVC) Conduit

E. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing

F. NEMA BI 50063 – PVC Plastic Utilities Duct for Underground Installation

G. NEMA TC 9 – Fittings for PVC Plastic Utility Duct for Underground Installation

H. NFPA 70 – National Electrical Code

I. UL 651 – Schedule 40 and 80 Rigid PVC Conduit

J. UL 651A – Type EB and A Rigid PVC Conduit and HDPE Conduit

K. UL E53373 – Underground Fiber Reinforced Epoxy Conduit (FRE)

L. UL 6 – Electrical Rigid Metallic Conduit-Steel

1.04 SUBMITTALS

A. Product data for the following:

(1) Duct bank materials, including spacers and miscellaneous components

(2) Ducts and conduits and their accessories, including elbows, end bells, bushings, seals, bends, fittings, plugs, pull tape, and solvent cement

(3) Warning tape

(4) Warning plank

B. Manufacturer’s Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

C. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual routing of conduits and ductbanks.

(2) Operation and Maintenance Data:

(a) Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements:

(1) Comply with NFPA 70

(2) Comply with ANSI C2

(3) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Deliver ducts to project site with end capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 CONDUITS

A. Rigid Steel Conduit (RSC):_____ ANSI C80.1, UL 6, heavy wall, hot dipped, galvanized steel _____.

B. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 _____, UL 651, with matching fittings by same manufacturer, complying with NEMA TC 3 and UL 651, listed for underground use, _____.

C. Size:

(1) 4” (103 mm) nominal for voltages below 600 V and communications

(2) 5” (129 mm) nominal for voltages above 600 V

2.02 NONMETALLIC DUCTS

A. Underground Plastic Utilities Duct: NEMA BI 50063, Type EB-20-PVC, ASTM F512, UL 651A, with matching fittings by the same manufacturer, complying with NEMA TC 9.

B. Underground Plastic Utilities Duct: NEMA BI 50063, _____, ASTM F512, with matching fittings by the same manufacturer, complying with NEMA TC 9.

C. Underground Fiber Reinforced Epoxy Conduit (FRE): UL E53373

2.03 DUCT ACCESSORIES

A. Duct Spacers:

(1) Rigid PVC interlocking spacers.

(2) Factory-fabricated, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling. Horizontal and vertical locking separation of _____ between ducts _____.

B. Elbows: Material to match conduit; minimum bend radius of _____.

C. Bell Ends: Manufactured bell ends of appropriate sizes at each end of conduit; pre-manufactured system for PVC with conduit seals, provisions for roughing into the concrete pour and waste stops, when entering a new building or a new manhole.

D. Bushings: Groundable steel bushings of appropriate sizes on all metal conduits where bell ends are not used; pre-manufactured system for PVC with conduit seals, provisions for roughing into concrete pour and water stops, when entering a new or existing building or a new or existing _____.

E. Seals: Mechanical interlocking assembly seal of modular synthetic rubber links properly sized to fit the pipe and tightened in place, in accordance with manufacturer’s instructions, when entering an existing building or _____ below grade and concrete shall be core drilled for the appropriate size conduit and seal.

F. Plugs: Closure plugs or caps of same material as conduit at ends of unused sections.

G. Pull Tape: Nylon pull tape with measurement markings in uniform lengths in each empty duct.

H. Grounding:

(1) Steel grounding bushings, where bell ends are not used.

(2) Bonding fitting with bonding strap on steel conduit with end bells.

I. Warning Tape: Underground line warning tape specified in Section 26 05 53 - Electrical Systems Identification.

J. Concrete Dye Color: Red dye for electrical ductbank and orange dye for communications ductbank added to _____.

K. Solvent Cement: Recommended by conduit manufacturer.

L. Multicell Raceway Systems: An outer shell with pre-lubricated inner ducts preinstalled. A typical assembly: 4” (100 mm) shell with 4 cells of 1-1/2" (41 mm) inner ducts. The outer shell: Available in bullet-resistant fiberglass, galvanized steel, and electrical metallic tubing; manufactured for direct burial and concrete encasement installation methods.

M. PVC and High-Density Polyethylene (HDPE) Bundles: For installation in large-bore steel casings. The bundles: Assembled with bore spacers to keep conduits aligned within the casing.

N. Preassembled Multiduct Kits: Communication ducts, assembled with duct spacers, ready to lay in trenches for direct burial or encasement. A typical preassembled kit: Four 1-1/2” (41 mm) ducts in 20 ft (6.1 m) lengths.

PART 3 - EXECUTION

3.01 COORDINATION

A. Coordinate layout and installation of ducts with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and ductbank entrances into _____ with final locations and profiles of ducts and ductbanks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect. For manholes and handholes construction, refer to Section 26 05 43.19 - Manholes and Hardware.

C. Adjust the depth of electrical utilities to avoid existing utilities with no change to contract price.

D. Utility Coordination: When duct lines are being constructed for use by a utility serving the project, consult with them for duct size and quantity, minimum bending radii, maximum distance between pulling points, grounding details, termination arrangement, and other criteria.

E. Duct Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

(1) Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

(2) Drawings shall be signed and sealed by a qualified professional engineer.

3.02 EXISTING UTILITIES

A. The existing utilities shown on contract drawings have been plotted from available records. No guarantee is made as to accuracy of locations indicated and is shown for the benefit of Contractor.

B. Contact all serving utility companies and have them locate their lines prior to commencing work. Telephone “Call Before You Dig” _____, 48 hours prior to commencing work. Coordinate with Owner all existing utility lines prior to commencing work.

C. Protect shown, visible and located utilities from damage. Promptly repair all active shown, visible and located utilities damaged by construction. This repair shall be made solely at the expense of the Contractor.

D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

3.03 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

(1) Notify _____ no fewer than _____ days in advance of proposed interruption of electrical service.

(2) Do not proceed with interruption of electrical service without written permission from the _____.

3.04 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends, both horizontally and vertically, at other locations, unless otherwise indicated. All 90-degree sweeps with radius 10 ft (3 m) or less shall be rigid steel conduit.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer’s written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane. Do not use conduit that requires the use of couplings for straight runs. Use acceptable PVC terminal adapters when joining PVC conduit to metallic fittings or rigid metal conduit.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10” (250 mm) o.c. for 5" (129 mm) ducts, and vary proportionately for other duct sizes.

(1) Begin change from regular spacing to end-bell spacing 10 ft (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.

(2) Direct Buried Duct Banks: Install an expansion and deflection fitting in each conduit in area of disturbed earth adjacent to manhole or handhole.

(3) Concrete Enclosed Duct Banks: Install watertight expansion fitting in each conduit, with internal bonding jumper to allow for 3/4” (19 mm) movement in any direction.

(4) Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least _____ outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 26 05 33 - Raceway and Boxes for Electrical Systems.

F. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand minimum of 15 psig (103.4 kPa) hydrostatic pressure. Provide watertight entrance sealing device where an underground conduit enters a structure through a concrete roof or membrane waterproofed wall or floor.

G. Fire Stops: Provide fire stop openings around electrical penetrations to maintain fire-resistance rating, where underground raceways penetrate fire-rated walls or floors.

H. Pulling Cord: Install 100 lb (45 kg) test nylon cord in ducts, including spares. Identify with tags at each end and at any intermediate pull point the origin and destination of each spare duct. _____ Provide a removable permanent cap over each end of each spare duct.

I. Concrete Encased Ducts: Support ducts on duct spacers.

(1) Spacer Installation:

(a) Provide spacers close enough to prevent sagging and deforming of ducts, with not less than _____ spacers per 20 ft (6.1 m) of duct. Secure spacers to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6" (150 mm) between tiers. Tie entire assembly together using tie wires and reinforcing steel. Install base and intermediate spacers at every coupling point of each duct line for a separation horizontally and vertically per NEC.

(2) Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

(a) Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer’s written recommendations or use other specific measures to prevent expansion-contraction damage.

(b) Terminate each pour in a vertical plane if more than one pour is necessary and install 3/4” (19 mm) reinforcing rod dowels extending 18" (450 mm) into concrete on both sides of joint near corners of envelope. Obtain Architect’s approval for the number and location of dowels.

(3) Pouring Concrete: Space concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for ductbank application.

(4) Reinforcement: Reinforce concrete-encased ductbanks where they cross disturbed earth and where indicated. Arrange reinforcing bars and ties without forming conductive or magnetic loops around ducts or duct groups. Size reinforcing bars and wire ties as indicated on drawings. Provide rebars with minimum of 2” (50 mm) of concrete on sides, top and bottom. Reinforcing bars shown in sections are required throughout.

(5) Forms: Use walls of trench to form side walls of ductbank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms of materials and in a manner acceptable to Architect.

(6) Minimum Space between Ducts: 3” (80 mm) between ducts and exterior envelope wall, 2" (50 mm) between ducts for like services, and 4" (100 mm) between power and signal ducts.

(7) Depth: Install top of ductbank at least _____ below finished grade in areas not subject to deliberate traffic, and at least _____ below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

(8) Maintain a grade of at least 4” (100 mm) per 100 ft (30.5 m), either from one manhole or pull box to the next, or from a high point between them, depending on surface contour.

(9) Warning Tape: Refer to requirements in 26 05 53 - Electrical Systems Identification.

(10) Place ductbanks on an undisturbed soil base if possible. Where concrete encased ductbank is installed over an extensive area of disturbed earth such that within the periphery of a building, provide a separate concrete base under the ductbank to ensure stability of raceways during installation. Allow this base to set before ductbank is installed.

J. Direct Buried Duct Banks:

(1) Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

(2) Space spacers close enough to prevent sagging and deforming of ducts, with not less than _____ spacers per 20 ft (6.1 m) of duct. Secure spacers to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6" (150 mm) between tiers.

(3) Excavate trench bottom to provide firm and uniform support for ductbank. Prepare trench bottoms as specified in Section 26 05 43.13 - Excavation and Backfill.

(4) Install backfill as specified in Section 26 05 43.13 - Excavation and Backfill.

(5) After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4” (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 26 05 43.13 - Excavation and Backfill.

(6) Install ducts with a minimum of 3” (80 mm) between ducts for like services and 6" (150 mm) between power and signal ducts.

(7) Depth: Install top of ductbank at least 36” (914 mm) below finished grade, unless otherwise indicated.

(8) Set elevation of bottom of ductbank below the frost line.

K. Stub-Ups:

(1) Use manufactured PVC duct elbows for stub-ups at poles and equipment and at building entrances through floor, unless otherwise indicated. Extend concrete encasement throughout length of the elbow. Concrete encasement applies to concreted encased ducts.

(2) Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

(a) Couple steel conduits to ducts with adapters designed for this purpose and encase couplings with 3” (80 mm) of concrete. Concrete encasement applies to concrete encased ducts.

(b) Stub-Ups to Equipment: For equipment mounted on outdoor concrete pads, extend steel conduit horizontally a minimum of _____ from edge of equipment pad or foundation. Encase in concrete for concrete encased ducts. Install insulated grounding bushings on terminations at equipment.

L. Arrangement and Routing:

(1) Arrange multiple duct runs substantially in accordance with details shown on drawings. Locate underground ducts where indicated on drawings and grade to the elevations shown on civil drawings.

(2) Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where duct runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the _____ for written instructions before further work is done.

(3) Maintain a 12” (300 mm) minimum vertical separation between ducts and other systems at crossings where other utility piping systems are encountered or being installed along a raceway route. Maintain a 12" (300 mm) minimum separation between ducts and other systems in parallel runs. Do not place ducts over valves or couplings in other piping systems. Refer conflicts with these requirements to the _____ for written instructions before further work is done.

(4) Provide markers at grade to indicate direction of underground conduits provided under this contract. Provide markers consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction. Provide markers at all bends and at intervals not exceeding 100 ft (30.5 m) in straight runs. Use markers made of sheet bronze not less than 1/4" (6 mm) thick embedded in and secured to the top of concrete posts. User markers not less than 10" (250 mm) long and 3/4" (19 mm) wide and marked ELECTRIC CABLES in letters 1/4" (6 mm) high incised into the bronze to a depth of 3/32" (2 mm).

(5) Enter manholes and structures with ducts at right angles.

3.05 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600V: RNC, NEMA Type _____-PVC, in concrete encased ductbank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600V and Less: RNC, NEMA Type _____-PVC, in concrete encased ductbank, unless otherwise indicated.

C. Ducts for Electrical Feeders 600V and Less: RNC, NEMA Type _____-PVC, in direct buried ductbank, unless otherwise indicated.

D. Ducts for Electrical Branch Circuits: RNC, NEMA Type _____-PVC, in direct buried ductbank, unless otherwise indicated.

E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type _____-PVC, in concrete encased ductbank, unless otherwise indicated.

F. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: _____ installed in _____ ductbank, unless otherwise indicated.

G. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type _____-PVC, in direct buried ductbank, unless otherwise indicated.

H. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EB-2--PVC, in concrete encased ductbank, unless otherwise indicated.

I. Underground Ducts Crossing _____: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.06 EARTHWORK

A. Excavation and Backfill: Comply with Section 26 05 43.13 - Excavation and Backfill, do not use heavy-duty, hydraulic-operated compaction equipment.

3.07 CONCRETE

A. Concrete: 3000 psi (211 kg/cm²), 28-day strength, complying with Division 03 – Concrete, where concrete encased.

3.08 GROUNDING

A. Ground underground ducts according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

3.09 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

(1) Demonstrate capability and compliance with requirements on completion of installation of underground ducts.

(2) Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80% fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Preparation for pulling in conductors:

(1) Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

(2) Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

C. Do not backfill underground direct buried and concrete encased ducts until the Architect has inspected them. Notify Architect 24 h in advance of duct concrete pour or backfill of direct buried ducts.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 26 05 43

SECTION 26 05 43.13 - EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 31 2000 - Earth Moving

B. Section 26 05 43 - Underground Ducts And Raceways For Electrical Systems

1.02 DESCRIPTION

A. Section lists methods and materials for trench excavation and backfill for electrical and communications conduits in ductbanks. Refer to Section 26 05 43 - Underground Ducts And Raceways For Electrical Systems.

1.03 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

B. Excavation: Removal of material encountered above sub-grade elevations and to lines and dimensions indicated.

C. Duct: A single underground conduit encased in concrete or direct buried.

D. Duct Bank: Two or more ducts run together.

E. Fill: Soil materials used to raise existing grades.

F. Sub-grade: Surface or elevation remaining after completing excavation, or top surface of fill or backfill immediately below subbase, drainage fill, or topsoil materials.

G. Utilities: On-site underground ducts and ductbanks as well as underground services within buildings.

1.04 SUBMITTALS

A. Submit list of materials to be used for backfill.

1.05 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at project site to comply with requirements in Division 01 Section “Project Coordination.”

PART 2 - PRODUCTS

2.01 FILL MATERIAL

A. Type 1 Fill:

(1) Material from excavation separated from materials, which do not compact by tamping and rolling. No stones larger than 3” (80 mm) and no building, organic, or corrosive or frozen materials and no lumps larger than 6" (150 mm).

B. Type 2 Fill:

(1) Sand or gravel materials with none larger than 2” (50 mm) and of that portion passing the #4 (4.75 mm) sieve less the 5% to pass #200 sieve.

C. Type 3 Fill:

(1) Gravel of rounded to sub-angular shape, screened, which will pass 3/4” (19 mm) sieve and retained on #4 (4.75 mm) sieve.

D. Type 4 Fill:

(1) Pit run rock or gravel with maximum stone size of 1” (25 mm).

E. Type 5 Fill:

(1) Pea gravel, screened, which will pass 3/8” (9.5 mm) sieve and retained on #4 (4.75 mm) sieve.

2.02 CRUSHED ROCK

A. Crushed Rock: 1-1/4” (32 mm) minus, unless smaller is required for bedding material.

2.03 SAND

A. Sand: Clean and washed building sand.

2.04 TOPSOIL

A. Topsoil: Equal in quality to that removed.

2.05 SOD

A. New Sod: Mature, densely rooted grass free of weeds and objectionable grasses.

2.06 PLANTS

A. Plants: Obtained from a commercial nursery and be similar to those replaced.

PART 3 - EXECUTION

3.01 PREPARATION

A. Establish grade lines and locations of roadways and sidewalks, grade beams, and pill caps. Provide necessary stakes and batter boards.

B. Verify elevations of existing utilities prior to excavation for new ducts.

C. Verify locations of _____ with civil drawings.

D. Coordinate excavation and backfill with Section 31 2000 – Earth Moving.

E. Verify footings and foundations with structural drawings.

F. Verify underground sanitary and sewer with plumbing and civil drawings.

3.02 EXCAVATION

A. Provide excavation for underground work, including ducts, vaults, manholes, handholes, pull boxes____, unless otherwise shown or specified. Lay duct in open trench, except when Architect gives written permission for tunneling.

B. Excavate trench _____ to 24” (600 mm) wider than duct or ductbank dimensions and minimum of 3" (80 mm) below bottom of duct.

C. Include clearing, tree removal, grubbing, pavement removal, substructure removal such as walls, footings, and piers, and all incidental work such as tunneling, sheet piling, shoring, underpinning, pumping, bailing, and transportation. Coordinate excavation extending beyond construction limits with Construction Manager and Owner.

D. Do not provide blasting on this project without written permission of Architect and Owner.

E. _____

F. Over excavate 3” (80 mm) and fill with 3" (80 mm) of sand, where trench bottom is rock, or rocky, or contains debris larger than 1" (25 mm), or material with sharp edges.

G. Perform all crossings of concrete or asphalt after surface material has been saw cut to required width and removed.

H. Conform to utility company requirements for excavation and vault installation in addition to contract document requirements where excavations are for installing utility company’s ducts and vaults.

3.03 ROCK EXCAVATION

A. Use mechanical methods to remove rock in trenches for underground ducts.

B. Refer to Geotechnical Report available from Architect/Engineer for data on rock.

C. Include rock excavation in the Bid, unless otherwise indicated.

3.04 INSTALLATION

A. Keep underground ducts to proper line and grade and sealed to prevent entrance of animals or foreign matter.

B. Provide bracing and sheet piling as necessary to support trenches. Comply with Local Regulations, applicable provisions of OSHA Regulations on trenching, or with provisions of “Manual of Accident Prevention in Construction” published by Associated General Contractors of America.

C. Do not lay duct in water.

D. Review project drawings for underground ductbank details.

E. Keep trench free from water until duct joint material has hardened and concrete encasement is in place.

F. Do not increase the contract cost due to presence of ground water in soil or necessity of sheet piling or bracing trenches. Adjust contract cost when sheet piling is left in place, on written order of Owner.

G. Do not remove sheet piling until trench is substantially backfilled. Cut off sheet piling left in place not less than 2 ft (0.6 m) below new, finished grade.

H. Place underground ducts on _____ compacted bedding of sand. Shape bedding for clearance for joints and fittings, tamped in place and graded evenly to ensure uniform bearing for the full length of duct. Do not support duct by blocking, planking or mounding of bedding material.

I. Install lines passing under foundations with minimum of _____ clearance to concrete and ensure there is no disturbance of bearing soil.

3.05 BACKFILL

A. Backfill around ducts by hand to depth of 12” (300 mm) above top of duct with _____ fill in 6" (150 mm) layers. Compact backfill thoroughly with compactor of suitable weight or with approved mechanical tamper. Do not use flooding or jetting with water.

B. Place backfill from 12” (300 mm) above duct to elevation of subgrade in layers not exceeding 8" (200 mm) in depth with _____ fill.

C. Backfill from 12” (300 mm) above duct to sub-grade with _____ fill, when excavating through areas which are to become walks, roads, driveways or parking areas of concrete, bituminous or exposed gravel surfacing or such areas are existing to remain. Backfill in 12" (300 mm) layers and compact with mechanical means to density 95% modified proctor.

D. Conform excavation, duct laying, backfilling, grading and surfacing, as herein specified, when excavation occurs on public property or areas beyond the property line. Comply with additional requirements for public utility or other authorities. Check with each utility and incorporate cost of any additional requirements in base bid.

E. Backfill around vaults and handholes to be free of debris larger than 1-3/4” (44 mm) in all directions to 1 ft (0.3 m) from vault.

F. Provide 6” (150 mm) of pea gravel or sand bedding for vaults and handholes larger than 3x3 FT (0.9x0.9 M). For handholes smaller than 3x3 ft (0.9x0.9 m), provide 3" (80 mm) pea gravel or sand.

G. Other backfill shall be free of debris larger than 6” (150 mm) in diameter.

H. Place backfill material so as to obtain a minimum degree of compaction of 95% of maximum density at optimum moisture content. Moisten backfill material as required to obtain proper compaction.

I. Broken pavement, concrete, sod, roots, and debris shall not be used for backfill.

3.06 DEWATERING

A. Provide, operate, and maintain all pumps or other dewatering equipment required for control of water in trenches and excavations for electrical and communications site work during the entire construction period.

3.07 SHORING

A. Provide as required by trenching and excavating to secure site work. Comply with applicable safety regulations.

3.08 FINISHING

A. On completion of trenching and backfilling operations, restore grades to original elevation or to new sub-grade elevation.

B. Replace surfaces to existing conditions when trenching is through existing areas or beyond construction limits.

C. Use 6” (150 mm) of topsoil and sod to match existing elevations in landscaped areas or as otherwise approved by Landscape Architect.

3.09 SURFACE FINISHING

A. Refinish every disturbed surface to its original condition.

B. Replace planted materials not surviving 90 days after contract acceptance at Contractor’s own expense.

C. Return after 1 year and re-fill, compact and refinish settled areas to grade.

3.10 CARE OF PLANTS AND TREES

A. Remove and safely store plants and trees with trunks smaller than 6” (150 mm) diameter prior to commencing site work. Avoid trees larger than 6" (150 mm) diameter when so indicated on drawings. Replace plants and trees upon completion of site work.

END OF SECTION 26 05 43.13

SECTION 26 05 43.19 - MANHOLES AND HARDWARE

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 03 30 00 - Cast-in-Place Concrete

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems

C. Section 26 05 43 - Underground Ducts And Raceways For Electrical Systems

D. Section 26 05 43.13 - Excavation and Backfill

1.02 DESCRIPTION

A. Section includes underground utility structures: _____ for power and communication cable systems.

1.03 REFERENCED STANDARDS

A. AASHTO HB 17 – Standard Specifications for Highway Bridges

B. ANSI C2 – National Electrical Safety Code

C. ASTM A48/A48M – Specification for Gray Iron Castings

D. ASTM C270 – Specification for Mortar for Unit Masonry

E. ASTM C387/C387M – Specification for Packaged, Dry, Combined Materials for Mortar and Concrete

F. ASTM C858 – Specification for Underground Precast Concrete Utility Structures

G. ASTM C891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures

H. ASTM C1037 – Practice for Inspection of Underground Precast Concrete Utility Structures

I. ASTM E329 – Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

J. ISO 9000 – Quality Management

K. ISO 10012 – Measurement Management Systems

L. NFPA 70 – National Electrical Code

M. SCTE 77 – Specification for Underground Enclosure Integrity

1.04 SUBMITTALS

A. Product Data:

(1) Accessories for underground utility structures.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

(1) Duct entry provisions, including locations and duct sizes

(2) Reinforcement details

(3) Frame and cover design and _____ frame support rings

(4) _____ details

(5) Grounding details

(6) Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps

(7) Joint details

C. Shop Drawings for Factory-Fabricated Handholes and Pull Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

(1) Duct entry provisions, including locations and duct sizes

(2) Cover design

(3) Grounding details

(4) Dimensioned locations of cable rack inserts, and pulling-in and lifting irons

D. Product Certificates: For concrete and steel used in precast concrete _____, as required by ASTM C858.

E. Qualification Data: For professional engineer and testing agency.

F. Source quality-control test reports.

G. Field quality-control test reports.

(1) Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

H. Manufacturer’s Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual location of underground utility structures.

(2) Operation and Maintenance Data:

(a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated

B. Comply with ANSI C2

C. Comply with NFPA 70

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store _____ underground utility structures at project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

B. Lift and support precast concrete units only at designated lifting or supporting points.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

A. Extra Materials:

(1) Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

(2) Furnish cable-support stanchions, arms, _____ and associated fasteners in quantities equal to _____ of quantity of each item installed.

PART 2 - PRODUCTS

2.01 PRECAST CONCRETE _____

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom. Frame and cover shall form top of enclosure and shall have load rating consistent with that of _____.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(1) Carder Concrete Products

(2) Christy Concrete Products

(3) Elmhurst-Chicago Stone Co.

(4) Oldcastle Precast Group

(5) Riverton Concrete Products; a division of Cretex Companies, Inc.

(6) Utility Concrete Products, LLC.

(7) Utility Vault Co.

(8) Wausau Tile, Inc.

(9) Jensen Precast

C. Comply with ASTM C858 _____ and with interlocking mating sections, complete with accessories, hardware, and features.

(1) Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and ductbanks plus an additional 12" (300 mm) vertically and horizontally to accommodate alignment variations.

(a) Windows: Located not less than 6" (150 mm) from interior surfaces of walls, floors, or roofs of _____, but close enough to corners to facilitate racking of cables on walls.

(b) Window opening: Cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of ductbanks.

(c) Window openings: Framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

(2) Duct Entrances in _____ Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

(a) Type and size: Fittings matched to duct or conduit to be terminated.

(b) Fittings: Aligned with elevations of approaching ducts and located near interior corners of _____ to facilitate racking of cable.

D. Concrete Knockout Panels: 1-1/2” (40 mm) to 2" (50 mm) thick, for future conduit entrance and sleeve for ground rod.

E. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the groundwater level at grade.

2.02 CAST-IN-PLACE _____

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features, with concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C858 and with Section 03 30 00 - Cast-in-Place Concrete.

C. Structural Design Loading: As specified in Part 3 “Underground Enclosure Application” Article.

2.03 PRECAST CONCRETE HANDHOLES AND PULL BOXES

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

(1) Carder Concrete Products
(2) Christy Concrete Products
(3) Elmhurst-Chicago Stone Co.
(4) Oldcastle Precast Group
(5) Riverton Concrete Products; a division of Cretex Companies, Inc.
(6) Utility Concrete Products, LLC.
(7) Utility Vault Co.
(8) Wausau Tile, Inc.
(9) Jensen Precast

B. Comply with ASTM C858 for design and manufacturing processes.

C. Structural Load Ratings: As specified in Part 3 “Underground Enclosure Application.”

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or pull box.

(1) Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
(2) Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
(3) Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
(a) Cover Hinges: Concealed, with hold-open ratchet assembly
(b) Cover Handle: Recessed
(4) Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
(a) Cover Hinges: Concealed, with hold-open ratchet assembly
(b) Cover Handle: Recessed
(5) Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
(6) Cover Legend: Molded lettering, _____
(7) Configuration: Units shall be designed for flush burial and have _____ bottom, unless otherwise indicated.
(8) Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
(a) Extension shall provide increased depth of _____.
(b) Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
(9) Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and ductbanks plus an additional 12” (300 mm) vertically and horizontally to accommodate alignment variations.
(a) Windows: Located no less than 6” (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
(b) Window opening: Cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie-in to concrete envelopes of ductbanks.
(c) Window openings: Framed with at least two additional NO. 4 steel reinforcing bars in concrete around each opening.
(10) Duct Entrances in Handhole Walls:

(a) Type and size: Fittings matched to duct or conduit to be terminated.

(b) Fittings: Aligned with elevations of approaching ducts and located near interior corners of handholes to facilitate racking of cable.

(11) Handholes _____ and larger: Inserts for cable racks and pulling-in irons installed before concrete is poured.

2.04 HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

(1) Color: _____.

(2) Configuration: Designed for flush burial and have _____ bottom, unless otherwise indicated.

(3) Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

(4) Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

(5) Cover Legend: Molded lettering, _____

(6) Direct Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

(7) Duct Entrance Provisions: Duct-terminating fittings mated with entering ducts for secure, fixed installations in enclosure wall.

(8) Handholes _____ and larger: Factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Pull Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

(1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(a) Armorcast Products Company

(b) Carson Industries LLC.

(c) CDR Systems Corporation

(d) NewBasis

C. Fiberglass Handholes and Pull Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure jointed to polymer concrete top ring or frame.

(1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(a) Armorcast Products Company

(b) Carson Industries LLC.

(c) Christy Concrete Products

(d) Synertech Moulded Products, Inc.; a division of Oldcastle Precast

D. Fiberglass Handholes and Pull Boxes: Molded of fiberglass-reinforced polyester resin, with covers of _____.

(1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(a) Carson Industries LLC.

(b) Christy Concrete Products

(c) Nordic Fiberglass, Inc.

E. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover: _____.

(1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(a) Carson Industries LLC.

(b) Nordic Fiberglass, Inc.

(c) PenCell Plastics

2.05 UTILITY STRUCTURE ACCESSORIES

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

(1) Bilco Company (The)

(2) Campbell Foundry Company

(3) Carder Concrete Products

(4) Christy Concrete Products

(5) East Jordan Iron Works, Inc.

(6) Elmhurst-Chicago Stone Co.

(7) Jensen Precast

(8) McKinley Irion Works, Inc.

(9) Neenah Foundry Company

(10) NewBasis
(11) Oldcastle Precast Group
(12) Osburn Associates, Inc.
(13) Pennsylvania Insert Corporation
(14) Riverton Concrete Products; a division of Cretex Companies, Inc.
(15) Strongwell Corporation; Lenoir City Division
(16) Underground Devices, Inc.
(17) Utility Concrete Products, LLC.
(18) Utility Vault Co.
(19) Wausau Tile, Inc.

B. _____ Frames, Covers, and Chimney Components: Comply with structural design loading specified for _____.
   (1) Frame and Cover: Weatherproof, _____ with milled cover-to-frame bearing surface; diameter _____.
      (a) Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   (2) Cover Legend: Cast in. Selected to suit system.
      (a) Legend: “ELECTRIC-LV” for duct system with power wires and cables for systems operating at 600 V and less.
      (b) Legend: “ELECTRIC-HV” for duct systems with medium-voltage cables.
      (c) Legend: “SIGNAL” for communications, data, and telephone duct systems.
   (3) _____ Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
      (a) Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 ft³ (0.06 m³) where packaged mix complying with ASTM C387/C387M, Type M, may be used.

C. _____ Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2” (50 mm) diameter eye, and 1x4" (25x100 mm) bolt.
   (1) Working Load Embedded in 6” (150 mm), 4000 psi (281 kg/cm²) Concrete: 13000 lbf (5897 kgf) minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4” (32 mm) diameter eye, rated _____ minimum tension.

F. Pulling-in and Lifting Irons in Concrete Floors: 7/8” (22 mm) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
   (1) Ultimate Yield Strength: 40,000 lbf (18,144 kgf) shear and 60000 lbf (27216 kgf) tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts for noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2” (13 mm) ID by 2-3/4" (70 mm) deep, flared to 1-1/4" (32 mm) minimum at base.
   (1) Tested Ultimate Pullout Strength: 12,000 lbf (5443 kgf) minimum.

H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2” (13 mm) bolt, 5300 lbf (2404 kgf) rated pullout strength, and minimum 6800 lbf (3084 kgf) rated shear strength.

I. Cable Rack Assembly: Steel, _____ galvanized, except insulators.
   (1) Stanchions: T-section or channel; 2-1/4” (58 mm) nominal size; punched with 14 holes on 1-1/2" (40 mm) centers for cable-arm attachment.
   (2) Arms: 1-1/2” (40 mm) wide, lengths ranging from 3" (75 mm) with 450 lb (204 kg) minimum capacity to 18" (450 mm) with 250 lb (113 kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
   (3) Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
   (1) Stanchions: Nominal 36” (920 mm) high by 4" (100 mm) wide, with minimum of 9 holes for arm attachment.
   (2) Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3” (75 mm) with 450 lb (204 kg) minimum capacity to 20" (500 mm) with 250 lb (113 kg) minimum capacity. Top of arm shall be nominally 4" (100 mm) wide, and arm shall have slots along full length for cable ties.

K. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35°F (1.7°C). Capable of withstanding temperature of 300 °F (149 °C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

L. Fixed _____ Ladders: Arranged for attachment to _____ of _____. Ladder, mounting brackets and braces: Fabricated from _____.

M. Portable _____ Ladders: UL-listed, heavy-duty _____ specifically designed for portable use for access to electrical _____. Minimum length equal to distance from deepest _____ floor to grade plus 36” (920 mm). _____ required.

N. Cover Hooks: _____ required.

2.06 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C1037.

B. Nonconcrete Handhole and Pull Box Prototype Test: Test prototypes of _____ and pull boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

(1) Tests of materials shall be performed by an independent testing agency.

(2) Strength of tests of complete pull boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

(3) Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 UNDERGROUND ENCLOSURE APPLICATION

A. _____: _____ concrete:

(1) _____ Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

(2) _____ Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

B. Handholes and Pull Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

(1) Handholes and Pull Boxes in Roadways and Other Deliberate Traffic Paths: Precast concrete AASHTO HB 17, _____ structural load rating.

(2) Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: _____ structural load rating.

(3) Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: _____ structural load rating.

(4) Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: _____, structurally tested according to SCTE 77 with 3000 lbf (360.1 kgf) vertical loading.

3.02 INSTALLATION OF CONCRETE _____, HANDHOLES, AND PULL BOXES

A. Cast-in-Place _____ Installation:

(1) Finish interior surfaces with a smooth-troweled finish.

(2) Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2” (40 mm) to 20" (50 mm) thick, arranged as indicated.

(3) Cast-in-place concrete, formwork, and reinforcement are specified in Section 03 30 00 - Cast-in-Place Concrete.

B. Precast Concrete _____ and Handhole Installation

(1) Comply with ASTM C891, unless otherwise indicated.

(2) Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

(3) Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1” (25 mm) sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

(4) Concrete: 5000 psi (352 kg/sq cm) 28-day strength, complying with Division 03 – Concrete.

C. Elevations:

(1) _____ Roof: Install with rooftop at least 15” (380 mm) below finished grade.

(2) _____ Frame: In paved areas and traffic-ways, set frames flush with finished grade. Set other _____ frames 1” (25 mm) above finished grade.

(3) Install handholes with bottom below the frost line, _____ below grade.

(4) Handhole Covers: In paved areas and traffic-ways set surface flush with finished grade. Set covers of other handholes 1” (25 mm) above finished grade.

(5) Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of _____ via drain lines where indicated. Coordinate with drainage provisions indicated.

E. _____ Access: Circular opening in manhole roof; sized to match cover size.

(1) _____ with Fixed Ladders: Offset access opening from _____ centerlines to align with ladder.

(2) Install chimney, constructed of precast concrete collars and rings, to support frame and cover and to connect cover with _____ roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of _____ after concrete has cured at least 3 days. Waterproofing materials and installation are specified in Division 07 Section _____." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of _____ chimneys after mortar has cured at least 3 days.

G. Dampproofing: Apply dampproofing to exterior surfaces of _____ after concrete has cured at least 3 days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of _____ chimneys after mortar has cured at least 3 days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, _____ cable arms, _____ as required for installation and support of cables and conductors and as indicated.

I. Fixed _____ Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in _____.

J. Field-Installed Bolting Anchors in _____ and Concrete Handholes: Do not drill deeper than 3-7/8" (98 mm) for _____ and 2" (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

K. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each _____ cover.

L. Pack and smooth non-shrink grout at all rough edges around duct entrances at each _____.

3.03 INSTALLATION OF HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and pull boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2" (13 mm) sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and traffic-ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1" (25 mm) above finished grade.

D. Install handholes and pull boxes with bottom below the frost line. Insert depth of frost line below grade at project site below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetration after fittings are sealed.

G. For enclosures installed in _____ and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on _____.

(1) Concrete: 3000 psi (211 kg/sq cm), 28-day strength, complying with Section 03 30 00 - Cast-in-Place Concrete, with a troweled finish.

(2) Dimensions: 10" (250 mm)wide by 12" (300 mm) deep.

H. Install drainage through the _____ of each handhole and pull box via drain lines where indicated.

3.04 GROUNDING

A. Ground utility structures according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

(1) Demonstrate capability and compliance with requirements on completion of installation of underground utility structures.

(2) Test ____ grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Interpret test results in writing and submit to Engineer.

3.06 CLEANING

A. Clean internal surfaces of _____, including sump and remove foreign material, after completing the installation of all devices, equipment, cables and terminations.

B. Remove water from _____. If _____ continue to fill up with water, Contractor shall pump them regularly until the source of water has been detected and corrected.

END OF SECTION 26 05 43.19

SECTION 26 05 43.23 - UNDERGROUND ELECTRICAL SERVICE

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 00 00 - General Electrical Requirements

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems

C. Section 26 05 43 - Underground Ducts And Raceways For Electrical Systems

D. Section 26 05 43.19 - Manholes and Hardware

1.02 DESCRIPTION

A. Utility Company is _____.

B. Primary Service Characteristics

(1) Primary service from terminal pole to building will be _____-1 V, 3-wire, 3-phase.

(2) Primary service from terminal pole to building will be _____-1 V, 4-wire, 3-phase.

C. Secondary Service Characteristics

(1) Secondary service will be _____-1 V, 3-wire, single-phase for lighting, _____-2 V, 3-wire, 3-phase for power.

(2) Secondary service will be _____-1 V, 4-wire, 3-phase for lighting, _____-2 V, 3-wire, 3-phase for power.

(3) Secondary service will be _____-1 V, 4-wire, 3-phase for combined lighting and power.

(4) Secondary service will be _____-1 V, 4-wire, 3-phase for incandescent lighting and receptacles, _____-2 V, _____-3 wire, 3-phase for fluorescent lighting and power.

D. Provide electrical service system except for the following which will be provided by Utility Company:

(1) Duct from terminal pole to building

(2) Conduit from terminal pole to building

(3) Duct from transformer to building

(4) Protective device at terminal pole

(5) Protective device at transformer

(6) Transformer

(7) Metering at terminal pole

(8) Metering at transformer

(9) Cable from terminal pole to transformer

(10) Cable from terminal pole to building

(11) Cable from transformer to building

(12) Primary cable as shown

(13) Secondary cable as shown

1.03 SEQUENCING, SCHEDULING

A. Coordinate electrical service with Utility.

B. Utility costs shall be included in Base Bid.

PART 2 - PRODUCTS

2.01 NOT APPLICABLE

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide ductbanks as specified in Specification Section 26 05 43 - Underground Ducts And Raceways For Electrical Systems.

B. Provide manhole as specified in Specification Section 26 05 43.19 - Manholes and Hardware.

END OF SECTION 26 05 43.23

SECTION 26 05 53 - ELECTRICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 13.16 - Medium-Voltage, Single- and Multi-Conductor Cables
B. Section 26 05 16 - Owner-Furnished Equipment
C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
D. Section 26 05 33 - Raceway and Boxes for Electrical Systems
E. Section 26 05 43 - Underground Ducts And Raceways For Electrical Systems
F. Section 26 05 73 - Power System Studies
G. Section 26 09 13 - Electrical Power Monitoring and Control
H. Section 26 09 23 - Lighting Control Devices
I. Section 26 09 43 - Network Lighting Controls
J. Section 26 11 16 - Secondary Unit Substations
K. Section 26 12 13 - Liquid-Filled, Medium-Voltage Transformers
L. Section 26 12 16 - Dry-Type, Medium-Voltage Transformers
M. Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
N. Section 26 13 16 - Medium-Voltage Fusible Interrupter Switchgear
O. Section 26 13 19 - Medium-Voltage Vacuum Interrupter Switchgear
P. Section 26 13 23 - Medium-Voltage Pad-Mounted Switchgear
Q. Section 26 22 00 - Low-Voltage Transformers
R. Section 26 23 00 - Low-Voltage Switchgear
S. Section 26 24 13 - Switchboards
T. Section 26 24 16.13 - Lighting and Appliance Panelboards
U. Section 26 24 16.16 - Distribution Panelboards
V. Section 26 24 19 - Motor-Control Centers
W. Section 26 25 00 - Enclosed Bus Assemblies
X. Section 26 26 00 - Power Distribution Units
Y. Section 26 27 13 - Electrical Metering
Z. Section 26 27 26 - Wiring Devices
AA. Section 26 28 16 - Enclosed Switches and Circuit Breakers
BB. Section 26 29 13 - Enclosed Controllers
CC. Section 26 32 13 - Engine Generators
DD. Section 26 33 53 - Static Uninterruptible Power Supply With Battery Energy Storage
EE. Section 26 36 23 - Automatic Transfer Switches
FF. Section 26 43 00 - Surge Protective Devices
GG. Section 28 46 10 - Addressable Fire Detection And Alarm Systems

1.02 DESCRIPTION

A. Section includes the following:
   (1) Identification for raceway and metal-clad cable
   (2) Identification for conductors and communication and control cable
   (3) Underground-line warning tape
   (4) Warning labels and signs
   (5) Instruction signs and posted drawings
   (6) Equipment identification nameplates
   (7) Wiring devices identification
   (8) Miscellaneous identification products

B. Refer to the respective Division 26 Sections, and Sections in other Divisions that specify electrical components, for additional electrical identification requirements.

1.03 REFERENCE STANDARDS

A. ANSI C2 – National Electrical Safety Code

B. ANSI Z535.4 – National Standards for Product Safety Signs and Labels

C. 29 CFR 1910 – Labor, Part 1910 – Occupational Safety and Health Standards, Section 1910.145 – Specifications for Accident Prevention Signs and Tags

D. NFPA 70 – National Electrical Code

1.04 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Torque log for all terminations 100A and over. Log shall identify target torque values, as they are found via manufacturer documentation and individual locations.

C. Nameplate Schedule: Prior to making nameplates, submit a complete schedule to Architect for approval indicating nameplate size, lettering size, color and actual nameplate information.

D. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.05 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.06 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MSI), Seton, or approved equal.

C. Color for Printed Legend:

(1) Power Circuits: Black letters on an orange field.

(2) Legend: Indicate system or service and voltage, if applicable.

D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.

F. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2" (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.

G. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2" (50 mm) wide; compounded for outdoor use.

2.02 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend.

B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

C. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.076 mm) thick by 1 to 2" (25 to 50 mm) wide.

D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

E. Aluminum Wraparound Marker Labels: Cut from 0.014” (0.36 mm) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

F. Metal Tags: Brass or aluminum, 2” x 2” x 0.05” (50 mm x 50 mm x 1.27 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

G. Write-On Tags: Polyester tag, ____ thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

(1) Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

H. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

2.03 UNDERGROUND-LINE WARNING TAPE

A. Manufacturers: Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

B. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

(1) Not less than 6” (150 mm) wide by 4 mils (0.102 mm) thick.

(2) Compounded for permanent direct-burial service.

(3) Embedded continuous metallic strip.

(4) Printed legend shall indicate type of underground line.

(5) Red tape for electrical and orange tape for communications / controls installations.

2.04 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Self-Adhesive Arc Flash Warning Labels: Industrial grade, made of durable polyester with over-laminate to withstand harsh environments (UV rays, scratches and most chemicals).

(1) Manufacturer: Seton or approved equal

D. Engraved Plastic Signs: Engraving stock, melamine plastic laminate, minimum 1/16” (1.6 mm) thick for signs up to 20 sq inch (2000 sq mm) and 1/8" (3.2 mm) thick for larger sizes.

(1) Engraved legend with black letters on white face.

(2) Punched or drilled for mechanical fasteners.

E. Baked-Enamel Warning Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4” (6 mm) grommets in corners for mounting. Nominal size, 7x10" (178x250 mm).

F. Metal-Backed, Butyrate Warning Signs for Exterior Use: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396” (1.01 mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4" (6 mm) grommets in corners for mounting. Nominal size, 10x14" (250x350 mm).

G. Warning label and sign shall include, but are not limited to, the following legends:

(1) Multiple Power Source Warning: “DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES.”

(2) Workspace Clearance Warning: “WARNING – OSHA REGULATION – AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36" (914 mm).”

(3) Arc Flash Labels: Per ANSI Z535.4, the signal word WARNING appearing in black letters on an orange background, with second line below (Arc Flash and Shock Hazard) in black letters on white background and third line below (Appropriate PPE Required) in black letters on white background. Include the following information on the label:

(a) Equipment name

(b) Available bolted current

(c) Flash protection boundary distance

(d) Incident energy level at 18” (450 mm) expressed in cal/cm2

(e) Personnel protective equipment (PPE) class

(f) Voltage shock hazard

(g) Limited shock approach boundary

(h) Restricted shock approach boundary

2.05 TORQUE MARKING

A. Contractor shall keep a log of torque values used for project. This record shall incorporate name of installer for each specific location with date/time.

B. Torque marks shall be made on nut side and extend to a non-rotating surface. Torque marks shall be made at time of torquing – placing torque marks after the fact is not permitted but instead must be re-torqued and marked.

C. Torque seal: (Blue) Cross-Check or similar manufacturer shall be used for terminations 100A and over. Use of permanent black marker is not acceptable.

2.06 INSTRUCTION SIGNS AND POSTED DRAWINGS

A. Instruction Signs: Engraved, laminated acrylic or melamine plastic, minimum 1/16” (1.6 mm) thick for signs up to 20 sq inch (2000 sq mm) and 1/8" (3.2 mm) thick for larger sizes.

(1) Engraved legend with _____.

(2) Punched or drilled for mechanical fasteners.

(3) Mounting Frames: Extruded aluminum, 4-point screw mount with 1/8” (3.2 mm) clear plexiglass cover.

B. Posted Drawings: Print electrical riser diagrams on 20 lb (9.1 kg) bond paper. (Blueprint paper is not acceptable.) Reduce drawings to approximately 1/2 size using Xerox reduction process. Contact Engineer to obtain updated original plans for printing.

2.07 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Engraved, Three-layer, Laminated Acrylic or Melamine Nameplate: Punched or drilled for screw mounting. White letters on a black background, except emergency power equipment nameplates are to have white letters on a red background. Minimum letter height shall be 3/8” (9.5 mm) unless otherwise noted.

B. Stenciled Legend: In non-fading, waterproof, _____ ink or oil-based, alkyd enamel paint. Minimum letter height shall be _____.

2.08 WIRING DEVICES IDENTIFICATION

A. Refer to Section 26 27 26 - Wiring Devices for requirements.

2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, type 6/6 nylon cable ties.

(1) Minimum Width: 3/16” (4.8 mm)

(2) Tensile Strength: 50 lb (22.7 kg) minimum

(3) Temperature Range: -40°F to 185°F (-40°C to 85°C)

(4) Color: Black, except where used for color-coding

B. Paint: Paint materials and application requirements are specified in Division 09 – Finishes painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 APPLICATION

A. Raceway and Ductbanks More Than 600 V Concealed within Buildings: 4” (100 mm) wide black stripes on 10" (250 mm) centers over orange background that extends full length of raceway or duct and is 12" (300 mm) wide. Stencil legend “DANGER CONCEALED HIGH-VOLTAGE WIRING” with 3" (80 mm) high black letters on 20" (500 mm) centers. Stop stripes at legends. Apply to the following finished surfaces:

(1) Floor surface directly above conduits running beneath and within 12” (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.

(2) Wall surfaces directly external to raceways concealed within wall.

(3) Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Metal-Clad Cables More Than 600 V: _____

(1) Identify covers of exposed junction and pull boxes with red paint. Stencil the legend “DANGER – HIGH VOLTAGE _____ VOLTS” in black letters 1/2” (13 mm) high.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than _____: Identify with orange _____.

(1) Identify 4” (100 mm) round, 4" (100 mm) square and 4-11/16" (119 mm) junction boxes concealed above ceiling or exposed with neat lettering on cover with permanent black marking pen. Identify source, circuit number, phase, and control circuit number.

D. Accessible Raceways and Cables of Auxiliary Electrical Systems: Identify the following systems with color-coded, _____:

(1) Fire Alarm System (including covers of pull and junction boxes): Red
(2) Fire-Suppression Supervisory and Control System: Red and yellow
(3) Combined Fire Alarm and Security System: Red and blue
(4) Security System: Blue and yellow
(5) Mechanical and Electrical Supervisory System: Green and blue
(6) Telecommunication System: Green and yellow

E. Power-Circuit Conductor Identification: For _____ conductors No. _____ AWG and larger in vaults, pull and junction boxes, manholes, and handholes use _____. Identify source and circuit number of each set of conductors or other appropriate number or letter to expedite future tracing and troubleshooting. For single conductor cables, identify phase in addition to the above. Phase identification shall be consistent throughout the system.

F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use _____. Identify each ungrounded conductor according to source and circuit number.

G. Conductors to Be Extended in the Future and Spare Conductors: Attach _____ to conductors and list source and circuit number.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

(1) Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
(2) Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
(3) Coordinate identification with project drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. _____

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply _____. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access to equipment.

(1) Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, the following:
(a) Power transfer switches
(b) Controls with external control power connections
(2) Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
(3) Arc Flash Warning Labels: install per NFPA 70 for each switchgear, switchboard, panelboard, motor control center, industrial control panel (every enclosure that may contain energized conductors or components). Locate labels so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.
(4) Available Fault Current Labels: install per NFPA 70 for each piece of service entrance equipment. Locate labels so they are visible to the personnel before examination, adjustment, servicing or maintenance of the equipment.

K. Instruction Signs and Posted Drawings:

(1) Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend printed in all capital letters of 12 pt size minimum where instructions are needed for system or equipment operation.
(2) Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8" (9.5 mm) high letters for emergency instructions at equipment used for _____.

L. Essential Electrical System in Hospitals:

(1) Identify raceways and covers of pull and junction boxes as follows:
(a) Life Safety Branch: Yellow
(b) Critical Branch: Orange
(c) Equipment System: Green

M. Emergency Electrical System Junction and Pull Boxes:

(1) Identify with spray-painted covers as follows:
(a) 480/277 V circuits: _____
(b) 120/208 V circuits: _____

N. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply nameplates to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

(1) Nameplate Instructions:

(a) Indoor Equipment: Engraved, laminated acrylic or melamine nameplate. Unless otherwise indicated, provide a single line of text with 3/8” (9.5 mm) minimum high letters 1/4" (6 mm)on 1-1/2" (40 mm) high nameplate; where 2 lines of text are required, use nameplates sized 2" (50 mm) high.

(b) Outdoor Equipment: _____

(c) Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

(2) Install nameplates for equipment including, the following:

(a) Panelboards, electrical cabinets, and enclosures

(b) Access doors and panels for concealed electrical items

(c) Electrical switchgear, switchboards, and distribution panelboards including each feeder device within the equipment enclosures.

(d) Transformers

(e) Electrical substations

(f) Emergency system boxes and enclosures

(g) Motor-control centers, including each device

(h) Disconnect switches

(i) Enclosed circuit breakers

(j) Motor controllers

(k) Pushbutton stations

(l) Power transfer equipment

(m) Contactors

(n) Remote-controlled switches, dimmer modules, and control devices

(o) Battery inverter units

(p) Battery racks

(q) Power-generating units

(r) Voice and data cable terminal equipment

(s) Master clock and program equipment

(t) Intercommunication and call system master and staff stations

(u) Television/audio components, racks, and controls

(v) Fire alarm control panel and annunciators

(w) Security and intrusion-detection control stations, control panels, terminal cabinets, and racks

(x) Monitoring and control equipment

(y) Uninterruptible power supply equipment

(z) Terminals, racks, and patch panels for voice and data communication and for signal and control functions

(aa) Non-concealed junction box covers of auxiliary electrical systems

(3) Provide the following information on each nameplate:

(a) Equipment name/tag:

1) Matching the designation from the contract documents, or identifying the load controlled or function of the equipment where no specific tag is shown on the contract documents.

2) For disconnect switches, use the prefix “SW-” followed by the name of the equipment served, example: “SW-PMP-201.”

(b) Equipment operating voltage, phase, wiring configuration, and ampacity:

1) Example: “208V/3PH/4W/225A”

(c) Source of power supply, including circuit number:

1) Example: “FED FROM LP-2/45”

O. For service entrance equipment, provide a nameplate identifying the maximum available fault current and “as of” effective date.

(1) Example: “MAXIMUM AVAILABLE FAULT CURRENT 33,500A AS OF 2017/06/15.”

P. Access Panel Identification: Furnish typewritten charts with identification and location of access panels serving equipment and incorporate in O&M Manuals.

3.02 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Install non-adhesive signs and plastic nameplates parallel to equipment lines; attach with screws and auxiliary hardware appropriate to the location and substrate. Secure to inside surface of door or panelboard that is recessed in finished locations.

F. Posted Drawings and Operating Instructions: Mount drawings and operating procedures on the wall immediately adjacent to the piece of equipment for which the instructions apply. If sufficient wall space is available, mount directly to one of the sheet metal panels of the equipment.

G. Warning Signs: Install warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with ANSI A13.1 standard color and design.

   (1) Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either preprinted or hand printed to convey the message; example: “DO NOT OPEN THIS SWITCH WHEN BREAKER IS CLOSED.”

H. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50 ft (15.2 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.

I. Color-Coding for Phase _____Identification, 600 V or Less: Use colors listed below for ungrounded _____ conductors.

   (1) Color shall be _____.

   (2) Colors for 208/120 V Circuits:

      (a) Phase A (left bus in panelboard): Black

      (b) Phase B (center bus in panelboard): Red

      (c) Phase C (right bus in panelboard): Blue

      (d) Neutral: White

      (e) Equipment Ground: Green

   (3) Colors for 480/277 V Circuits:

      (a) Phase A (left bus in panelboard): Brown

      (b) Phase B (center bus in panelboard): Orange

      (c) Phase C (right bus in panelboard): Yellow

      (d) Neutral: Gray

      (e) Equipment Ground: Green

   (4) Field-applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6” (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two runs of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

J. Aluminum Wraparound Marker Nameplates and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

K. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6” to 8” (150 mm to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench _____ exceeds 16" (400 mm) overall.

L. Painted Identification: Prepare surface and apply paint according to Division 09 – Finishes painting Sections.

END OF SECTION 26 05 53

SECTION 26 05 73 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 53 - Electrical Systems Identification
B. Section 26 08 12 - Power Distribution Acceptance Tests
C. Section 26 08 13 - Power Distribution Acceptance Test Tables
D. Section 26 11 16 - Secondary Unit Substations
E. Section 26 12 16 - Dry-Type, Medium-Voltage Transformers
F. Section 26 13 16 - Medium-Voltage Fusible Interrupter Switchgear
G. Section 26 13 19 - Medium-Voltage Vacuum Interrupter Switchgear
H. Section 26 13 23 - Medium-Voltage Pad-Mounted Switchgear
I. Section 26 22 00 - Low-Voltage Transformers
J. Section 26 23 00 - Low-Voltage Switchgear
K. Section 26 24 13 - Switchboards
L. Section 26 24 16.13 - Lighting and Appliance Panelboards
M. Section 26 24 16.16 - Distribution Panelboards
N. Section 26 24 19 - Motor-Control Centers
O. Section 26 28 13 - Fuses
P. Section 26 28 16 - Enclosed Switches and Circuit Breakers
Q. Section 26 29 13 - Enclosed Controllers
R. Section 26 36 23 - Automatic Transfer Switches

1.02 DESCRIPTION

A. Section includes computer based, fault current, arc flash, and overcurrent protective device coordination studies for an electrical distribution system, based on actual equipment supplied. Set protective devices based on results of the protective device coordination study.
   (1) Coordination of series-rated devices is permitted only where indicated on drawings.
B. Furnish field information and data needed for the studies.
C. Available fault current and electrical equipment interrupting capacity indicated on drawings are based on the short circuit study performed during design as part of the construction documents.

1.03 REFERENCE STANDARDS

A. IEEE C57.12.10 – American National Standard for Transformers-230 kV and Below 833/958-8333/10 417 kVA, Single-Phase, and 750/862-60 000/80 000/100 000 kVA, Three-Phase, w/o Load Tap Changing; and 3750/4687-60 000/80 000 kVA with Load Tap Changing-Safety Requirements
B. ANSI C57.12.22 – American National Standard for Transformers-Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA & Smaller: High-Voltage, 34 500 GrdY/19 920 V & Below; Low Voltage, 480 V & Below-Requirements
C. ANSI C57.12.40 – American National Standard for Secondary Network Transformers-Subway and Vault Types (Liquid Immersed)-Requirements
D. ANSI C57.12.90 – General Requirements for Liquid-Immersed Distribution Power and Regulating Transformers
E. IEEE C57.96 – Distribution and Power Transformers, Guide for Loading Dry-Type (Appendix to ANSI C57.12 Standards)
F. IEEE Std 3001 Standards: Power Systems Design
G. IEEE Std 3004 Standards: Protection & Coordination
H. IEEE Std 3002 Standards: Power Systems Analysis
I. IEEE 620 – Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines
J. IEEE Std 3004 Standards: Protection & Coordination
K. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations
L. IEEE C37.010 – Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

M. IEEE C37.20.1 – IEEE Standard for Metal-Enclosed, Low-Voltage Power Circuit Breaker Switchgear
N. ANSI C37.46 – American National Standard Specifications for Power Fuses and Fuse-Disconnecting Switches
O. IEEE C57.12.00 – General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
P. IEEE C57.96 – IEEE Guide for Loading Dry-Type Distribution and Power Transformers
Q. ICEA P-32-382 – Short-Circuit Characteristics of Insulated Cable
R. ICEA P-45-482 – Short-Circuit Performance of Metallic Shielding and Sheaths of Insulated Cable
S. NEMA MG 00001 – Motors and Generators
T. NFPA 70 – National Electrical Code (NEC)
U. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
V. NFPA 70C – Hazardous Locations Classification
W. NFPA 70E – Standard for Electrical Safety in Workplace

1.04 SUBMITTALS

A. Product Data: Computer software program to be used for studies. Include specific software version for owner record.
B. Product Certificates:
   (1) Coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 3002.3.
   (2) Arc flash calculations computer software programs, certifying compliance with IEEE 1584.
C. Qualification Data: For coordination study specialist.
   (1) Submit qualifications of the organization proposed for performing the study. Include description of the equipment and computer-based computation methods or programs used and the names and experience histories of the personnel who will perform the study.
D. Other Action Submittals: Subsequent to having approval for system protective devices submit the following in digital format:
   (1) Electrical one-line drawing drafted in computer software program with component names.
      (a) Component names shall be easily traceable to the names used in the Construction Documents.
      (b) Drawing minimum text height of 3/32”. Maximum paper size 30”x42”. Provide multiple drawing sheets as required.
   (2) Fault current study report
   (3) Equipment evaluation report
   (4) Coordination study input data, including completed computer program input data sheets
   (5) Coordination Study Report
   (6) Arc Flash Study and Report
   (7) Arc Flash labels
   (8) Serving utility information with utility letterhead, including:
      (a) Protective device part numbers/settings
      (b) Maximum available 1P and 3P fault
      (c) Line conductor sizes/lengths
      (d) Transformer impedance
      (e) Serving voltage
   (9) Provide copy of Owner’s electrical safety program if site specific standards vary from instructions noted in this project specification. All software files, including report documents and system study native files (including relevant library files), to allow review and future use of files
   (10) Sample energized work permit form

1.05 QUALITY ASSURANCE

A. Perform studies using computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
B. Coordination Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   (1) Perform study under the direct supervision and control of a Registered Professional Electrical Engineer licensed in the _____ of _____, with a minimum of 5 yrs recent experience in performing protective device coordination studies, arc flash calculations, and electrical system analysis. Final report shall be signed and sealed by said engineer.

C. Comply with IEEE 3002.3 for general study procedures.

D. Comply with IEEE 1584 for arc flash calculations.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

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

B. Basis of Design Product:

(1) CYME International, Inc.

(2) EDSA Micro Corporation

(3) SKM Systems Analysis, Inc.

(4) ETAP

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 3002.3 and IEEE 1584.

B. Computer software program shall be capable of plotting and diagramming time-current characteristic curves as part of its output. Computer software program reports device settings and ratings of all overcurrent protective devices and demonstrates selective coordination by computer-generated, time-current coordination plots.

C. Arc Flash Calculations: Software program capable of calculating Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices for coordination are indicated on drawings.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

C. Provide the study based on the actual electrical equipment supplied for the project.

3.02 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

(1) Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with power riser diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

(2) Impedance of utility service entrance(s).

(3) Power Riser Diagrams: In hard copy and electronic copy formats, showing the following:

(a) Circuit breaker and fuse-current ratings and types

(b) Relays and associated power and current transformer ratings and ratios

(c) Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios

(d) Generator kilovolt amperes, size, voltage, and source impedance

(e) Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length

1) Prior to equipment purchase, utilize conservative lengths (up/down included) based on planned conduit routing to validate equipment ratings. Final study to utilize contractor provided as-built lengths to confirm equipment ratings.

(f) Busway ampacity and impedance

(g) Motor horsepower and code letter designation according to NEMA MG 00001

(h) Load current that is the basis for sizing continuous ratings of circuits for cables and equipment

(4) Data sheets to supplement power riser diagrams, cross-referenced with tag numbers on diagrams, showing the following:

(a) Special load considerations, including starting inrush currents and frequent starting and stopping

(b) Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability

(c) Motor full-load current, locked-rotor current, service factor, starting time, type of start, and thermal-damage curve

(d) Generator thermal-damage curve

(e) Ratings, types, and settings of utility company’s overcurrent protective devices

(f) Special overcurrent protective device settings or types stipulated by utility company

(g) Time-current characteristic curves of devices indicated to be coordinated

(h) Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers

(i) Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays

(j) Panelboards, switchboards, automatic transfer switch, ampacity, and interrupting rating in amperes rms symmetrical

1) Automatic transfer switch withstand rating to comply with UL 1008. Equivalent trip curves are not accepted for specific breaker rated equipment – exact breaker and associated trip unit must be listed on UL certification.

3.03 FAULT CURRENT STUDY

A. Calculate maximum available short circuit current in amperes rms symmetrical at circuit breaker positions of electrical power distribution system. Provide calculation for a current immediately after initiation and for a three-phase bolted short circuit at the following:

(1) _____ bus

(2) Distribution panelboard

(3) Branch circuit panelboard

(4) Disconnect switches

(5) Automatic transfer switch

(6) Manual transfer switch

(7) Equipment fed by Variable Frequency Drive (VFD)

(8) Industrial control panels including air handling equipment, elevator controllers, etc.

B. For standard non-bypass Pulse Width Modulation VFDs, a line short circuit condition may be ignored.

C. Verify mechanical equipment served meets or exceeds maximum short circuit available.

D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for project. Include studies of system switching configurations and alternate operations that could result in maximum fault conditions.

(1) Model the entire electrical distribution system from utility company point of connection to circuit breakers in 208 V distribution panels at secondary side of distribution transformers. Include mechanical HVAC equipment, motor driven equipment feeder circuits, and elevator feeder circuits.

(2) Model shall include components of the distribution system which would be exposed to fault current levels of 10,000 A symmetrical on a calculated basis.

(3) Study shall include closed transition operation of automatic transfer switches _____ and worst-case short circuit rating shall be included in analysis for each piece of equipment as defined above. The closed transition and normal operation short circuit ratings shall both be used to explore the worst-case arc fault rating for each piece of electrical equipment as defined above.

E. Calculate momentary and interrupting duties on basis of maximum available fault current.

F. Perform calculations to verify interrupting ratings of overcurrent protective devices in compliance with _____ and IEEE 242.

(1) Transformers:

(a) IEEE C57.12.10

(b) ANSI C57.12.22

(c) ANSI C57.12.40

(d) IEEE C57.12.00

(e) IEEE C57.96

(2) Medium-Voltage Circuit Breakers: IEEE C37.010

(3) Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1

(4) Low-Voltage Fuses: ANSI C37.46

G. Study Report:

(1) Show calculated X/R ratios and equipment interrupting rating (5-cycle) fault currents on power riser diagrams in report. List other output values from computer analyses, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault current values for 3-phase, 2-phase, and phase-to-ground faults.

(2) Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high voltage circuit breakers to set relays and assess the sensitivity of overcurrent relays.

H. Equipment Evaluation Report:

(1) Prepare report on adequacy of overcurrent protective devices and conductors by comparing fault current ratings of devices with calculated fault current momentary and interrupting duties.

(2) For 600V overcurrent protective devices, ensure interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

(3) For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.

(4) Verify adequacy of phase conductors at maximum 3-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure short circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

(5) Notify Owner/Engineer promptly of discrepancies, problem areas, or inadequacies and provide recommendations for problem resolution.

3.04 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault current study. Comply with IEEE 3002.3.

(1) Calculate maximum and minimum 1/2-cycle short circuit currents.

(2) Calculate maximum and minimum interrupting duty (5 cycles to 2 seconds) short circuit currents.

(3) Calculate maximum and minimum ground-fault currents.

B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

C. Comply with _____ recommendations for fault currents and time intervals.

D. Transformer Primary Overcurrent Protective Devices:

(1) Devices non-operational in response to the following:

(a) Inrush current when first energized

(b) Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

(c) Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

(2) Protect transformers according to IEEE C57.12.00, for fault currents by device settings.

E. Protect motors served by voltages more than 600 V according to IEEE 620.

F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate equipment withstands the maximum short circuit current for a time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short circuit current. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

G. Include voltage classes of equipment from utility's incoming line protective device down to and including each panelboard. The phase and ground overcurrent protection shall be included as well as settings for other adjustable protective devices.

H. Selective Coordination: Overcurrent devices installed upstream and downstream of automatic transfer switches and/or associated with NEC Article 700 Emergency and 701 Legally Required loads shall be selectively coordinated from source of supply (both normal and emergency sources) through final device. Change specific circuit breakers (type, frame, trip-unit, etc.) and equipment bus rating as necessary to meet this requirement. Selective coordination of the system indicated on the one-line diagram is based on (list manufacturer) equipment.

(1) Additionally, provide selective coordination for ground fault through-out.

I. Coordination Study Report: Prepare a written report indicating results of coordination study:

(1) Tabular Format of Settings Selected for Overcurrent Protective Devices:

(a) Device tag

(b) Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values

(c) Circuit breaker sensor rating; and long-time, short-time, and instantaneous settings

(d) Fuse-current rating and type

(e) Ground-fault relay-pickup and time-delay settings

(f) Manufacturer and type of device

(g) Range of adjustments and recommended settings

(2) Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate adequate time separation exists between devices installed in series, drawn to show the boundaries of device operation on log-log scale graphs, including power utility company's upstream devices. Where time current curves do not explicitly illustrate selective coordination but breakers have been tested and documented as being selectively coordinated, submit manufacturer's literature to substantiate device coordination. Include on curve sheet a title and legend identifying portion of the system covered. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

(a) Device tag
(b) Voltage and current ratio for curves
(c) Three-phase and single-phase damage points for each transformer
(d) No damage, melting, and clearing curves for fuses
(e) Cable damage curves
(f) Transformer inrush points, full-load amps, and damage curves
(g) Maximum fault current cutoff point
(h) Generator decrement curve and full-load amps

(3) Plot characteristics where applicable:

(a) _____voltage fuses including minimum melt, total clearing and damage bands
(b) Low-voltage circuit breaker trip devices
(c) Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
(d) Ground-fault protective devices
(e) Motor starting characteristics and motor damage points
(f) Generator short circuit decrement curve and generator damage point
(g) Conductor damage curves
(h) Electric utility's protective devices
(i) Medium-voltage equipment relays

(4) Notify Owner/Engineer promptly of discrepancies, problem areas, or inadequacies and provide recommendations for problem resolution. Propose approaches to effectively protect the underrated equipment. Present technical evaluation with discussion of logical compromises for best coordination.

J. Completed data sheets for setting of overcurrent protective devices.

3.05 ARC FLASH STUDY

A. Perform arc flash calculations for Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances. Utilize short circuit rating of equipment identified in fault current study – note infinite bus fault current alone is not acceptable.

B. Model worst-case arc flash conditions_____.

(1) Equipment with PPE rating greater than 2 shall be investigated. Investigation shall include adjustment of upstream overcurrent device settings to determine if PPE rating can be reduced with minimal compromise to coordination with other overcurrent devices.

C. Arc Flash Study Report: Provide study results in tabular form and include:

(1) Device or bus name
(2) Bolted fault and arcing fault current levels
(3) Arc Flash Incident Energy (AFIE) level at 455 mm expressed in cal/cm2
(4) Flash protection boundary distances including:

(a) Limited shock approach boundary
(b) Restricted shock approach boundary

(5) Trip/Delay time
(6) Breaker opening time
(7) Working distance
(8) Equipment class and bus gap
(9) Personal protective equipment class (PPE)

D. Provide recommendation for reducing AFIE levels and enhancing worker safety.

3.06 FIELD QUALITY CONTROL

A. Inspect, set, test, and calibrate the protective relays, circuit breakers, fuses, and other applicable devices per requirements in Section 26 08 12 - Power Distribution Acceptance Tests and Section 26 08 13 - Power Distribution Acceptance Test Tables.

B. Upon final approval of study, provide weatherproof vinyl or polyester arc flash label for all electrical equipment defined above. Label shall include calculated flash protection boundary, incident energy in cal/cm2 at working distance (mm working distance based on equipment class, per IEEE 1584), required PPE level, limited approach, restricted approach, equipment name, company name/logo who performed the study, available fault current, _____ and date label was produced.

(1) Label to comply with ANSI Z535. Use “WARNING” (ANSI safety orange background with an orange exclamation point safety symbol) for all arc flash levels.

(2) Per NFPA 70E 130.5(C), due to use of incident energy analysis method, PPE categories shall not be provided on labels unless site specific standard PPE categories differ from incident energy levels noted in NFPA 70E Table 130.7(C)(16).

(3) Include verbiage on label noting study should be re-examined once every (5) years or upon modifications to electrical system.

3.07 ADJUSTING

A. Make modifications to equipment, as required, to accomplish conformance with equipment evaluation study.

B. Adjust relay and overcurrent protective device settings according to recommended settings table provided by overcurrent protective device coordination study.

C. Notify Owner/Engineer in writing of any required major modifications.

3.08 INSTALLATION

A. Install arc labels on each piece of equipment prior to energizing equipment.

B. Arc flash labels shall be protected by clear plastic cover, weatherproof type material, or laminated and mounted on front of equipment. Taping of PPE label to front of equipment is unacceptable.

C. Arc flash label shall be clearly visible upon approach to equipment.

D. For large pieces of equipment, label shall be placed near main overcurrent device or incoming feeder to equipment. For equipment such as switchboards, UPS, or switchgear, with multiple vertical sections, provide (1) label per vertical section.

E. Contractor to provide one-line diagrams (meet IEEE/ANSI standard 141), mounted on 24”x36” (minimum) Styrofoam backboard. These one-line diagrams shall be mounted in each electrical room.

F. Label shall be mounted at a minimum of 42” (1070 mm) to bottom and maximum 66" (1680 mm) to top above finished floor.

END OF SECTION 26 05 73

SECTION 26 05 93 - ELECTRICAL SYSTEMS FIRESTOPPING

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 07 84 00 - Firestopping

B. Section 26 05 33 - Raceway and Boxes for Electrical Systems

C. Section 26 05 36 - Cable Trays for Electrical Systems

D. Section 26 25 00 - Enclosed Bus Assemblies

1.02 DESCRIPTION

A. Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions (walls, partitions, floors, and ceilings) including both empty openings and openings containing electrical penetrating items, including raceways, cables, cable trays, busways, and wireways.

1.03 REFERENCE STANDARDS

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

B. UL 1479 - Fire Tests of Through-Penetration Firestops

1.04 PERFORMANCE REQUIREMENTS

A. Provide firestop system to resist spread of fire, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Firestop systems shall be UL Classified for the application and correspond to those indicated by reference to designations listed by UL Fire Resistance Directory.

C. Conform to applicable Code requirements of Authority Having Jurisdiction.

1.05 SUBMITTALS

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

B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.

(1) Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetration items, including documentation of UL certification for firestop systems.

C. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Material Safety Data Sheets provided with product delivered to job site.

E. Certification of compliance with Building Codes of the _____ of _____.

F. Inspection reports

G. Onsite Training Letter: Firestop manufacturer to provide and contractor to submit letter stating the names(s) of the companies, person(s) in attendance and date of onsite training as required in section 1.7.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.

B. Firestopping tests shall be performed by a qualified testing and inspecting agency, or another agency performing testing and follow-up inspection services for firestop systems acceptable to Authorities Having Jurisdiction.

C. Manufacturer’s representative shall be on-site during initial installation of firestop systems to train appropriate Contractor personnel in proper selection and installation procedures.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers’ labels identifying product, type and manufacturer, and UL Label where applicable.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

C. Handle in accordance with recommended procedures, precautions, or remedies described in material safety data sheets as applicable.

1.08 PROJECT CONDITIONS

A. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop systems' manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturers' written instructions by natural means or, where this is inadequate, forced-air circulation.

1.09 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner's inspecting agency at least 7 days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's inspecting agency and building inspector, if required by Authorities Having Jurisdiction.

1.10 SEQUENCING

A. Sequence work to avoid interferences with building finishes and installation of other products.

1.11 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. 3M (Fire Protection Products Division), Hilti Inc, Tremco (Sealant/Weatherproofing Division), Nelson Firestop Products, Specified Technologies Inc, RectorSeal Corporation, _____.

2.02 MATERIALS

A. Firestop Products: UL 1479, ASTM E814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance; materials shall not contain flammable solvents.

B. Firestop Systems: Produced by the same manufacturer.

C. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

(1) Sealants: 250 g/L

(2) Sealant Primers for Nonporous Substrates: 250 g/L

(3) Sealant Primers for Porous Substrates: 775 g/L

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for opening configurations, penetrating items and other conditions affecting performance of firestopping.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean out openings immediately prior to installing through-penetration firestop system to comply with firestop system manufacturer's written instructions.

B. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

C. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

3.03 INSTALLATION

A. Comply with "System Performance Requirements" Article in Part 1 and with firestop system manufacturer's written installation instructions and drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during application as required. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Each conduit penetration through a fire rated assembly is to be dedicated to a single conduit. Multiple conduits penetrating a single opening is not acceptable unless a UL listed, multi-conduit assembly is used.

3.04 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include label(s) complying with 1 or 2 below.

(1) Custom label with the following information:

(a) The words: “Warning—Through-Penetration Firestop System—Do Not Disturb. Notify Building Management of Any Damage.”

(b) Contractor’s name, address, and phone number

(c) Through-penetration firestop system designation of applicable testing and inspecting agency

(d) Date of installation

(e) Through-penetration firestop system manufacturer’s name

(f) Installer’s name

(2) Manufacturer’s preprinted labels with similar information per 1 above.

3.05 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.

(1) Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Provide certification by Installer that all through-penetration firestop systems have been firestopped in accordance with applicable Building Codes of the _____ of _____.

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

D. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with specifications.

3.06 CLEANING

A. Clean surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION 26 05 93

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Commissioning of Electrical Systems is the process of ensuring that the Electrical System is installed and performs interactively according to the basis of design criteria and meets the building's operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up, and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for the discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Electrical System from installation to complete dynamic operation and optimization.

B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Agent (CxA). Primary elements of Commissioning during the construction, acceptance, and warranty phases of the project include:

(1) Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.

(2) Demonstrate functional operational performance of equipment and systems in the commissioning program.

(3) Verify Operations and Maintenance (O&M) documentation submitted is complete. Provide required documentation and information to the General Contractor to allow compilation of Building Systems Manuals in accordance with Section 01 78 23 - Building System Manuals (O&M).

(4) Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.

(5) Verify systems are interacting and performing optimally in accordance with the system sequence of operations.

(6) Furnish labor and material to accomplish electrical system commissioning and systems testing as specified herein and other related sections.

1.02 RELATED SECTIONS

A. Section 01 79 13 - Demonstration and Training

B. Section 01 78 23 - Building System Manuals (O&M)

C. Section 01 91 13 - General Commissioning Requirements

D. Section 01 91 14 - Functional Testing Requirements

1.03 SUBMITTALS

A. Refer to Section 01 91 13 - General Commissioning Requirementsfor commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxA, in addition to the copies required by the Owner and Design Professional.

1.04 COORDINATION

A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

B. All maintenance points for components installed by the contractor for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 - General Commissioning Requirementsfor additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.

C. Datalogging equipment or software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.01 COMMISSIONING

A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13 - General Commissioning Requirements.

B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting Contractor Pre-Testing. Both of these documents are required prior to the CxA scheduling the Functional Performance Testing. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.

C. Construction Checklists for each type of equipment and system shall be provided to the installation contractors by the CxA via the web-based commissioning application for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.

D. For equipment and system components requiring a manufacturer's representative for Construction Checklists and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the CxA.

E. Functional Testing Procedures for each type of equipment and system shall be provided to the installation contractors by the CxA for use by the contractor in documenting the performance of the Contractor Pre-Testing. Refer to Section 01 91 14 - Functional Testing Requirementsfor further information.

F. Completed Start-up checklists and Construction Checklists for all pieces of equipment shall be submitted by contractors to the CxA through the General Contractor prior to the scheduling of the final Functional Performance Testing that is witnessed by the CxA.

3.02 TRAINING

A. Contractor responsible for the installation of the system shall coordinate the participation of other subcontractors and manufacturer's representatives in the training program in accordance with requirements of 01 79 13 - Demonstration and Training 01 79 13A - Demonstration and Training Sample Agenda.

3.03 OPERATIONS AND MAINTENANCE DATA

A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications

3.04 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing

(1) Refer to Sections 01 91 13 - General Commissioning Requirementsand 01 91 14 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment systems.

END OF SECTION 26 08 00

SECTION 26 08 12 - POWER DISTRIBUTION ACCEPTANCE TESTS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 13.16 - Medium-Voltage, Single- and Multi-Conductor Cables
B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems
D. Section 26 05 73 - Power System Studies
E. Section 26 08 13 - Power Distribution Acceptance Test Tables
F. Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
G. Section 26 13 23 - Medium-Voltage Pad-Mounted Switchgear
H. Section 26 22 00 - Low-Voltage Transformers
I. Section 26 23 00 - Low-Voltage Switchgear
J. Section 26 24 13 - Switchboards
K. Section 26 27 13 - Electrical Metering
L. Section 26 28 16 - Enclosed Switches and Circuit Breakers
M. Section 26 29 13 - Enclosed Controllers
N. Section 26 32 13 - Engine Generators
O. Section 26 36 23 - Automatic Transfer Switches

1.02 DESCRIPTION

A. Section includes acceptance testing requirements for assessing the suitability for service and reliability of the power distribution system.
B. Contractor to ensure all tested electrical equipment, both Contractor and Owner supplied, is operational and within industry and manufacturer’s tolerances and is installed in accordance with design specifications.
C. Tests and inspections shall be performed after installation.
D. Tests and inspections shall determine suitability for energization.
E. Electrical systems shall pass tests prior to substantial completion or Owner occupancy.
F. This specification requires Contractor to engage services of testing agency.
G. All test tables referenced in this specification provided in Section 26 08 13 - Power Distribution Acceptance Test Tables.
H. Items to be tested and inspected as follows:
   (1) 600-volt conductors and cables
   (2) Medium-voltage cables
   (3) Electrical metering
   (4) Engine generator
   (5) Dry type transformers (small)
   (6) Dry type transformers (large)
   (7) Liquid filled transformers
   (8) Low-voltage switchgear
   (9) Switchboard
   (10) Medium-voltage metal-enclosed air switches
   (11) Medium-voltage oil switches
   (12) Medium-voltage air circuit breakers
   (13) Medium-voltage vacuum circuit breakers
   (14) Low-voltage power circuit breakers
   (15) Low-voltage insulated-case/molded-case circuit breakers
   (16) Low-voltage disconnect switches
   (17) Medium-voltage SF6 circuit breakers
   (18) Medium-voltage SF6 switches
   (19) Medium-voltage surge arresters

(20) Network protectors (600 V class)
(21) Automatic transfer switches
(22) Motor control and motor control center
(23) Ground fault protection systems
(24) Grounding systems
(25) Protective relays (as applicable)
(26) Instrument transformers
(27) Thermographic survey

1.03 REFERENCE STANDARDS

A. ANSI/IEEE C2 – National Electrical Safety Code
B. ANSI/IEEE C37 – Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses
C. ANSI/IEEE C37.04 – Standard Rating Structure for AC High Voltage Circuit Breaker
D. ANSI/IEEE C57 – Distribution, Power, and Regulating Transformers
E. ANSI/IEEE C57.13.1 – Guide for Field Testing of Relaying Current Transformers
F. ANSI/IEEE C57.13.3 – Grounding of Instrument Transformer Secondary Circuits and Gases
G. ANSI/IEEE c57.104 – Guide for the Interpretation of Gases Generated in Oil-immersed Transformers
H. ANSI/IEEE C62 – Surge Protection
I. ANSI/IEEE 43 – IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery
J. ANSI/IEEE 48 – Standard Test Procedure and Requirements for High-Voltage Alternating-Current Cable Terminations
K. ANSI/IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
L. ANSI/IEEE 141 – IEEE Recommended Practice for Electrical/Power Distribution for Industrial Plants (IEEE Red Book)
M. ANSI/IEEE 142 – IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)
N. ANSI/IEEE 241– IEEE Recommended Practice for Electrical Power Systems in Commercial Buildings (IEEE Gray Book)
O. ANSI/IEEE 242 – IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)
P. ANSI/IEEE 399 – IEEE Recommended Practice for Power Systems Analysis (IEEE Brown Book)
Q. ANSI/IEEE 400 – Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field
R. ANSI/IEEE 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (IEEE Orange Book)
S. ANSI/IEEE 493 – IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (IEEE Gold Book)
T. ANSI/IEEE 1100 – IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book)
U. ASTM D877/D877M – Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
V. ASTM D823 – Standard Practices for Sampling Electrical Insulating Liquids
W. ASTM D924 – Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids
X. ASTM D971 – Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Methods
Y. ASTM D974 – Standard Test Method for Acid and Base Number by Color-Indicator Titration
Z. ASTM D1298 – Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
AA. ASTM D1500 – Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)
BB. ASTM D1524 – Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field

CC. ASTM D1816 – Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes

DD. ASTM D2285 – Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop-Weight Method

EE. ASTM D3612 – Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography

FF. ASTM D3613 – Standard Practice for Sampling Insulating Liquids for Gas Analysis and Determination of Water Content

GG. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

HH. NEMA AB 4 – Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications

II. NEMA MG 00001 – Motors and Generators

JJ. NFPA 70 – National Electrical Code

KK. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

LL. NFPA 70E – Electrical Safety Requirements for Employee Workplaces

MM. NFPA 101 – Life Safety Code

NN. NFPA 110 – Emergency and Standby Power Systems

OO. NIST – National Institute of Standards and Technology

PP. OSHA – Part 1910 – Subpart S – 1910.308 – Special Systems

1.04 SUBMITTALS

A. Test Reports: Include the following:

(1) Summary of project

(2) Description of equipment tested

(3) Equipment used to conduct the test

(4) Description of test

(5) Test results, as compared to manufacturers' or industry accepted standards and tolerances

(6) Conclusions and recommendations

(7) Signature of responsible test organization authority

B. List of equipment used to perform tests. Identify the following:

(1) Type

(2) Manufacturer

(3) Model number

(4) Serial number

(5) Date of last calibration

(6) Documentation of calibration leading to NIST standards

1.05 QUALITY ASSURANCE

A. Qualifications of Testing Agency:

(1) Testing firm shall be a corporately and financially independent testing organization that can function as an unbiased testing authority, professionally independent of the manufacturer, supplier, and installers of equipment or system evaluated by the testing firm.

(2) Testing firm shall be regularly engaged in testing of electrical equipment, devices, installations and systems.

(3) Testing firm shall meet Federal Occupational Safety and Health Administration (OSHA) requirements for accreditation of independent testing laboratories.

(4) On-site technical person shall be currently certified by the International Electrical Testing Association in electrical power distribution system testing.

(5) Testing firm shall use technicians who are regularly employed by the firm for testing services.

(6) Testing firm shall submit proof of above qualifications with bid documents when requested.

PART 2 - PRODUCTS

2.01 NOT APPLICABLE TO THIS SECTION.

PART 3 - EXECUTION

3.01 PREPARATION

A. Documentation: Deliver the following to testing firm, minimum two weeks prior to commencement of testing:

(1) Complete set of electrical plans and specifications, with available short circuit indicated on power riser diagrams.

(2) Approved submittals and shop drawings of equipment being tested.

(3) Pertinent change orders.

(4) Evaluation, overcurrent protective device coordination and arc flash studies, per requirements in Section 26 05 73 - Power System Studies.

B. Schedule: Notify Owner and Engineer 10 working days prior to performance of any tests.

C. Coordination: Coordinate with Construction Manager/Owner/Engineer the testing schedule and availability of equipment ready for testing.

D. Test Power: Provide test power (including specialized) for equipment testing before and after service energizing.

3.02 FIELD QUALITY CONTROL

A. Inspection and Test Procedures: Comply with NETA.

(1) 600 V Conductors and Cables:

(a) Visual and Mechanical Inspection:

1) Compare cable data with drawing and specifications.

2) Inspect exposed sections of cables for physical damage.

3) Verify tightness of accessible bolted electrical connections by calibrated torque wrench in accordance with manufacturer's published data or Table 12.

4) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."

5) Inspect compression-applied connectors for correct cable match and indentation.

6) Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.

7) For cables are terminated through window-type current transformers, provide an inspection to verify neutral and ground conductors are correctly placed for operation of protective devices.

8) Inspect for correct identification and arrangements.

9) Inspect jacket and insulation condition.

(b) Electrical Tests:

1) Perform insulation-resistance test using megohm meter. Applied potential to be 1000 VDC. Individually test each conductor with other conductors grounded. Test duration shall be one minute.

2) Perform continuity tests to ensure correct cable connection.

(c) Test Values:

1) Insulation-resistance values should not be less than 100 megohms.

(2) Medium-Voltage Cables:

(a) Visual and Mechanical Inspection:

1) Compare cable data with drawings and specifications.

2) Inspect exposed sections of cables for physical damage.

3) Verify tightness of accessible bolted connections by calibrated torque wrench in accordance with manufacturer's published data or Table 12.

4) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."

5) Inspect compression-applied connectors for correct cable match and indentation.

6) Inspection for shield grounding, cable support, and termination.

7) Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.

8) Inspect for adequate fireproofing in common cable areas, if specified.

9) For cables that are terminated through window-type current transformers, provide an inspection to verify neutral and ground conductors are correctly placed and shields are correctly terminated for operation of protective devices.

10) Inspect jacket and insulation condition.

11) Inspect for correct identification and arrangements.

(b) Electrical Tests:

1) Perform shield-continuity test on each power cable by ohmmeter method and record value.

2) Perform insulation-resistance test using megohm meter with voltage output of at least 2500 V. Individually test each conductor with other conductors and shields grounded. Test duration shall be 1 minute.

3) Perform DC high-potential test on cables, including terminations and joints after cable system installation and before placing cable in service. Adhere to precautions and limits as specified in applicable NEMA/ICEA Standards for the specific cable. Perform tests in accordance with ANSI/IEEE 400. Test voltages shall not exceed 80% of cable manufacturer's factory test value or maximum test voltage in Table 6.
    1. Ensure input voltage to test set is regulated.
    2. Current-sensing circuits in test equipment shall measure only leakage current associated with cable under test and shall not include internal leakage of test equipment.
    3. Record wet- and dry-bulb temperatures or relative humidity and temperature.
    4. Test each section of cable individually.
    5. Individually test each conductor with other conductors grounded. Ground all cable shields.
    6. Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable method as necessary.
    7. Ensure maximum test voltage does not exceed limits for terminators specified in ANSI/IEEE 48 or manufacturer's specifications.
    8. Apply DC high-potential test in at least 5 equal increments until maximum test voltage is reached. No increment shall exceed voltage rating of the cable. Record DC leakage current at each step after constant stabilization time consistent with system charging current.
    9. Raise conductor to specified maximum test voltage and hold for 15 minutes on shielded cable and 5 minutes on non-shielded cable. Record readings of leakage current at 30 seconds and one minute and at one-minute intervals thereafter.
    10. Reduce conductor test potential to zero and measure residual voltage at discrete intervals.
    11. Apply grounds for time period adequate to drain insulation stored charge.
    12. When new cables are spliced into existing cables, DC high-potential test shall be performed on new cable prior to splicing in accordance with this section. After test results are approved for new cable and splice is complete, perform insulation-resistance test and shield-continuity test on the length of new and existing cable including the splice. After satisfactory insulation-resistance test, DC high-potential test shall be performed on cable using test voltage acceptable to Owner and not exceeding 60% of factory test value.

(c) Test Values:
1) Shielding must exhibit continuity. Investigate resistance values in excess of 10 ohms per 1000 ft (300 m) of cable.
2) Graphic plots may be made of leakage current versus step voltage at each increment and leakage current versus time at final test voltages.
    1. Step voltage slope should be reasonably linear.
    2. Capacitive and absorption current should decrease continually until steady state leakage is approached.

(3) Electrical Metering:
(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Verify tightness of electrical connections.
4) Inspect cover gasket, cover glass, condition of spiral spring, disc clearance, contacts, and case-shorting contacts, as applicable.
5) Verify freedom of movement, correct travel and alignment, and tightness of mounting hardware.
(b) Electrical Tests:
1) Check calibration of meters at cardinal points.
2) Calibrate watt-hour meters according to manufacturer's published data.
3) Verify instrument multipliers.
4) Electrically confirm current transformer and voltage transformer secondary circuits are intact.

(4) Engine Generator:
(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect correct anchorage and grounding.
4) Inspect air baffles, filter media, and cooling fans.
5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.

6) Confirm correct application of manufacturer's recommended lubricants.

(b) Electrical and Mechanical Tests:

1) Perform insulation-resistance test on generator winding with respect to ground in accordance with ANSI/IEEE 43. Calculate polarization index.
2) Test protective relay devices in accordance with paragraph "Protective Relays."
3) Perform phase-rotation test to determine compatibility with load requirements.
4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
5) Perform vibration baseline test. Plot amplitude versus frequency for each main bearing cap.
6) Conduct performance test in accordance with NFPA 110, Section 7-13 (Installation Acceptance).
7) Verify correct functioning of governor and regulator.
8) Verify function and temperature regulation for battery and engine heaters.

(c) Test Values:

1) Polarization index values shall be in accordance with ANSI/IIEEE 43.
2) Vibration levels shall be in accordance with manufacturer's published data.
3) Performance tests shall conform to manufacturer's published data and NFPA 110.
4) Vibration amplitudes shall not exceed values shown in Table 10.
5) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.

(5) Dry Type Transformers (Small):

(a) Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify that resilient mounts are free and that any shipping brackets have been removed.
5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
6) Verify that as-lift tap connections are as specified.

(b) Electrical Tests:

1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground with test voltage in accordance with Table 5. Calculate dielectric absorption ratio or polarization index.

(c) Test Values:

1) Bolt-torque levels should be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Insulation-resistance test values at one minute should be in accordance with Table 5.
3) The dielectric absorption or polarization index shall be greater than 1.0 and shall be recorded for future reference.

(6) Dry Type Transformers (Large):

(a) Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Verify control and alarm settings on temperature indicators are as specified.
4) Verify cooling fans operate correctly and fan motors have correct overcurrent protection.
5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
6) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."
7) Perform specific inspections and mechanical tests as recommended by manufacturer.
8) Make a close examination of shipping brackets or fixtures that may not have been removed during installation. Ensure resilient mounts are free.
9) Verify seismic bracing is correct.
10) Verify winding core, frame, and enclosure grounding are correct.
11) Verify as-lift tap connections are as specified.

(b) Electrical Tests:

1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground with test voltage in accordance with Table 5.

2) Calculate polarization index.
3) Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's instructions.
4) Perform turns-ratio test on tap connections. Verify winding polarities are in accordance with nameplate.
5) Perform an excitation-current test on each phase.
6) Measure resistance of each winding at each tap connection.
7) Verify core is solidly grounded. If core is insulated and removable core ground strap is available, perform core insulation-resistance test at 500 VDC.
8) Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

(c) Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Insulation-resistance test values at one minute should not be less than values recommended in Table 5. Results shall be temperature corrected in accordance with Table 14.
3) Polarization index should be compared to manufacturer's factory test results. If manufacturer's data is not available, acceptance test results will serve as baseline data.
4) Turns-ratio test results should not deviate more than 0.5% from either adjacent coils or calculated ratio.
5) CH and CL dissipation-factor/power-factor values will vary due to support insulators and bus work used on dry transformers. The following should be expected on CHL power factors:
    1. Power Transformers: 2% or less
    2. Distribution Transformers: 5% or less
6) Consult transformer manufacturer's or test equipment manufacturer's data for additional information.
7) If winding-resistance test results vary more than 1% from adjacent windings, consult manufacturer.
8) Typical excitation current test data pattern for three-legged core transformer is two similar current readings and one lower current reading.
9) If core insulation resistance is less than one megohm at 500 VDC, consult manufacturer.

(7) Liquid Filled Transformers:

(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition for physical damage, cracked insulators, and tightness of connection.
3) Verify removal of shipping bracing after final placement.
4) Inspect impact recorder prior to unloading, if applicable.
5) Verify alarm, control, and trip settings on temperature and level indicators are as specified.
6) Verify cooling fans and pumps operate correctly and fans and pump motors have correct overcurrent protection.
7) Verify operation of alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.
8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
9) Perform thermographic survey in accordance with paragraph "Thermographic Survey."
10) Verify correct liquid level in tanks and bushings.
11) Perform specific inspections and mechanical tests as recommended by manufacturer.
12) Verify correct equipment grounding.
13) Verify seismic bracing is correct.

(b) Electrical Tests:
1) Perform insulation-resistance tests, winding-to-winding and each winding-to-grounding with test voltage in accordance with Table 5. Test duration shall be for 10 minutes with resistance tabulated at 30 seconds, 1 minute, and 10 minutes.
2) Calculate polarization index.
3) Perform a turns-ratio test on no-load tap-changer positions and load tap-changer positions. Verify tap setting is as specified. Verify winding polarities are in accordance with nameplate.
4) Perform insulation power-factor/dissipation-factor tests on windings and correct to 68°F (20°C) in accordance with test equipment manufacturer's instructions.

5) Perform power-factor/dissipation-factor tests (or hot collar watts-loss tests) on bushings and correct to 68°F (20°C) in accordance with test equipment manufacturer's instructions.
6) Perform excitation-current tests in accordance with test equipment manufacturer's instructions.
7) Measure resistance of each high-voltage winding in each no-load tap-changer position. Measure resistance of each low-voltage winding in each load tap-changer position, if applicable.
8) If core ground strap is accessible, measure core insulation resistance at 500 VDC.
9) Measure percentage of oxygen in nitrogen blanket.
10) Remove sample of insulating liquid in accordance with ASTM D923. Sample shall be tested for the following:
    1. Dielectric breakdown voltage: ASTM D877/D877M and/or ASTM D1816.
    2. Acid neutralization number: ASTM D974.
    3. Specific gravity: ASTM D1298.
    4. Interfacial tension: ASTM D971 or ASTM D2285.
    5. Color: ASTM D1500.
    6. Visual condition: ASTM D1524.
    7. Measure dissipation factor or power factor in accordance with ASTM D924.
11) Remove sample of insulating liquid in accordance with ASTM D3613 and perform dissolved gas analysis (DGA) in accordance with ANSI/IEEE c57.104 or ASTM D3612.
12) Test instrument transformers in accordance with paragraph "Instrument Transformers."
13) Test surge arresters in accordance with paragraph "Surge Arresters."

(c) Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Insulation-resistance test values at one minute should not be less than values recommended in Table 5. Resistance values to be temperature corrected in accordance with Table 14.
3) Polarization index should be compared to manufacturer's factory test results. If manufacturer's data is not available, acceptance test results will serve as baseline data.
4) Turns-ratio test results shall not deviate more than 0.5% from either the adjacent coils or the calculated ratio.
5) Maximum power factor of liquid-filled transformers corrected to 68°F (20°C) shall be in accordance with transformer manufacturer's published data. Representative values are shown in Table 3. Compare with test equipment manufacturer's published data.
6) Investigate bushing power factors and capacitances that vary from nameplate values by more than 10%. Investigate any bushing hot collar watts-loss results that exceed test equipment manufacturer's published data.
7) Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading.
8) Consult manufacturer if winding-resistance measurements vary more than 1% from adjacent windings.
9) Consult manufacturer if core insulation is less than one megohm at 500 VDC.
10) Insulating liquid shall comply with Table 4.
11) Evaluate results of dissolved-gas analysis in accordance with IEEE c57.104. Use results as baseline for future tests.

(8) Low-Voltage Switchgear and Switchboard Assemblies:
(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Confirm correct application of manufacturer's recommended lubricants.
4) Verify appropriate anchorage, required area clearances, grounding and correct alignment.
5) Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
6) Verify fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to circuit breaker's address for microprocessor-communication packages.
7) Verify that current and potential transformer ratios correspond to drawings.
8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench. Refer to manufacturer's published data or Table 12 for proper torque values.
9) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."
10) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

1. Attempt closure on locked-open devices. Attempt to open locked-closed devices.
2. Make key exchange with devices operated in off-normal positions.

11) Inspect insulators for evidence of physical damage or contaminated surfaces.

12) Verify correct barrier and shutter installation and operation.

13) Exercise active components.

14) Inspect mechanical indicating devices for correct operation.

15) Verify filters are in place and/or vents are clear.

16) Perform visual and mechanical inspection of instrument transformers, in accordance with paragraph “Instrument Transformers.”

17) Inspect control power transformers.

1. Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2. Verify that primary and secondary fuse ratings or circuit breakers match drawings.
3. Verify correct functioning of draw-out disconnecting and grounding contacts and interlocks.

(b) Electrical Tests:

1) Perform tests on all instrument transformers in accordance with paragraph “Instrument Transformers.”

2) Perform resistance tests through bus joints with low-resistance ohmmeter. Joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.

3) Perform insulation-resistance tests in each bus section, phase-to-phase and phase-to-ground for one minute in accordance with Table 1.

4) Perform over-potential test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer’s published data. In the absence of any published data, Table 2 shall apply. Test voltage shall be applied for one minute.

5) Perform insulation-resistance tests at 1000 VDC on control wiring. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer’s recommendation.

6) Perform current injection tests on the entire current circuit in each section of switchgear.

1. Perform current tests by primary injection, where possible, with magnitudes such that minimum of 1.0 amp flows in secondary circuit.
2. Where primary injection is impractical, utilize secondary injection with minimum current of 1.0 amp.
3. Test current at each device.

7) Determine accuracy of meters and calibrate watt-hour meters in accordance with paragraph “Electrical Metering.” Verify multipliers.

8) Perform phasing check on double-ended switchboard/switchgear to ensure correct bus phasing from each source.

9) Perform the following tests on control power transformers:

1. Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with Table 1 unless otherwise specified by manufacturer.
2. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.
3. Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.
4. Verify correct function of control transfer relays located in switchboard/switchgear with multiple control power sources.

10) Potential Transformer Circuits:

1. Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with Table 1, unless otherwise specified by manufacturer.
2. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage.
3. Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.

11) Verify operation of switchgear/switchboard space heaters.

(c) Test Values:

1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare bus connection resistances to values of similar connections.
3) Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation resistance less than this table or manufacturer's minimum should be investigated. Over-potential tests should not proceed until insulation-resistance levels are raised above minimum values.
4) Bus insulation shall withstand the over-potential test voltage applied.
5) Contact resistance values shall not exceed high limit of normal range as indicated in manufacturer's published data. If manufacturer's data is not available, investigate values that deviate from similar bus by more than 50% of lowest value.

(9) Medium-Voltage Metal-Enclosed Air Switches:

(a) Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Confirm correct application of manufacturer's recommended lubricants.
4) Verify appropriate anchorage, alignment and required area clearances.
5) Verify appropriate equipment grounding.
6) Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.
7) Verify fuse sizes and types are in accordance with drawing and short-circuit and coordination studies.
8) Verify expulsion-limiting devices are in place on holders having expulsion-type elements.
9) Verify each fuse holder has adequate mechanical support.
10) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
11) Test interlocking systems for correct operating and sequencing.
12) Verify correct phase-barrier materials and installation.
13) Compare switchblade clearances with industry standards.
14) Inspect indicating and control devices for correct operation.
15) Record as-found and as-left operation-counter readings.

(b) Electrical Tests:

1) Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute. Test voltage shall be in accordance with manufacturer's published data or Table 1.
2) Perform an over-potential test on each pole with switch closed. Test each pole-to-ground with other poles grounded. Test voltage shall be in accordance with manufacturer's published data or Table 11.
3) Measure contact resistance across each switchblade and fuse holder.
4) Measure fuse resistance.
5) Verify space heater operation.
6) Perform insulation-resistance test on control wiring at 1000 VDC. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state relays. Follow manufacturer's recommendations.

(c) Test Values:

1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Insulation shall withstand over-potential test voltage applied.
3) Minimum insulation-resistance shall be in accordance with manufacturer's published data or Table 1.
4) Investigate any contact resistance values that deviate from adjacent poles or similar switches by more than 50% of lowest value.
5) Investigate fuse resistance values that deviate from each other by more than 15%.
6) Control wiring insulation-resistance shall comply with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation resistance less than this table or manufacturer's minimum shall be investigated.

(10) Medium-Voltage Oil Switches:

(a) Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, grounding and required clearances.

4) Perform mechanical operation and contact alignment tests on both the switch and its operating mechanism.
5) Check each fuse holder for adequate support and contact.
6) Verify fuse sizes and types correspond to drawings.
7) Test electrical and mechanical interlock systems for correct operation and sequencing.
8) Verify tightness of accessible bolted electrical connections and/or cable connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
9) Perform thermographic survey of accessible bolted electrical connections in accordance with paragraph "Thermographic Survey."
10) Verify insulating oil level is correct.
11) Confirm correct application of manufacturer's recommended lubricants.
12) Record as-found and as-left operation-counter readings.

(b) Electrical Tests:
1) Measure contact resistance.
2) Remove a sample of insulating liquid in accordance with ASTM D923. Sample shall be tested for the following:
1. Dielectric breakdown voltage: ASTM D877/D877M.
2. Color: AASTM D1500.
3. Visual condition: ASTM D1524.
3) Perform insulation-resistance tests pole-to-pole, pole-to-ground, and across open poles. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data.
4) Perform insulation-resistance test on control wiring at 1000 VDC. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state relays. Follow manufacturer's recommendation.
5) Perform and over-potential test on each pole with switch closed. Test each pole-to-ground with other poles grounded. Test voltage shall be in accordance with manufacturer's published data or Table 11.

(c) Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Contact resistance values shall not exceed high limit of normal range as indicated in manufacturer's published data. If manufacturer's data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50% of lowest value.
3) Insulating liquid shall comply with Table 4.
4) Control wiring insulation resistance shall comply with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation resistance less than this table or manufacturer's minimum shall be investigated.

(11) Low-Voltage Power Circuit Breakers:

(a) Visual and Mechanical Inspection:
1) Compare nameplate data with drawings and specifications.
2) Inspect physical and mechanical conditions.
3) Confirm correct application of manufacturer's recommended lubricants.
4) Inspect anchorage, alignment, and grounding.
5) Inspect arc chutes.
6) Inspect moving and stationary contacts for condition, wear, and alignment.
7) Verify maintenance devices are available for servicing and operating breaker.
8) Verify primary and secondary contact wipe and other dimensions vital to satisfactory operation of breaker are correct.
9) Perform mechanical operator and contact alignment tests on breaker and its operating mechanism.
10) Verify tightness of accessible bolted bus connections by calibrated torque-wrench method. Refer to manufacturer's instructions or Table 12 for correct torque levels.
11) Perform thermographic survey of accessible bolted bus connections in accordance with paragraph "Thermographic Survey."
12) Check cell fit and element alignment.
13) Check racking mechanism.
14) Record as-found and as-left operation-counter readings.

(b) Electrical Tests:
1) Perform contact-resistance test.

2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase. Test duration shall be one minute. Use a minimum test voltage in accordance with Table 1 or manufacturer's published data.
3) Perform insulation-resistance test at 1000 VDC on control wiring. Test duration shall be one minute. Do not perform test on wiring connected to solid-state components. Follow manufacturer's recommendation.
4) Make adjustments for final trip settings in accordance with overcurrent protective device coordination study.
5) Determine minimum pickup current by primary current injection.
6) Determine long-time delay by primary current injection.
7) Determine short-time pickup and delay by primary current injection.
8) Determine ground-fault pickup and delay by primary current injection.
9) Determine instantaneous pickup value by primary current injection.
10) Verify trip unit calibrations by secondary injection.
11) Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to ensure operation of shunt trip devices. Check operation of electrically operated breakers in their cubicles. Perform minimum operation voltage on shunt trip and close coils in accordance with Table 20.
12) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrically close and trip operations, trip-free, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators.
13) Check charging mechanism.
14) Determine minimum operation voltage on shunt trip and close coils in accordance with Table 20.

(c) Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare microhm or millivolt drop values to adjacent poles or similar breakers. Investigate deviations of more than 50% of the lowest value. Investigate any value exceeding manufacturer's recommendations.
3) Circuit breaker insulation resistance shall be in accordance with Table 1.
4) Control wiring insulation-resistance shall comply with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation-resistance less than this table or manufacturer's minimum shall be investigated.
5) Trip characteristics of breakers shall fall within manufacturer's published time-current tolerance bands.
6) Minimum operation voltages on shunt trip and close coils shall be in accordance with manufacturer's published data. In the absence of manufacturer's data, refer to Table 20.

(12) Low-Voltage Insulated-Case/Molded-Case Circuit Breakers, 225A and Larger:
(a) Visual and Mechanical Inspection:
1) Compare nameplate date with drawings and specifications.
2) Inspect circuit breaker for correct mounting.
3) Check cell fit, element alignment and racking mechanism for draw-out breakers.
4) Operate circuit breaker to ensure smooth operation.
5) Inspect case for cracks or other defects.
6) Verify tightness of accessible bolted electrical connections and/or cable connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
7) Inspect mechanism contacts and arc chutes in unsealed units.

(b) Electrical Tests:
1) Perform a contact-resistance test.
2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase. Test duration shall be one minute. Use a minimum test voltage in accordance with Table 1 or manufacturer's published data.
3) Perform insulation-resistance test at 1000 VDC on all control wiring. Test duration shall be one minute. Do not perform the test on wiring connected to solid-state components. Follow manufacturer's recommendation.
4) Perform adjustments for final trip settings in accordance with overcurrent protective device coordination study.
5) Perform long-time delay time-current characteristic tests by passing 300% rated current through each pole separately, unless series testing is required to defeat ground fault functions.
6) Determine short-time pickup and delay by primary current injection.

7) Determine ground-fault pickup and time delay by primary current injection.
8) Determine instantaneous pickup current by primary injection using run-up or pulse method.
9) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.
10) Verify trip unit calibrations by secondary injection.
11) Determine minimum operation voltage on shunt trip and close coils in accordance with Table 20.
12) Check charging mechanism.

(c) Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare microhm or millivolt drop values to adjacent poles or similar breakers. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.
3) Circuit breaker insulation-resistance shall be in accordance with Table 1.
4) Control wiring insulation-resistance shall comply with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation resistance less than this table or manufacturer's minimum shall be investigated.
5) Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in Table 7. Circuit breakers exceeding specified trip time at 300% of pickup shall be tagged defective.
6) For molded-case circuit breakers, instantaneous pickup values shall be within manufacturer's published data or tolerances shown in Table 8.
7) Minimum operation voltages on shunt trip and close coils shall be in accordance with manufacturer's published data. In the absence of manufacturer's data, refer to Table 20.

(13) Low-Voltage Disconnect Switches:
(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, grounding, and required clearances.
4) Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.
5) Verify that fuse sizes and types are in accordance with drawings, short-circuit and overcurrent protective device coordination studies.
6) Verify that each fuse has adequate mechanical support and contact integrity.
7) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
8) Perform thermographic survey of accessible bolted electrical connection in accordance with paragraph "Thermographic Survey."
9) Verify operation and sequencing of interlocking systems.
10) Verify correct phase barrier installation.
11) Verify correct operation of all indicating and control devices.
12) Confirm correct application of manufacturer's recommended lubricants.

(b) Electrical Tests:
1) Measure contact resistance across each switchblade and fuseholder.
2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground. Test duration shall be one minute. Use a minimum test voltage in accordance with Table 1 or manufacturer's published data.
3) Measure fuse resistance.
4) Perform ground fault test, if applicable.

(c) Test Values:
1) Compare bolted connection resistances to values of similar connections.
2) Bolt-torque levels should be in accordance with Table 12, unless otherwise specified by the manufacturer.
3) Compare microhm or millivolt drop values to adjacent poles or similar switches. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.
4) Minimum insulation-resistance shall be in accordance with manufacturer's published data or Table 1.
5) Investigate fuse-resistance values that deviate from each other by more than 15%.

(14) Medium-Voltage SF6 Circuit Breakers:
(a) Visual and Mechanical Inspection:

1) Compare equipment nameplate date with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment and grounding.
4) Verify that all maintenance devices such as special tools and gauges specified by the manufacturer are available for servicing and operating the breaker.
5) Remove a sample of SF6 gas if provisions are made for sampling and test in accordance with Table 13.
6) Inspect operating mechanism and SF6 gas-insulated system in accordance with manufacturer's published data.
7) Test for SF6 gas leaks if temperature-corrected pressure/density alarms or metering indicate a need.
8) Verify correct operation of alarms and pressure-limit switches for pneumatic, hydraulic, and SF6 gas pressure as recommended by manufacturer.
9) If recommended by manufacturer, slow close/open breaker and check for binding, friction, contact alignment, and penetration. Verify that contact sequence is in accordance with manufacturer's published data. In the absence of manufacturer's published data, refer to ANSI/IEEE C37.04.
10) Perform time-travel analysis.
11) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
12) Confirm correct application of manufacturer's recommended lubricants.
13) Record as-found and as-left operation-counter readings.

(b) Electrical Tests:

1) Measure contact resistance.
2) Perform insulation-resistance tests pole-to-pole, pole-to-ground, and across open poles. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data.
3) Perform insulation-resistance test on control wiring at 1000 VDC. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state relays. Follow manufacturer's recommendation.
4) Verify trip, close, trip-free, and anti-pump function.
5) Perform power-factor or dissipation-factor tests on breaker and bushings. Use hot collar procedures if bushings are not equipped with power-factor tap.
6) Perform over-potential test in accordance with manufacturer's published data.
7) Perform minimum pickup voltage tests on trip and close coils in accordance with Table 20.
8) Trip circuit breaker by operation of each protective device.
9) Test instrument transformers in accordance with paragraph "Instrument Transformers."

(c) Test Values:

1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare microhm or millivolt values to adjacent poles or similar breakers or manufacturer's published data. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.
3) Compare circuit breaker travel and velocity values with manufacturer's published data.
4) Circuit breaker insulation resistance should be in accordance with Table 1. Refer to Table 14 for temperature correction factors.
5) Dissipation-factor/power-factor test results shall be compared to previous tests of similar breakers or manufacturer's published data.
6) SF6 gas should have values in accordance with Table 13.
7) Insulation shall withstand over-potential test voltage applied.
8) Minimum pickup for trip and close coils shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, refer to Table 20.

(15) Medium-Voltage SF6 Switches:

(a) Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment and grounding.
4) Inspect and service mechanical operator and SF6 gas-insulated system in accordance with the manufacturer's published data.
5) Inspect operating mechanism and SF6 gas-insulated system in accordance with manufacturer's published data.

6) Verify correct operation of SF6 gas pressure alarms and limit switches, if applicable, as recommended by the manufacturer.
7) Measure critical distances as recommended by the manufacturer.
8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
9) Verify each fuse has adequate mechanical support and contact integrity.
10) Verify fuse sizes and types correspond to drawings.
11) Verify operation and sequencing of interlocking systems.
12) Confirm correct application of manufacturer's recommended lubricants.
13) Test for SF6 gas leaks in accordance with manufacturer's published data.
14) Record as-found and as-left operation-counter readings.

(b) Electrical Tests:
1) Measure contact resistance.
2) Perform insulation-resistance tests pole-to-pole, pole-to-ground, and across open poles. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data.
3) Perform insulation-resistance test on control wiring at 1000 VDC. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state relays. Follow manufacturer's recommendations.
4) Remove a sample of SF6 gas if provisions are made for sampling and test in accordance with Table 13.
5) Perform over-potential test across each gas bottle with the switch in the open position in accordance with the manufacturer's published data.
6) Verify open and close operation from control devices, if applicable.

(c) Test Values:
1) Bolt-torque levels shall be in accordance with Table 12 unless otherwise specified by manufacturer.
2) Compare microhm or millivolt drop values to adjacent poles or similar switches. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.
3) Insulation-resistance should be in accordance with manufacturer's published data or Table 1.
4) Critical distances of operating mechanism should be in accordance with manufacturer's published data.
5) The gas interrupters shall withstand the over-potential voltage applied.
6) Insulation shall withstand over-potential test voltage applied.
7) SF6 gas should have values in accordance with Table 13.

(16) Medium-Voltage Surge Arresters:
(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment and grounding.
4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
5) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
6) Verify the stroke counter is correctly mounted and electrically connected, if applicable.
7) Record stroke counter reading.

(b) Electrical Tests:
1) Perform resistance measurements through bolted connections.
2) Perform insulation-resistance test in accordance with Table 1.
3) Test grounding connection with a point-to-point resistance test.
4) Perform a watts-loss test.

(c) Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare microhm or millivolt drop values to manufacturer's published data. In the absence of manufacturer's data, compare similar units. Investigate deviations of more than 50% from lowest value.
3) Insulation resistance should be in accordance with manufacturer's published data or Table 1.
4) Resistance between the arrester ground terminal and ground shall be less than 0.5 ohm.

5) Compare watts-loss to similar units.

(17) Network Protectors – 600V Class:

(a) Visual and Mechanical Inspection:

1) Open protector and rack it out of enclosure. Note network bus and transformer generally will be energized. Exercise extreme caution. Observe clearance and check for smoothness of operation when racking.
2) Compare equipment nameplate data with drawings and specifications.
3) Inspect physical and mechanical condition.
4) Inspect anchorage, alignment and grounding.
5) Confirm correct application of manufacturer's recommended lubricants.
6) Inspect enclosure door gasket and sight glass for damage.
7) Inspect interior of enclosure for debris or damaged components. Inspect insulating components, current-carrying parts, and secondary disconnecting devices. Exercise extreme caution when working around network bus conductors.
8) Check for missing parts on protector. Check tightness of electrical and mechanical connections. Tighten as necessary according to manufacturer's published data.
9) Inspect insulating barriers for damage and correct mounting.
10) Inspect network protector fuse covers, fuses, and blown fuse indicators for damage. Inspect closing motor brushes and commutator surface for damage. Inspect motor brake mechanism, if applicable.
11) Remove and inspect arc chutes for damage.
12) Verify sequence of main and arcing contacts by slow-closing protector. Adjust as necessary according to manufacturer's published data.
13) Manually open and close protector and verify mechanism latches correctly in each position. Verify correct operation of position indicator.
14) Verify electrical connections to network and auxiliary relays. Inspect electromechanical relays for freedom of movement of internal parts.
15) Verify electrical connections to auxiliary switches, secondary disconnects, current transformers, voltage transformers, control power transformers, closing motors, contactors, trip coils, loading resistors, and other auxiliary devices.
16) Record the as-found and as-left operations-counter reading.
17) Perform leak test on submersible enclosure in accordance with manufacturer's published data.

(b) Electrical Tests:

1) Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with protector closed and across each open pole. Test duration shall be one minute. Test voltage shall be in accordance with Table 1 or manufacturer's published data.
2) Perform insulation-resistance tests at 1000 VDC for one minute on control wiring and electromechanical components. For units with solid-state components, follow manufacturer's recommendations.
3) Verify current transformer ratios in accordance with paragraph "Instrument Transformers."
4) Measure contact resistance.
5) Measure resistance of each protector power fuse.
6) Measure minimum pickup voltage of motor control relay.
7) Verify motor can charge closing mechanism at minimum voltage specified by manufacturer.
8) Measure minimum pickup voltage of trip actuator. Verify actuator resets correctly.
9) Calibrate network protector relays in accordance with paragraph "Protective Relays."
10) Verify phase rotation, phasing and synchronized operation as required by the application.
11) Perform operational tests:
    1. Verify correct operation of mechanical and electrical interlocks.
    2. Verify trip-free operation.
    3. Verify correct operation of auto-open-close control handle.
    4. Verify protector will close with voltage on transformer side only.
    5. Verify protector will open when source feeder breaker is opened.

(c) Test Values:

1) Insulation-resistance of protector components shall be in accordance with Table 1.
2) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by the manufacturer.

3) Control wiring insulation shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation-resistance less than this table or manufacturer's minimum should be investigated.
4) Contact resistance shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, compare contact resistance to adjacent poles or similar protectors. Investigate deviations of more than 50% of the lowest value.
5) Fuse resistance values shall not deviate by more than 15% of the lowest reading.
6) Minimum voltage to operate trip actuator shall not exceed 7.5% of rated control circuit voltage.
7) Minimum acceptable motor-closing voltage shall not exceed 75% of rated control circuit voltage.
8) Network protector should automatically close upon closing feeder breaker with normal load demand and automatically trip when source feeder breaker is opened.

(18) Automatic Transfer Switches:
(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Confirm correct application of manufacturer's recommended lubricants.
4) Verify manual transfer warnings are attached and visible.
5) Verify tightness of control connections.
6) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
7) Perform thermographic survey of accessible bolted electrical connections in accordance with paragraph "Thermographic Survey."
8) Perform manual transfer operation.
9) Verify positive mechanical interlocking between normal and alternative sources.
10) Inspect anchorage, alignment, grounding and required clearances.
(b) Electrical Tests:
1) Measure contact resistance.
2) Perform insulation-resistance tests, phase-to-phase and phase-to-ground, with switch in both source positions. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data. For control devices that cannot tolerate test voltage, follow manufacturer's recommendation.
3) Verify settings and operation of control devices.
4) Calibrate and set relays and timers in accordance with paragraph "Protective Relays."
5) Verify phase rotation, phasing and synchronized operation as required by the application.
6) Perform automatic transfer tests:
1. Simulate loss of normal power.
2. Return to normal power.
3. Simulate loss of emergency power.
4. Simulate all forms of single-phase conditions.
7) Verify correct operation and timing of following functions:
1. Normal source voltage-sensing relays.
2. Engine start sequence.
3. Time delay upon transfer.
4. Alternate source voltage-sensing relays.
5. Automatic transfer operation.
6. Interlocks and limit switch function.
7. Time delay and retransfer upon normal power restoration.
8. Engine cool down and shutdown feature.
(c) Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Insulation-resistance test voltage and minimum values shall be in accordance with Table 1.
3) Compare microhm values to adjacent poles or similar switches. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.

(19) Motor Control and Motor Control Center:
(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.

2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment and grounding.
4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
5) Verify controller mechanical operations. Inspect gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.
6) Verify motor running protection installed and properly sized.
7) Confirm correct application of manufacturer's recommended lubricants.

(b) Electrical Tests:
1) Perform resistance tests through all bus joints with low-resistance ohmmeter. Any joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.
2) Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground with controller closed and across each open pole. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data. For control devices that cannot tolerate test voltage, follow manufacturer's recommendations.
3) Perform insulation-resistance tests at 1000 VDC on control wiring. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer's recommendations.
4) Test motor protection devices in accordance with manufacturer's published data. In the absence of manufacturer's data, use paragraph "Protective Relays."
5) Test circuit breakers in accordance with paragraph "Low-Voltage Insulated-Case/Molded-Case Circuit Breakers."
6) Perform operational tests by initiating control devices.

(c) Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare bus connection resistances to values of similar connections.
3) Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation-resistance less than this table or manufacturer's minimum should be investigated.
4) Motor protection parameters shall be in accordance with manufacturer's published data.

(20) Ground Fault Protection Systems:

(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Visually inspect components for damage and errors in polarity or conductor routing:
1. Verify ground connection is made ahead of neutral disconnect link and on line side of any ground fault sensor.
2. Verify neutral sensors are connected with correct polarity on both primary and secondary.
3. Verify all phase conductors and neutral pass through sensor in same direction for zero sequence systems.
4. Verify grounding conductors do not pass through zero sequence sensors.
5. Verify grounded conductor is solidly grounded.
3) Verify tightness of accessible bolted electrical connections, including control circuits, by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
4) Verify correct operation of self-test panel.
5) Set pickup and time-delay settings in accordance with settings provided on drawings and in specifications. Record operation and test sequences as required by NFPA 70.
6) Verify the control power transformer has adequate capacity for the system.

(b) Electrical Tests:
1) Measure system neutral-to-ground insulation resistance with neutral disconnect link temporarily removed. Replace neutral disconnect link after testing.
2) Perform insulation-resistance test of control wiring at 1000 VDC for one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer's recommendations.
3) Perform the following pickup tests using primary injection:
1. Verify relay does not operate at 90% of pickup setting.
2. Verify pickup is less than 125% of setting or 1200 amp, whichever is smaller.

4) For summation type systems using phase-neutral current transformers, verify correct polarities by applying current to each phase-neutral current transformer pair. This test also applies to molded-case breakers using external neutral current transformer.
    1. Relay should operate when current direction is the same relative to polarity marks in the two current transformers.
    2. Relay should not operate when current direction is opposite relative to polarity marks in the two current transformers.
5) Measure time delay of the relay at 150% or greater of pickup.
6) Verify reduced voltage tripping capability: 55% for AC systems and 80% for DC systems.

(c) Test Values:
1) System neutral-to-ground insulation shall be minimum of one megohm.
2) Insulation resistance values shall be in accordance with Table 1.
3) Relay timing shall be in accordance with manufacturer's specifications but must also be no longer than one second at 3000 amp.
4) Bus bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.

(21) Grounding Systems:
(a) Visual and Mechanical Inspection:
1) Verify ground system is in compliance with drawings, specifications, and NFPA 70.
2) Inspect physical and mechanical condition.
3) Inspect anchorage.

(b) Electrical Tests:
1) Perform fall-of-potential or alternative test in accordance with ANSI/IEEE 81 on the main grounding electrode or system.
2) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
3) Make resistance measurements in dry weather not earlier than 48 hours after rainfall.

(c) Test Values:
1) The resistance between the main grounding electrode and ground should be no greater than five ohms. (Reference ANSI/IEEE 142.) Investigate any values above five ohms and notify Engineer immediately for further instructions.
2) Investigate point-to-point resistance values that exceed 0.5 ohm.

(22) Protective Relays (as applicable):
(a) Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect relays and cases for physical damage. Remove shipping restraint material.
3) Tighten case connectors. Inspect cover for correct gasket seal. Clean cover glass. Inspect shorting hardware, connection paddles, and knife switches. Remove foreign material from case. Verify target reset.
4) Inspect relay for foreign material, particularly in disc slots of damping and electromagnets. Verify disk clearance. Verify contact clearance and spring bias. Inspect spiral spring convolutions. Inspect disk and contacts for freedom of movement and correct travel. Verify tightness of mounting hardware and connections. Burnish contacts. Inspect bearings and pivots.
5) Set relays in accordance with coordination study supplied.

(b) Electrical Tests:
1) Perform insulation-resistance test on each circuit-to-frame. Determine from manufacturer's instructions allowable procedures for this test for solid-state and microprocessor-based relays.
2) Inspect targets and indicators. Determine pickup and dropouts of electromechanical targets. Verify operation of light-emitting diode indicators. Set contrast for liquid-crystal display readouts.
3) Functional Operation:
    1. IEEE 2/62 Timing Relay
        a. Determine time delay.
        b. Verify operation of instantaneous contacts.
    2. IEEE 21 Distance Relay
        a. Determine maximum reach.
        b. Determine maximum torque angle.
        c. Determine offset.

d. Plot impedance circle.

3. IEEE 24 V/Hz Relay
   a. Determine pickup frequency at rated voltage.
   b. Determine pickup frequency at second voltage level.
   c. Determine time delay.
4. IEEE 25 Sync Check Relay
   a. Determine closing zone at rated voltage.
   b. Determine maximum voltage differential that permits closing at zero degrees.
   c. Determine live line, live bus, dead line, and dead bus set points.
   d. Determine time delay.
   e. Verify dead bus/live line, dead line/live bus and dead bus/dead line control functions.
5. IEEE 27 Undervoltage Relay
   a. Determine dropout voltage.
   b. Determine time delay.
   c. Determine time delay at second point on timing curve for inverse time relays.
6. IEEE 32 Directional Power Relay
   a. Determine minimum pickup at maximum torque angle.
   b. Determine closing zone.
   c. Determine maximum torque angle.
   d. Determine time delay
   e. Verify time delay at second point on timing curve for inverse time relays.
   f. Plot operating characteristic.
7. IEEE 40 Loss of Field (Impedance) Relay
   a. Determine maximum reach.
   b. Determine maximum torque angle.
   c. Determine offset.
   d. Plot impedance circle.
8. IEEE 46 Current Balance Relay
   a. Determine pickup of each unit.
   b. Determine percent slope.
   c. Determine time delay.
9. IEEE 46N Negative Sequence Current Relay
   a. Determine negative sequence alarm level.
   b. Determine negative sequence minimum trip level.
   c. Determine maximum time delay.
   d. Verify two points on (I2)2t curve.
10. IEEE 47 Phase Sequence or Phase Balance Voltage Relay
    a. Determine positive sequence voltage to close normally open contact.
    b. Determine positive sequence voltage to open normally closed contact (undervoltage trip).
    c. Verify negative sequence trip.
    d. Determine time delay to close normally open contact with sudden application of 120% of pickup.
    e. Determine time delay to close normally closed contact upon removal of voltage when previously set to rated system voltage.
11. IEEE 49R Thermal Replica Relay
    a. Determine time delay at 300% of setting.
    b. Determine second point on operating curve.
    c. Determine pickup.
12. IEEE 49T Temperature (RTD) Relay
    a. Determine trip resistance.
    b. Determine reset resistance.
13. IEEE 50 Instantaneous Overcurrent Relay
    a. Determine pickup.

b. Determine dropout.
c. Determine time delay.

14. IEEE 51 Time Overcurrent
    a. Determine minimum pickup.
    b. Determine time delays at 2 points on time current curve.
15. IEEE 55 Power Factor Relay
    a. Determine tripping angle.
    b. Determine time delay.
16. IEEE 59 Overvoltage Relay
    a. Determine overvoltage pickup.
    b. Determine time delay to close contact with sudden application of 120% of pickup.
17. IEEE 60 Voltage Balance Relay
    a. Determine voltage difference to close contacts with one source at rated voltage.
    b. Plot operating curve for relay.
18. IEEE 63 Transformer Sudden Pressure Relay
    a. Determine rate-of-rise or pickup level of suddenly applied pressure in accordance with manufacturer's specifications.
    b. Verify operation of 63 FPX seal-in circuit.
    c. Verify trip circuit to remote breaker.
19. IEEE 64 Ground Detector Relay
    a. Determine maximum impedance to ground causing relay pickup.
20. IEEE 67 Directional Overcurrent Relay
    a. Determine directional unit minimum pickup at maximum torque angle.
    b. Determine closing zone.
    c. Determine maximum torque angle.
    d. Plot operating characteristics.
    e. Determine overcurrent unit pickup.
    f. Determine overcurrent unit time delay at 2 points on time current curve.
21. IEEE 79 Reclosing Relay
    a. Determine time delay for each programmed reclosing interval.
    b. Verify lockout for unsuccessful reclosing.
    c. Determine reset time.
    d. Determine close pulse duration.
    e. Verify instantaneous overcurrent lockout.
22. IEEE 81 Frequency Relay
    a. Verify frequency set points.
    b. Determine time delay.
    c. Determine undervoltage cutoff.
23. IEEE 85 Pilot Wire Monitor
    a. Determine overcurrent pickup.
    b. Determine undercurrent pickup.
    c. Determine pilot wire ground pickup level.
24. IEEE 87 Differential
    a. Determine operating unit pickup.
    b. Determine operation of each restraint unit.
    c. Determine slope.
    d. Determine harmonic restraint.
    e. Determine instantaneous pickup.
    f. Plot operating characteristics for each restraint.

(c) Control Verification:

1) Verify each relay contact performs its intended function in control scheme including breaker trip tests, close inhibit tests, 86 lockout tests, and alarm functions.
2) For microprocessor-based relays, verify all inputs, outputs, internal logic, and timing elements used in protection, metering, and control functions.

(d) Systems Tests:

1) After the equipment is energized, measure magnitude and phase angle of inputs and compare to expected values.

(e) Test Values:

1) When not otherwise specified, use manufacturer's recommended tolerances.

2) When critical test points are specified, relay should be calibrated to those points even though other test points may be out of tolerance.

(23) Instrument Transformers:

(a) Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.

2) Inspect physical and mechanical condition.

3) Verify correct connection of transformers with system requirements.

4) Verify adequate clearance between primary and secondary circuit wiring.

5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.

6) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."

7) Verify required grounding and shorting connections provide contact.

8) Verify correct operation of transformer withdrawal mechanism and grounding operation.

9) Verify correct primary and secondary fuse sizes for potential transformers.

10) Confirm correct application of manufacturer's recommended lubricants.

(b) Electrical Tests – Current Transformers:

1) Perform insulation-resistance test of current transformer and wiring-to-ground at 1000 VDC. Do not perform this test on wiring connected to units with solid-state components. Follow manufacturer's recommendations.

2) Perform polarity test of each current transformer.

3) Perform ratio-verification test using voltage or current method in accordance with ANSI/IEEE C57.13.1.

4) Perform excitation test on transformers used for relaying applications in accordance with ANSI/IEEE C57.13.1.

5) Measure current circuit burdens at transformer terminal and determine total burden.

6) When applicable, perform insulation-resistance and dielectric withstand tests on primary winding with secondary grounded. Test voltages shall be in accordance with Tables 5 and 9 respectively.

7) Verify that current circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3.

(c) Electrical Tests – Voltage Transformers:

1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages shall be applied for one minute in accordance with Table 5. For units with solid-state components, follow manufacturer's recommendation.

2) Perform polarity test on each transformer to verify polarity marks or H1-X1 relationship as applicable.

3) Perform turns ratio test on all tap positions, if applicable.

4) Measure potential circuit burdens at transformer terminals and determine total burden.

5) Perform dielectric withstand test on primary windings with secondary windings connected to ground. Dielectric voltage shall be in accordance with Table 9. Test voltage shall be applied for one minute.

(d) Test Values:

1) Insulation-resistance measurement on instrument transformer shall not be less than that shown in Table 5.

2) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by the manufacturer.

3) Polarity results shall agree with system drawings.

4) Compare measured burdens to calculated burdens supplied by Owner.

5) Ratio accuracies shall be within 0.5% of nameplate or manufacturer's published data.

6) Insulation shall withstand over-potential test voltage applied.

(24) Thermographic Survey:

(a) Visual and Mechanical Inspection:

1) Inspect physical, electrical, and mechanical conditions.

2) Remove all necessary covers prior to thermographic inspection.

3) Equipment to be inspected shall include all current-carrying devices. Provide report including the following:
    1. Discrepancies.
    2. Temperature difference between area of concern and reference area.
    3. Cause of temperature difference.
    4. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    5. Identify load conditions at time of inspection.
    6. Provide photographs and thermogram of deficient area.

(b) Test Parameters:
1) Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 2°F at 86°F (1°C at 30°C).
2) Equipment shall detect emitted radiation and convert detected radiation to visual signal.
3) Thermographic surveys should be performed during periods of maximum possible loading but not less than 40% of rated load of the electrical equipment being inspected. Refer to NFPA 70B, Section 20.17 (Infrared Inspection).

(c) Test Results:
1) Temperature differences of 2°F to 5°F (1°C to 3°C) indicate possible deficiency and warrant investigation.
2) Temperature differences of 7°F to 27°F (4°C to 15°C) indicate deficiency, repair as time permits.
3) Temperature differences of 29°F (16°C) and above indicate major deficiency, repair immediately.
4) Suggested actions based on temperature rise can be found in Table 18.

B. Test Reports:
(1) Testing firm shall do the following:
(a) Prepare test report, including description of equipment tested, description of test, test results, conclusions and recommendations, retesting results, list of test equipment used and calibration date.
(b) Show test results in comparison to industry and manufacturer's values and tolerances.
(c) Interpret test results in writing and give recommendations for acceptance or rejection upon consultation with Engineer and prior to energizing equipment.
(d) Assure electrical equipment is operational and within industry and manufacturer's tolerances, and is installed in accordance with contract documents.
(e) Assure suitability of energization.
(f) Report to the Owner and Engineer any system, material, or workmanship that is found defective on the basis of acceptance tests.
(g) Retest equipment when required.
(h) Maintain written record of tests.
(i) Utilize safety practices during the tests in accordance with:
1) Acceptable state and local safety operating procedures
2) Owner's safety practices
3) OSHA
4) NFPA 70E
(j) Perform tests with apparatus de-energized and grounded, except where otherwise specifically required ungrounded by test procedures.
(k) Assemble and certify final test report.
(l) Provide 4 copies of complete test report.
(m) Attach label to all tested equipment with indication of date tested and testing firm name.
(2) Contractor shall do the following:
(a) Investigate, replace, or repair any fault in material or in any part of the installation revealed by the tests.
(b) Deliver one copy of each test report directly to Engineer within 30 days after completion of testing, unless directed otherwise. Insert a copy of each test report in the equipment operation and maintenance manuals.

C. Test Equipment:
(1) Test Instrument Calibration:
(a) Testing firm shall have calibration program that assures test instruments are maintained with rated accuracy.
(b) Instruments shall be calibrated in accordance with the following frequency schedule:
1) Field instruments: Analog, 6 months maximum; Digital, 12 months maximum
2) Laboratory instruments: 12 months

3) Leased specialty equipment: 12 months where accuracy is guaranteed by lessor

(c) Dated calibration labels shall be visible on test equipment.

(d) Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.

(e) Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.

(f) Equipment used for field testing shall be more accurate than instrument being tested.

(g) Calibrating standard applied to testing equipment shall be of higher accuracy than instrument tested.

END OF SECTION 26 08 12

SECTION 26 08 13 - POWER DISTRIBUTION ACCEPTANCE TEST TABLES

TABLE 1
INSULATION RESISTANCE TEST VALUES
ELECTRICAL APPARATUS AND SYSTEMS

Voltage Rating	Minimum DC Test Voltage	Recommended Minimum Insulation Resistance In Megohms
250	500	25
600	1,000	100
1,000	1,000	100
2,500	1,000	500
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
34,500 and above	15,000	100,000

See Table 14 for temperature correction factors.

TABLE 2

SWITCHGEAR LOW-FREQUENCY WITHSTAND TEST VOLTAGES

Type of Switchgear	Rated kV	Maximum Test Voltage kV	
		AC	DC
Low-Voltage Power Circuit Breaker Switchgear	.254	1.6	2.3
	.508	1.6	2.3
	.635	1.6	2.3
MC (Metal-Clad Switchgear)	4.76	14.0	20.0
	8.25	27.0	37.0
	15.0	27.0	37.0
	27.0	45.0	+
	38.0	60.0	+
SC (Station-Type Cubicle Switchgear)	15.5	37.0	+
	38.0	60.0	+
	72.5	120.0	+
MEI (Metal-Enclosed Interrupter Switchgear)	4.76	14.0	20.0
	8.25	19.0	27.0
	15.0	27.0	37.0
	15.5	37.0	52.0
	25.8	45.0	+
	38.0	60.0	+

Derived from ANSI/IEEE C37.20.2-1993, Paragraph 5.5, Metal-Clad and Station-Type Cubicle Switchgear and C37.20.3-1993, Paragraph 5.5, Metal-Enclosed Interrupter Switchgear, and includes 0.75 multiplier with fraction rounded down.

The column headed “DC, Maximum Test Voltage kV” is given as a reference only for those using DC tests to verify the integrity of connected cable installations without disconnecting the cables from the switchgear. It represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for voltage rating of switchgear. The presence of this column in no way implies any requirement for a DC withstand test on AC equipment or that a DC withstand test represents an acceptable alternative to the low-frequency withstand tests specified in this specification, either for design tests, production tests, conformance tests, or field tests. When making DC tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

Because of the variable voltage distribution encountered when making DC withstand tests, the manufacturer should be contacted for recommendations before applying DC withstand tests to the switchgear. Voltage transformers above 34.5kV should be disconnected when testing with DC. Refer to ANSI/IEEE C57.13-1993 (IEEE Standard Requirements for Instrument Transformers) paragraph 8.8.2.

+ Consult Manufacturer

TABLE 3

RECOMMENDED DISSIPATION FACTOR/POWER FACTOR AT 20°C

LIQUID FILLED TRANSFORMERS, REGULATORS, AND REACTORS

ACCEPTANCE TEST VALUES

Oil, Silicone, and Less-Flammable Hydrocarbon Maximum Value (Percent)	
New Power Transformers and Reactors	0.5%
New Distribution Transformers and Regulators	1.0%
Remanufactured Power Transformers and Reactors	1.0%
Remanufactured Distribution Transformers and Regulators	1.5%

TABLE 4

INSULATING FLUID LIMITS

Table 4.1Test Limits for New Insulating Oil Received in New Equipment		
Mineral Oil		
Test	**ASTM Method**	**# 69 kV and Below**
Test	**ASTM Method**	**# 69 kV and Below**
Dielectric breakdown, kV minimum	D877	30
Dielectric breakdown, kV minimum @ 0.04" (1 mm) gap	D1816	25
Dielectric breakdown, kV minimum @ 0.08" (2 mm) gap	D1816	45
Interfacial tension mN/m minimum	D971 or D2285	38
Neutralization number, mg KOH/g maximum	D974	0.015
Water content, (ppm) maximum	D1533	20
Power factor at 25°C, %	D924	0.05
Power factor at 100°C, %	D924	0.40
Color	D1500	1.0
Visual condition	D1524	Bright and clear
Table 4.2 Test Limits for Silicone Insulating Liquid in New Transformers		
Test	**ASTM Method**	**Acceptable Values**
Dielectric breakdown, kV minimum	D877	30
Visual	D2129	clear, free of particles
Water content, (ppm) maximum	D1533	50
Dissipation/power factor, 60 Hz, % max. @ 25°C	D924	0.1
Viscosity, cSt @ 25°C	D445	47.5 – 52.5
Fire point, °C, minimum	D92	340
Neutralization number, mg KOH/g max.	D974	0.01

ANSI/IEEE C57.111-1989 (R1995), Guide for Acceptance of Silicone Insulating Fluid and Its Maintenance in Transformers, Table 2.

TABLE 4 (CONT.)

INSULATING FLUID LIMITS

Table 4.3 Typical Values for Less-Flammable Hydrocarbon Insulating Liquid Received in New Equipment

ASTM Method	Test	Results		
		Minimum		Maximum
D1816	Dielectric breakdown voltage for 0.08" (2 mm) gap, kV	40	34.5 kV class and below	---
		60	Desirable	
D1816	Dielectric breakdown voltage for 0.04" (1 mm) gap, kV	20	34.5 kV class and below	---
		30	Desirable	
D974	Neutralization number, mg KOH/g	----		0.03
D877	Dielectric breakdown voltage kV	30		----
D924	AC loss characteristic (dissipation factor), % 25°C 100°C	 ---- ----		 0.1 1
D1533B	Water content, (ppm)	----		25
D1524	Condition-visual	Clear		
D92	Flash point (°C)	275		----
D92	Fire point (°C)	300a		----
D971	Interfacial tension, mN/m, 25°C	38		----
D445	Kinematic viscosity, mm^2/s. (cSt), 40°C	1.0 X 10^2(100)		1.3 X 10^2(130)
D1500	Color	----		L2.5

ANSI/IEEE C57.121-1998, IEEE Guide for Acceptance and Maintenance of Less-Flammable Hydrocarbon Fluid in Transformers, Table 3.

The test limits shown in this table apply to less-flammable hydrocarbon fluids as a class. Specific typical values for each brand of fluid should be obtained from each fluid manufacturer.

If the purpose of the HMWH installation is to comply with the NFPA 70 National Electrical Code, this value is the minimum for compliance with NEC Article 450.23.

TABLE 5

TRANSFORMER INSULATION-RESISTANCE

ACCEPTANCE TEST VOLTAGE AND MINIMUM RESULTS

Transformer Coil Rating Type in Volts	Minimum DC Test Voltage	Recommended Minimum Insulation Resistance in Megohms	
		Liquid Filled	Dry
0 - 600	1000	100	500
601 - 5000	2500	1000	5000
5001 - 15000	5000	5000	25000

See Table 14 for Temperature Correction Factors.

NOTE: Since insulation resistance depends on insulation rating (kV) and winding capacity (kVA), values obtained should be compared to manufacturer's test data.

TABLE 6

MEDIUM-VOLTAGE CABLES

ACCEPTANCE TEST VALUES

Table 6.1 DC Test Voltages

Rated Voltage Phase-to-Phase kV	Conductor Sizes AWG or kcmil (mm)	Nominal Insulation Thickness mils (mm)		Maximum DC Field Test Voltages, kV During/After Installation	
		100% Insulation Level	133% Insulation Level	100% Insulation Level	133% Insulation Level
5	8-1000 (8.4-507)	90 (2.29)	115 (2.92)	28	36
	Above 1000 (507)	140 (3.56)	140 (3.56)	28	36
8	6-1000 (13.3-507)	115 (2.92)	140 (3.56)	36	44
	Above 1000 (507)	175 (4.45)	175 (4.45)	36	44
15	2-1000 (33.6-507)	175 (4.45)	220 (5.59)	56	64
	Above 1000 (507)	220 (5.59)	220 (5.59)	56	64
25	1-2000 (42.4-1013)	260 (6.60)	320 (8.13)	80	96
28	1-2000 (42.4-1013)	280 (7.11)	345 (8.76)	84	100
35	1/0-2000 (53.5-1013)	345 (8.76)	420 (10.7)	100	124

Tables derived from ANSI/ICEA S-93-639/NEMA WC 74-2000, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy; ANSI/ICEA S-94-649-2000, Standard for Concentric Neutral Cables Rated 5,000 – 46,000 Volts; ANSI/ICEA S-97-682-2000, Standard for Utility Shielded Power Cables Rated 5,000 – 46,000 Volts; and The Okonite Company, High-Voltage Proof Testing.

The DC field test voltages listed above are intended for cable designed in accordance with ICEA specifications. When older cables or other types/classes of cables or accessories are connected to the system, voltages lower than those shown may be necessary. Consult the manufacturers of the cables and/or accessories before applying the test voltage.

TABLE 6 (CONT.)

MEDIUM-VOLTAGE CABLES

ACCEPTANCE TEST VALUES

Table 6.2 AC Test Voltages					
Rated Voltage Phase-to-Phase kV	**Conductor Sizes AWG or kcmil (mm)**	**Nominal Insulation Thickness mils (mm)**		**AC Test Voltage, kV**	
		100% Insulation Level	**133% Insulation Level**	**100% Insulation Level**	**133% Insulation Level**
Rated Voltage Phase-to-Phase kV	**Conductor Sizes AWG or kcmil (mm)**	**Nominal Insulation Thickness mils (mm)**		**AC Test Voltage, kV**	
		100% Insulation Level	**133% Insulation Level**	**100% Insulation Level**	**133% Insulation Level**
5 kV	8-1000	90 (2.29)	115 (2.92)	18	23
	1001-3000	140 (3.56)	140 (3.56)	28	28
8 kV	6-1000	115 (2.92)	140 (3.56)	23	28
	1001-3000	175 (4.45)	175 (4.45)	35	35
15 kV	2-1000	175 (4.45)	220 (5.59)	35	44
	1001-3000	220 (5.59)	220 (5.59)	44	44
25 kV	1-3000	260 (6.60)	320 (8.13)	52	64
28 kV	1-3000	280 (7.11)	345 (8.76)	56	69
35 kV	1/0-3000	345 (8.76)	420 (10.7)	69	84

Tables derived from ANSI/ICEA S-93-639/NEMA WC 74-2000, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy; ANSI/ICEA S-94-649-2000, Standard for Concentric Neutral Cables Rated 5,000 – 46,000 Volts; ANSI/ICEA S-97-682-2000, Standard for Utility Shielded Power Cables Rated 5,000 – 46,000 Volts.

All AC voltages are RMS values.

TABLE 6 (CONT.)

MEDIUM-VOLTAGE CABLES

ACCEPTANCE TEST VALUES

Table 6.3
Partial Discharge Requirements
for Semiconducting Coating and Tape Designs Only

Rated Circuit Voltage Phase-to-Phase Volts	Minimum Partial Discharge Extinction Level, kV	
	100% Insulation Level	133% Insulation Level
2001-5000	4	5
5001-8000	6	8
8001-15000	11	15

ANSI/ICEA S-93-639/NEMA WC 74-2000, 5-56 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

Table 6.4
Very Low Frequency Testing Levels
0.1 Hz Test Voltage (RMS)

System Voltage Phase-to-Phase(kV) (RMS)	Proof Phase-to-Ground(kV) (RMS)
5	10
15	22
25	33
35	47

TABLE 7

MOLDED-CASE CIRCUIT BREAKERS

VALUES FOR INVERSE TIME TRIP TEST

(AT 300% OF RATED CONTINUOUS CURRENT OF CIRCUIT BREAKER)

Range of Rated Continuous Current Amperes	Maximum Trip Time in Seconds For Each Maximum Frame Rating[1]	
	250V	**251 - 600V**
0-30	50	70
31-50	80	100
51-100	140	160
101-150	200	250
151-225	230	275
226-400	300	350
401-600	----------	450
601-800	----------	500
801-1000	----------	600
1001-1200	----------	700
1201-1600	----------	775
1601-2000	----------	800
2001-2500	----------	850
2501-5000	----------	900

Reproduction of Table 5-3 from NEMA AB 4-1996.

[1] For integrally-fused circuit breakers, trip times may be substantially longer if tested with the fuses replaced by solid links (shorting bars).

TABLE 8

INSTANTANEOUS TRIP SETTING TOLERANCES FOR FIELD TESTING

OF MARKED ADJUSTABLE TRIP CIRCUIT BREAKERS

	Tolerances of High and Low Settings	
Ampere Rating	High	Low
Adjustable	+40%	-30%
Non-adjustable	+25%	-25%

For circuit breakers with nonadjustable instantaneous trips, tolerances apply to the manufacturer's published trip range, i.e., +40% on high side, -30% on low side.

TABLE 9

INSTRUMENT TRANSFORMER DIELECTRIC TESTS

FIELD ACCEPTANCE

Nominal System (kV)	BIL(kV)	Applied Potential Tests Field Test Voltage (kV)	
		AC	DC[1]
0.6	10	3	4
1.2	30	7.5	10
2.4	45	11.25	15
5.0	60	14.25	19
8.7	75	19.5	26
15	95	25.5	34
15	110	25.5	34
25	125	30	40
25	150	37.5	50
34.5	150	37.5	50
34.5	200	52.5	70

Derived from Paragraph 8.8.2 and Tables 2 and 7 of ANSI/IEEE C57.13-1993 (Standard Requirements for Instrument Transformers).

[1] DC potential tests are not recommended for transformers rated higher than 200 kV BIL. DC tests may prove beneficial as a reference for future testing. In such cases the test direct voltage should not exceed the original factory test RMS alternating voltages.

TABLE 10

MAXIMUM ALLOWABLE VIBRATION AMPLITUDE

RPM @60 Hz	Velocity in/s peak	Velocity mm/s	RPM @60 Hz	Velocity in/s peak	Velocity mm/s
3600	0.15	3.8	3000	0.15	3.8
1800	0.15	3.8	1500	0.15	3.8
1200	0.15	3.8	1000	0.13	3.3
900	0.12	3.0	750	0.10	2.5
720	0.09	2.3	600	0.08	2.0
600	0.08	2.0	500	0.07	1.7

Derived from NEMA publication MG 1-1998, Section 7.8.1, Table 7-1. Table is unfiltered vibration limits for resiliently mounted machines. For machines with rigid mounting, multiply the limiting values by 0.8.

TABLE 11

OVERPOTENTIAL TEST VOLTAGES FOR ELECTRICAL APPARATUS OTHER THAN INDUCTIVE EQUIPMENT

Nominal System (Line) Voltage[1] (kV)	Insulation Class	AC Factory Test (kV)	Maximum Field Applied AC Test (kV)	Maximum Field Applied DC Test (kV)
1.2	1.2	10	6.0	8.5
2.4	2.5	15	9.0	12.7
4.8	5.0	19	11.4	16.1
8.3	8.7	26	15.6	22.1
14.4	15.0	34	20.4	28.8
18.0	18.0	40	4.0	33.9
25.0	25.0	50	30.0	42.4
34.5	35.0	70	42.0	59.4
46.0	46.0	95	57.0	80.6
69.0	69.0	140	84.0	118.8

[1] Intermediate voltage ratings are placed in the next higher insulation class.

TABLE 12

U.S. STANDARD

BOLT TORQUES FOR BUS CONNECTIONS

HEAT-TREATED STEEL – CADMIUM OR ZINC PLATED

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (psi)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4	6	8	8
5/16	7	11	15	18
3/8	12	20	27	30
7/16	19	32	44	48
1/2	30	48	68	74
9/16	42	70	96	105
5/8	59	96	135	145
3/4	96	160	225	235
7/8	150	240	350	380
1.0	225	370	530	570

BOLT TORQUES FOR BUS CONNECTIONS

SILICON BRONZE FASTENERS[1]

TORQUE (FOOT POUNDS)

Bolt Diameter in (Inches)	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

[1] Bronze alloy bolts shall have a minimum tensile strength of 70,000 psi.

TABLE 12 (CONT.)

BOLT TORQUES FOR BUS CONNECTIONS

ALUMINUM ALLOY FASTENERS[2]

TORQUE (FOOT POUNDS)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

[2] Aluminum alloy bolts shall have a minimum tensile strength of 55,000 psi.

BOLT TORQUES FOR BUS CONNECTIONS

TORQUE (FOOT POUNDS)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

[3] Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy.

Belleville washers: 302 alloy.

TABLE 13

SF_6 GAS TESTS

Test	Method	Serviceability Limits[a]
Moisture	Hygrometer	Per manufacturer or 200 ppm[b]
SF_6 decomposition byproducts	ASTM D 2685	500 ppm
Air	ASTM D 2685	5000 ppm[c]
Dielectric breakdown Hemispherical contents	0.10" gap at atmospheric pressure	11.5 – 13.5 kV[d]

[a] In the absence of consensus standards dealing with SF6 gas tests, the NETA Standards Review Council suggests the above representative values.

[b] According to some manufacturers.

[c] Dominelli, N. and Wylie, L., Analysis of SF6 Gas as a Diagnostic Technique for GIS, Electric Power Research Institute, Substation Equipment Diagnostics Conference IV, February 1996.

[d] Per Even, F.E., and Mani, G. Sulfur Fluorides, Kirk, Othmer Encyclopedia of Chemical Technology, 4th ed., 11,428, 1994.

Reference: IEC 61634 High-Voltage Switchgear and Controlgear – Use and Handling of Sulfur Hexafluoride (SF6) in High-Voltage Switchgear and Controlgear.

TABLE 14

INSULATION RESISTANCE CONVERSION FACTORS FOR

CONVERSION OF TEST TEMPERATURE TO 20°C

Temperature		Multiplier	
°C	**°F**	**Apparatus Containing Immersed Oil Insulations**	**Apparatus Containing Solid Insulations**
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.25
30	86	1.98	1.58
35	95	2.80	2.00
40	104	3.95	2.50
45	113	5.60	3.15
50	122	7.85	3.98
55	131	11.20	5.00
60	140	15.85	6.30
65	149	22.40	7.90
70	158	31.75	10.00
75	167	44.70	12.60
80	176	63.50	15.80

TABLE 15 (NOT USED)
HIGH-POTENTIAL TEST VOLTAGE
AUTOMATIC CIRCUIT RECLOSERS

Nominal Voltage Class, kV	Maximum Voltage, kV	Rated Impulse Withstand Voltage, kV	Maximum Field Test Voltage, kV, AC
14.4	15.0	95	35
14.4	15.5	110	50
24.9	27.0	150	60
34.5	38.0	150	70
46.0	48.3	250	105
69.0	72.5	350	160

Derived from ANSI/IEEE C37.61-1973(R1992), Standard Guide for the Application, Operation, and Maintenance of Automatic Circuit Reclosers and from C37.60-1981(R1992), Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems.

TABLE 16 (NOT USED)

HIGH-POTENTIAL TEST VOLTAGE

FOR ACCEPTANCE TEST OF LINE SECTIONALIZERS

Nominal Voltage Class, kV	Maximum Voltage, kV	Rated Impulse Withstand Voltage, kV	Maximum Field Test Voltage, kV, AC	DC 15 Minute Withstand (kV)
14.4 (1 Ø)	15.0	95	35	53
14.4 (1 Ø)	15.0	125	42	53
14.4 (3 Ø)	15.5	110	50	53
24.9 (1 Ø)	27.0	125	60	78
34.5 (3 Ø)	38.0	150	70	103

Derived from ANSI/IEEE C37.63-1984(R1990) Table 2 (Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers of AC Systems).

NOTE: Values of AC voltage given are dry test one-minute factory test values.

TABLE 17
DIELECTRIC WITHSTAND TEST VOLTAGES
METAL-ENCLOSED BUS

Type of Bus	Rated kV	Maximum Test Voltage, kV	
		AC	DC
Isolated Phase for Generator Leads	24.5	37.0	52.0
	29.5	45.0	--
	34.5	60.0	--
Isolated Phase for Other than Generator Leads	15.5	37.0	52.0
	25.8	45.0	--
	38.0	60.0	--
Nonsegregated Phase	0.635	1.6	2.3
	4.76	14.2	20.0
	15.0	27.0	37.0
	25.8	45.0	63.0
	38.0	60.0	--
Segregated Phase	15.5	37.0	52.0
	25.8	45.0	63.0
	38.0	60.0	--
DC Bus Duct	0.3	1.6	2.3
	0.8	2.7	3.9
	1.2	3.4	4.8
	1.6	4.0	5.7
	3.2	6.6	9.3

Derived from ANSI/IIEEE C37.23-1987, Tables 3A, 3B, 3C, 3D, and paragraph 6.4.2. The table includes a 0.75 multiplier with fractions rounded down.

NOTE:

The presence of the column headed “DC” does not imply any requirement for a DC withstand test on AC equipment. This column is given as a reference only for those using DC tests and represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for each class of bus.

Direct current withstand tests are recommended for flexible bus to avoid the loss of insulation life that may result from the dielectric heating that occurs with rated frequency withstand testing.

Because of the variable voltage distribution encountered when making DC withstand tests and variances in leakage currents associated with various insulation systems, the manufacturer should be consulted for recommendations before applying DC withstand tests to this equipment.

TABLE 18

THERMOGRAPHIC SURVEY

SUGGESTED ACTIONS BASED ON TEMPERATURE RISE

Temperature difference (TD) based on comparisons between similar components under similar loading	Temperature difference (TD) based upon comparisons between component and ambient air temperatures	Recommended action
1°C to 3°C	1°C to 10°C	Possible deficiency; warrants investigation
4°C to 15°C	11°C to 20°C	Indicates probably deficiency; repair as time permits
-- -- --	21°C to 40°C	Monitor until corrective measures can be accomplished
>15°C	>40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on □T. In the absence of consensus standards for TD, the values in this table will provide reasonable guidelines.

An alternative method of evaluation is the standards-based temperature rating system as discussed in Chapter 8.9.2, Conducting an IR Thermographic Inspection, Electrical Power Systems Maintenance and Testing, by Paul Gill, PE, 1998.

It is a necessary and valid requirement that the person performing the electrical inspection be thoroughly trained and experienced concerning the apparatus and systems being evaluated as well as knowledgeable of thermographic methodology.

TABLE 19

OVERPOTENTIAL TEST VOLTAGES

ELECTRICAL APPARATUS OTHER THAN INDUCTIVE EQUIPMENT

Nominal System (Line) Voltage[a] (kV)	Insulation Class	AC Factory Test (kV)	Maximum Field Applied AC Test (kV)	Maximum Field Applied DC Test (kV)
1.2	1.2	10	6.0	8.5
2.4	2.5	15	9.0	12.7
4.8	5.0	19	11.4	16.1
8.3	8.7	26	15.6	22.1
14.4	15.0	34	20.4	28.8
18.0	18.0	40	24.0	33.9
25.0	25.0	50	30.0	42.4
34.5	35.0	70	42.0	59.4

[a] Intermediate voltage ratings are placed in the next higher insulation class.

TABLE 20

RATED CONTROL VOLTAGES AND THEIR RANGES

FOR CIRCUIT BREAKERS

The maximum voltage is measured at the point of user connection to the circuit breaker (see Notes (9) (10)) with no operating current flowing, and the minimum voltage is measured with maximum operating current flowing.

Rated Control Voltages and their Ranges for Circuit Breakers					
Rated Control Voltage (8)	**Direct Current Voltage Ranges (1)(2) Volts, DC**		**Opening Functions All Types**	**Rated Control Voltage (60 Hz)**	**Alternating Current (1)(2)(3)(5) Closing, Tripping, and Auxiliary Functions**
	Closing and Auxiliary Functions				
	Indoor Circuit Breakers	**Outdoor Circuit Breakers**		**Single Phase**	**SINGLE PHASE**
24	---	---	14-28	120	104-127 (4)
48	38-56	36-56	28-56	240	208-254 (4)
				Polyphase	Polyphase
125	100-140	90-140	70-140		
250	200-280	180-280	140-280	208Y/120	180Y/104-220Y/127
---	---	---	---		
---	---	---	---	240	208-254

Derived from Table 8, ANSI C37.06-2000, AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities.

Rated Control Voltages and their Ranges for Circuit BreakersSolenoid-Operated Devices	
Rated Voltage	**Closing Voltage Ranges for Power Supply**
125 dc	90 – 115 or 105 – 130
250 dc	180 – 230 or 210 – 260
230 ac	190 – 230 or 210 - 260

Notes:

(1) Electrically operated motors, contactors, solenoids, valves, and the like need not carry a nameplate voltage rating that corresponds to the control voltage rating shown in the table as long as these components perform the intended duty cycle (usually intermittent) in the voltage range specified.

(2) Relays, motors, or other auxiliary equipment that function as a part of the control for a device shall be subject to the voltage limits imposed by this standard, whether mounted at the device or at a remote location.

(3) Includes supply for pump or compressor motors. Note that rated voltages for motors and their operating ranges are covered by ANSI/NEA MG-1-1978.

(4) Includes heater circuits.

(5) Voltage ranges apply to all closing and auxiliary devices when cold. Breakers using standard auxiliary relays for control functions may not comply at lower extremes of voltage ranges when relay coils are hot, as after repeated or continuous operation.

(6) Direct current control voltage sources, such as those derived from rectified alternating current, may contain sufficient inherent ripple to modify the operation of control devices to the extent that they may not function over the entire specified voltage ranges.

(7) This table also applies for circuit breakers in gas-insulation substation installations.

(8) For an outdoor circuit breaker, the point of user connection to the circuit breaker is the secondary terminal block point at which the wires from the circuit breaker operating mechanism components are connected to the user’s control circuit wiring.

(9) In cases where other operational ratings are a function of the specific control voltage applied, tests in C37.09 may refer to the “Rated Control Voltage.” In these cases, tests shall be performed at the levels in this column.

(10) For an indoor circuit breaker, the point of user connection to the circuit breaker is either the secondary disconnecting contact (where the control power is connected from the stationary housing to the removable circuit breaker), or the terminal block point in the housing nearest to the secondary disconnecting contact.

(11) Some solenoid operating mechanisms are not capable of satisfactory performance over the range of voltage specified in the standard; moreover, two ranges of voltage may be required for such mechanisms to achieve an acceptable standard of performance.

(12) The preferred method of obtaining the double range of closing voltage is by use of tapped coils. Otherwise, it will be necessary to designate one of the two closing voltage ranges listed above as representing the condition existing at the device location due to battery or lead voltage drop or control power transformer regulation. Also, caution should be exercised to ensure that the maximum voltage of the range used is not exceeded.

END OF SECTION 26 08 13

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 00 00 - General Electrical Requirements

B. Section 26 50 00 - Lighting

1.02 DESCRIPTION OF SYSTEM

A. Provide devices such as wall box dimmers, wall and ceiling-mounted occupancy sensors, ambient light sensors, sensor power packs, etc., as shown on drawings.

B. Openings shall be covered with devices and matching plates.

C. Devices of same type shall be from same manufacturer.

1.03 REFERENCE STANDARDS

A. UL 20 - General Use Snap Switches.

B. UL 773A - Non-Industrial Photoelectric Switches for Lighting Control.

C. UL 924 - Emergency Lighting and Power Equipment

D. NEMA WD 7 - Occupancy Motion Sensors.

1.04 SUBMITTALS

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

B. Shop Drawings shall include:

(1) Bill of material

(2) Schematic diagrams

(3) Suggested manufacturer layouts of all devices including overlays of product range.

C. Samples: One for each type of device and wall plate specified, in each color specified upon request.

D. Manufacturer's Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual locations and type of devices.

(2) Operation and Maintenance Data:

(a) Include in manufacturers' packing label warnings and instruction manuals with labeling conditions.

(b) Include source and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

A. Obtain devices from one source and by single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70 for components and installation.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers:

(1) Wall Box Dimmers: Acuity Brands Controls, Cooper Controls, Hubbell, Leviton, Lutron, Philips (Sunrise Series), Wattstopper

(2) Low Voltage Switches: Acuity Brands Controls, Cooper Controls, Hubbell, Leviton, Lutron, Philips, Wattstopper

(3) Sensors and Power Packs: Acuity Brands Controls, Cooper Controls, Hubbell, Leviton, Lutron, Philips, Wattstopper

(4) UL 924 Emergency Bypass/Control Device: Acuity Brands Controls, Hubbell, Leviton, Wattstopper, LVS

(5) Exterior Photocells: Cooper Controls, Hubbell, Intermatic, Leviton, Paragon, Tork

(6) Timeclocks: Intermatic, Paragon, Tork

(7) Self-Contained Automatic Timer Switches: Acuity Brands Controls, Cooper Controls, Hubbell, Leviton, Philips, Wattstopper

B. It is the responsibility of Electrical Contractor to ensure devices submitted meet or exceed functional intent and design quality standards.

2.02 FABRICATION AND MANUFACTURE

A. Devices shall be UL listed for loads and voltages as indicated in contract drawings and specifications.

2.03 WALL BOX DIMMERS

A. Dimmers shall:

(1) Operate in ambient temperature range of 32°F to 104°F (0°C to 40°C).

(2) Be linear slide or pushbutton preset or programmable dimmers with power-failure memory.

(3) Incorporate separate control of intensity and ON/OFF.

(4) Include voltage compensation circuitry that adjusts firing angle of dimmer to compensate light output for variations in AC line voltage. Dimmers in which firing angle is held constant with varying AC line voltage shall not be acceptable.

(5) Provide smooth and continuous IESNA Square Law Dimming Curve throughout entire dimming range.

(6) Incorporate filter network to minimize interference (RFI) with radio, audio, and video equipment.

(7) Incorporate air-gap switch to meet requirements of UL 20 for air-gap switches in incandescent dimmers.

B. Fluorescent dimmers shall:

(1) Be rated to control 430 mA rapid start, 800 mA high output or 265 mA lamps.

(2) Be approved by ballast manufacturer for control of ballasts provided.

(3) Contain relay to automatically remove power to circuit feeding dimming ballast when dimmer is OFF.

(4) Incorporate circuitry to prevent lights from momentarily “flashing” when dimmer is turned on or OFF.

(5) Different lamp lengths or one and two lamp ballasts on same circuit shall track evenly with no perceptible difference in light levels for same type of lamps.

(6) Dimmers and lamps shall have a dimming range from 100% down to _____% light output.

(7) Refer to Section 26 50 00 - Lighting for solid state dimming ballast specification.

C. LED dimmers shall:

(1) Be approved for use with luminaire and driver.

(2) Provide smooth non-flicker dimming of controlled luminaires.

(3) Be 0-10V type, unless otherwise noted on drawings.

(4) Provide at least 10 steps for continuously dimmed luminaires.

(5) Refer to Section 26 50 00 - Lighting for solid state dimming ballast/driver specification.

2.04 LOW-VOLTAGE SWITCHES

A. Low voltage switches shall:

(1) Mount in a single or double gang box.

(2) Be capable of multi-way switching.

2.05 OCCUPANCY AND VACANCY SENSORS

A. Sensors shall:

(1) Operate with all lamp and ballast combinations; including magnetic, hybrid, and solid-state ballasts/drivers.

(2) Operate with ultrasonic, microphonic, passive infrared or presence technologies as indicated on drawings.

(3) Have visible LED to indicate occupant detection.

(4) Have adjustable time delay or remote relay with a maximum setting of 30 minutes and adjustable sensitivity.

(5) Contain isolated relay with normally open, normally closed, and common outputs for use with HVAC system, data logging, controlled receptacles or other system control options where indicated in contract documents.

(6) Be provided with ceiling, wall or wall switch style mounting as indicated on drawings.

(7) Have daylight filter to ensure PIR sensor is insensitive to short-wavelength waves emitted by the sun.

(8) Incorporate by-pass switch to enable lighting to be turned on if sensor fails.

B. Occupancy Sensor shall:

(1) Provide automatic ON, automatic OFF operation where indicated on drawings.

C. Vacancy Sensor shall:

(1) Provide manual ON, automatic OFF operation where indicated on drawings.

2.06 AMBIENT LIGHT SENSORS

A. Ambient light sensors shall:

(1) Incorporate photoconductive cell to measure light levels between 1 and 1,000 footcandles.

(2) Be adjustable with deadband feature to prevent cycling of lighting from minor changes in cloud cover.

(3) Have adjustable time delay range from 3 to 5 minutes.

(4) Not permit lighting systems to be turned on if enough daylight is present.

(5) Incorporate by-pass switch to enable lighting to be turned on if sensor fails.

2.07 POWER PACKS

A. Sensor power packs shall:

(1) Be self-contained transformer relay modules.

(2) Have universal rated voltage inputs 120-277 VAC, 60 Hz.

(3) Have normally closed dry contacts rated for switching 120-277 volts, 60 Hz. 20 amp loads. Provide 24VDC output capable of controlling low-voltage occupancy sensors.

2.08 EXTERIOR OCCUPANCY SENSORS

A. Exterior occupancy sensors shall:

(1) Be a completely self-contained device capable of detecting presence in the controlled range by detecting changes between infrared energy in motion and the background space.

(2) Utilize passive infrared detection technology and a three level Fresnel lens to increase detection density and accuracy of motion detection.

(3) Be capable of mounting vertically or horizontally onto a standard outdoor junction box or integral to exterior luminaires.

(4) Cover up to 35 ft (10m) with a field of view of 180 degrees or 52.5 ft (16 m) with a field of view of 270 degrees.

(5) Have an operating temperature range of -40°F to 130°F (-40° C to 54°C).

(6) Be IP66 rated for outdoor applications.

(7) Include a built-in light level sensor, adjustable by the user that will keep lights from turning on during daylight hours.

(8) Have user-adjustable time delay settings, including an override ON option that enables controlled lights to be turned on remotely for the length of the time delay.

(9) Be compatible with all electronic ballasts and LED drivers with no minimum load requirements.

(10) Provide _____ control to reduce electric light levels from a minimum of 40% to a maximum of 80% based on area occupancy.

2.09 UL 924 EMERGENCY BYPASS/CONTROL DEVICES

A. UL 924 listed bypass relays shall:

(1) Be UL 924 listed and labeled for connection to both normal and emergency lighting power sources.

(2) Have universal rated voltage inputs 120-277 VAC, 60 Hz.

(3) Have normally closed dry contacts rated for switching 120-277 volts, 60 Hz. 20 amp loads.

(4) Have integral manual test switch.

(5) Have auxiliary isolated normally closed contact for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure.

(6) Have status indication for presence of normal and emergency power sources and current operational mode (normal or emergency).

(7) Utilize zero crossing circuitry to protect relay contacts from the damaging effects of inrush current generated by switching electronic ballast loads.

(8) Be forced into the emergency mode upon loss of normal power sense and turn ON the emergency lighting.

(9) Automatically switch emergency lighting ON/OFF as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting ON regardless of the state of any external control device until normal power is restored.

B. Operational temperature range shall be -40°F to 140°F (-40°C to 60°C).

C. Device shall have universal mounting; surface, above suspended ceiling or recessed.

2.10 EXTERIOR PHOTOCELLS

A. Photocells shall:

(1) Have universal rated voltage inputs 120-277 VAC, 60 Hz.

(2) Be rated for up to 2,000 watts.

(3) Have cadmium sulfide, 1” (25 mm) diameter cell.

(4) Have SPST normally closed contacts.

(5) Have a minimum delay of 3 minutes to prevent false switching.

B. ON/OFF adjustment shall be done by moving light selector with range from 2 to 50 footcandles.

C. Operational temperature range shall be -40°F to 140°F (-40°C to 60°C).

D. Enclosure shall be die cast zinc, gasketed for maximum weatherproofing.

E. Enclosure shall include positioning lug on top.

F. Mounting shall be for 1/2” (16 mm) conduit nipple.

2.11 TIMECLOCKS

A. Timeclocks shall:

(1) Be multi-purpose, 7-day, 365-day advance single and skip a day, combination 2-channel electronic astronomical time clock with SPDT switching configuration.

(2) Have universal rated voltage inputs 120-277 VAC, 60 Hz.

(3) Be capable of programming in AM/PM or 24-hour format by jumper selection or digital setting, in one-minute resolution, using 2 buttons for basic settings.

(4) Have 365-day and/or holiday selection capabilities, with 16 single date and 5 holiday selection options and user selectable daylight savings/standard time functions.

(5) Have 72-hour memory backup with rechargeable battery and charger.

(6) Have manual override, ON/OFF to the next scheduled event, using one button for each channel.

(7) Have operational temperature range of -40°F to 150°F (-40°C to 66°C).

(8) Have a maximum allowed over-ride period no greater than 2 hours.

B. Contacts shall be rated 10 amp resistive at 120/250 VAC, 7.5 amps inductive at 120/250 VAC, 5 amps inductive at 30 VDC and up to 1/2 hp (0.4 kW) at 250 VAC.

C. Display shall be LCD type.

D. Enclosure shall be rated for installation location.

2.12 SELF-CONTAINED AUTOMATIC TIMER SWITCHES

A. Timer switches shall:

(1) Have universal rated voltage inputs 120-277 VAC, 60 Hz.

(2) Be programmable to turn lights OFF after a preset time.

(3) Have a ground wire and ground strap for safety with a latching air gap relay switching mechanism.

(4) Use Zero Crossing Circuitry to increase the relay life, protect from the effects of inrush current.

(5) Be compatible with all electronic ballasts, motor loads, LEDs and LED drivers, compact fluorescent and inductive loads. Triac and other harmonic generating devices shall not be allowed.

(6) Have no minimum load requirement and shall be capable of controlling 0 to 800 watt incandescent, fluorescent @ 100/120 VAC, 50/60 Hz; 0 to 1200 watts fluorescent @ 230/277 VAC, 50/60 Hz; 1/6 hp @ 125 VAC. LED with internal or external driver@ 100/120VAC.

(7) Have the option for light flash warning at five minutes before the timer runs out and again when the countdown reaches one minute.

(8) Have the option for a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.

(9) Have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.

(10) Have a feature that shows the timer’s countdown.

(11) Have the calibration switch for setting time-out, time scroll, one second light flash, and beep warning shall be concealed to prevent tampering of adjustments and hardware.

(12) Have a maximum allowed over-ride period no greater than 2 hours.

(13) Be capable of operating as an ON/OFF switch.

(14) Utilize terminal style wiring.

(15) Have a 100% OFF override switch with no leakage current to the load.

2.13 FINISHES

A. Color:

(1) Wall box dimmers, low-voltage switches, occupancy sensors, ambient light sensors and device cover plates: _____.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install devices at heights scheduled, and as indicated on drawings.

B. Install wall devices vertically on latch side of door within 6” (150 mm) of frame edge, unless otherwise noted.

C. Install ceiling devices as shown on drawings and as recommended by device manufacturer.

D. Ceiling mounted occupancy sensors shall be located minimum of 6 ft (1.8 m) from supply air diffusers.

E. Install devices plumb, level with finished surfaces and free from blemishes.

F. Verify device locations prior to rough in.

G. Control wiring shall be low voltage, Class II wiring, electrically isolated from power wiring by a Class II transformer.

H. Provide separate neutral conductor for each dimmer.

I. Wiring shall be in conduit.

J. Electrical Contractor shall be responsible for final adjustment and testing of all devices.

3.02 TESTING

A. Verify proper location and operation of all devices.

B. Verify dimmers function without:

(1) Producing lamp flicker or audible noise.

(2) Interference of audio and visual equipment.

C. Adjust occupancy sensors for a _____ minute time delay.

D. Adjust occupancy sensor sensitivity such that movement outside range of coverage shall not trigger sensor.

E. Adjust ambient light sensor to maintain illuminance level equal to light level from controlled lighting in the space when no daylight is present or as indicated per drawings. Demonstrate ambient light sensor(s) control lighting as specified.

END OF SECTION 26 09 23

SECTION 26 09 43 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 00 00 - General Electrical Requirements

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

C. Section 26 05 33 - Raceway and Boxes for Electrical Systems

D. Section 26 09 23 - Lighting Control Devices

E. Section 26 27 26 - Wiring Devices

F. Section 26 50 00 - Lighting

1.02 DESCRIPTION OF WORK

A. Network Lighting Control System shall be a complete system for control, configuration, monitoring, and reporting via a computer software interface of lighting systems which meets characteristics and performance requirements as described within this specification.

(1) System shall include system backbone infrastructure, an intelligently distributed digital network of devices that may or may not be integral to luminaires, sensors, switches, relays, and other ancillary devices required for a complete and operable system.

(2) System shall include software interface.

(3) Lighting control system equipment shall be capable of being networked together, enabling communication between devices to provide a fully engineered solution.

(4) System shall be configured using control zones defined by common area and function. Sensing and control devices within zones shall provide lighting control as a stand-alone system if network connectivity or communication between control zones is lost, or where a network system is not required such as back of house spaces.

1.03 REFERENCE STANDARDS

A. NFPA 70 – National Electrical Code; National Fire Protection Association

B. NEMA – National Electrical Manufacturers Association

C. UL 20 – General Use Switches, plug load controls

D. UL 916 – Energy Management Equipment

E. UL 924 –Emergency Lighting Equipment

F. FCC - Federal Communications Commission Standards

G. Local Building and Energy Codes

1.04 SUBMITTALS

A. Bill of Materials: Complete list of parts needed to fully install selected system components.

B. Product Data (for each type of product indicated):

(1) Specification sheets with product descriptions.

(2) Manufacturer’s installation instructions.

(3) Operation and maintenance information for normal and emergency operation.

(4) Manufacturer shall provide rate sheet for onsite support.

C. Shop and Wiring Drawings:

(1) Detailed shop drawings of complete control system to be supplied:

(a) Manufacturer layouts of devices indicating placement of system components and required connections between each, wire counts, and coverage patterns.

(b) One-line diagram(s)

(c) Interconnection diagrams showing field-installed wiring and physical dimensions of each item.

(d) Diagrams showing interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of network protocol.

D. Schedules:

(1) Submit low voltage switch schedule for multi zone switches and controllers showing zones/scenes controlled.

E. Information Technology (IT):

(1) Connection information pertaining to interconnection with facility IT networking equipment and third-party systems shall be submitted.

F. Service Specification Sheets: Documentation indicating general service descriptions, including startup, training, post-startup support, and service contract terms.

G. Warranty: Copy of applicable warranty

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall be NALCTP Certified and experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.

B. Manufacturer Requirements:

(1) Manufacturer shall provide 24/7 telephone support by qualified technicians.

(a) Phone Support: Toll free technical support shall be available.

(b) Remote Support: Manufacturer shall offer remote support capability.

(c) Service Contract: Manufacturer shall offer a Service Contract that packages phone, remote, and onsite support calls for project. Response times for each type of support call shall be indicated in terms of service contract included in bid package.

C. Contractor shall ensure that lighting system control devices and assemblies are compatible and can be integrated into a system that operates as described in lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and controllers shall be resolved between Contractor and system provider, as required to ensure proper system operation and maintainability.

D. Performance Requirements: provide system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.

E. Code Requirements

(1) System components shall be UL listed and certified.

(2) System components shall be FCC /IC compliant.

(3) System components shall be installed in compliance with National Electrical Codes.

(4) Building Codes: Units shall be installed in compliance with applicable, local building codes.

(5) ISO Certification: System components shall be manufactured at ISO 9000 certified plants.

(6) Components and manufacturing facility where product was manufactured must be RoHS compliant.

F. Coordination

(1) Coordinate lighting control components to form an integrated interconnection of compatible components.

(a) Match components and interconnections for optimum performance of lighting control functions.

(2) Coordinate Sequence of Operations, Controls Matrix and Task Tuning Table with Architect/Engineer/Lighting Designer. Provide all programming requirements on lighting plans to be evaluated in system submittal

1.06 SUBSTITUTION REQUESTS

A. Shall be made not less than 10 days prior to bid date and will be evaluated prior to bid.

B. Shall include the following information indicating that proposed substitution is of similar construction quality and assembly and performance

(1) Specified and proposed manufacturer's product data sheet, noting options and features.

(2) Compliance statement consisting of line-by-line comparison that describes differences between specification requirements and equipment being proposed. Comparison shall include complete listing of how proposed equipment differs from that specified with regard to size, quantity, quality, method of control, features and functions, control software functions and installation requirements.

C. Equipment delivery lead time shall not be held as a valid reason for requesting controls system substitution unless lead time from specified manufacturer is in excess of 14 weeks. It shall be sole responsibility of Contractor to determine necessary equipment lead times, deliver submittals for review in a timely fashion, and place orders accordingly to ensure timely delivery.

D. When requesting a substitution, Contractor shall provide pricing for specified system and for proposed alternate, and delta savings to Owner to be realized by accepting proposed alternate. If requested, provide unit pricing for each component type specified to provide a baseline comparison for substitution request.

1.07 DELIVERY, STORAGE & HANDLING

A. Comply with manufacturer’s ordering instructions and lead-time requirements to avoid construction delays.

B. Deliver materials in manufacturer’s original, unopened, undamaged packaging with intact identification labels.

C. Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.08 WARRANTY

A. Provide manufacturer's warranty for a period of not less than five years from date of substantial completion. Warranty shall include all system hardware and software components. Manufacturer shall make available to Owner new parts, upgrades, and/or replacements for the entirety of warranty period following installation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS (ALPHABETICAL)

A. Athena by Lutron

B. nLight by Acuity Brands

C. NX Distributed Intelligence by Current

D. Wattstopper DLM by Legrand

E. Zum by Crestron

2.02 SYSTEM PERFORMANCE REQUIREMENTS

A. Occupancy Sensing:

(1) System shall provide 2 states of occupancy status; occupied or vacant. Based on this status system will adjust lights on or off or to configurable (dimmed) light level as indicated in Sequence of Operations shown on plans.

B. Daylight Control:

(1) Photosensor shall trigger changes to light levels with an adjustable delay time when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions by dimming ballasts and/or drivers.

(2) System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photosensors required.

(3) System shall react gradually and without flicker upon manual override inputs.

C. Time Clock Scheduling:

(1) System shall be programmable for time scheduling lights on or off via control software interface.

(2) Manual adjustments via wall stations or control software shall temporarily override off status imposed by time clock schedule.

(3) Prior to a scheduled lights-off event or expiry of a temporary override, system shall provide short light level drops or flashes as a warning to affected occupants. Warning time shall be programmable via software between 1 and 5 minutes.

(4) System shall automatically adjust for leap year and daylight savings time and shall provide weekly routine and annual holiday scheduling.

(5) System shall allow for scheduling via astronomic timeclock in addition to time of day inputs.

D. Emergency Mode:

(1) Upon loss of utility power, system shall immediately adjust emergency lights to full light output and retain that level until the mode is deactivated. This setting shall override all other inputs.

(2) System shall interface with building emergency monitoring system fire alarm via a single convenient point and not require multiple connections.

E. Firewall Security:

(1) Firewall technology shall be used to separate tenants from lighting control network.

(2) Network lighting control system shall include software technologies (firewall or other acceptable method) and built in policies for digital security that assure vendor and manufacturer maintenance access is separated from tenant's lighting control network and corporate LAN(s). Coordinate technologies and policies with client IT and facility network requirements.

(3) Network lighting control system shall include firewall security technologies to assure integrity of network lighting control system from digital intrusion. Standards for network security shall be manufactured to ISO/IEC 27000 standards.

2.03 LIGHTING CONTROL SOFTWARE

A. Shall provide start-up, configuration, management of the following system features:

(1) Occupancy/Vacancy control including time delays and sensitivity parameters

(2) Daylight control, including light level sensor parameters

(3) Time scheduling

(4) Lighting system zones

B. Shall provide reporting feature capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:

(1) Occupancy data by zone as well as by individual sensor

(2) Building wide occupancy status

(3) Energy Analysis data shall be exportable in CSV.

(4) Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.

C. Shall be used for energy reporting status and complete programming without the need for third party hardware or software.

(1) Software shall provide information on general system settings

(2) System software interface shall notify communication failures to system users.

(3) Software to be cloud based.

D. Shall provide tools that can be accessed via cloud. Tools shall show listed rooms or floor plan and associated control components.

E. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.

F. Programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to software and executed from the included program. Editing shall be available without need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. Program shall indicate status of connected devices on system and a warning indicator if a device goes offline.

2.04 EQUIPMENT

A. System Backbone Equipment

(1) Host PC/Server shall be provided to host controls software and communicate with IP networked devices.

(2) Connections to devices within a wired networked lighting control zone and to backbone components shall be with a single type of low voltage network cable, which shall be compliant with CAT5e specifications or higher.

(3) If a wireless system is selected, _____

(4) Where necessary, system shall provide option of having pre-terminated plenum rated low voltage network cabling supplied with hardware so as to reduce opportunity for improper wiring and communication errors during system installation.

(5) Following proper installation and provision of power, networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of programming mechanism (e.g., software application, handheld remote, pushbutton). The “out of box” default sequence of operations is intended to provide typical sequence of operations so as to minimize system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.

(6) Once software is installed, system shall be able to automatically discover connected devices without requiring any provisioning of system or zone addresses.

(7) Networked devices shall have ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

(8) System shall have ability to control (dim/switch) a group of luminaires with loads up to 16A.

B. Control Devices

(1) Control stations, occupancy sensors, and photosensors shall be low voltage that carry 0-10V control signals for communication.

(a) Wall stations shall:

1) Provide individual button for each zone. There shall be no buttons that are not associated to a zone. If there are 3 zones but a 3-button control station is not available by selected manufacturer, provide (1) 2-button and (1) 1-button controls station.

2) Button/Switch plate shall be capable of labeling/engraving and be white unless otherwise indicated on plans.

3) Have pre-set scene control.

4) Have ability to adjust dimming level for each zone where indicated on plans.

5) Mount in standard size wall box (suitable for multi gang installation) or on mounting brackets for low voltage devices.

6) With the exception of areas with stand-alone controls, system shall connect with wall stations.

(b) Occupancy sensors shall:

1) Use passive-infrared (PIR), or dual technology (DT) with a combination of PIR and microphonic or ultrasonic

2) Have adjustable time delay with a maximum setting of 20 minutes and adjustable sensitivity.

3) Contain isolated or remote relay with normally open, normally closed, and common outputs for use with HVAC system, data logging, controlled receptacles or other system control options where indicated in the contract documents.

4) Be provided with ceiling, wall or wall switch style mounting as indicated on drawings.
5) Have daylight filter to ensure PIR sensor is insensitive to short-wavelength waves emitted by the sun (where applicable).
6) Incorporate by-pass switch to enable lighting to be turned on if sensor fails.
7) Provide automatic on/automatic off or manual on/automatic off as indicated on the Network Controls Sequence of Operations with adjustability through network controls software.

(c) Photosensors shall:
1) Incorporate photoconductive cell to measure light levels between 1 and 1,000 footcandles.
2) Be adjustable with deadband feature to prevent cycling of lighting from minor changes in cloud cover.
3) Have adjustable time delay range from 3 to 5 minutes.
4) System programming shall not permit lighting systems to be turned on if enough daylight is present.
5) Incorporate by-pass switch to enable lighting to be turned on if sensor fails.

(d) Auxiliary Devices
1) Sensor power packs shall:
1. Be self-contained transformer relay modules.
2. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
3. Have dry contact closures rated for switching 120-277 volts, 60 Hz. 20 amp loads.
2) Emergency Bypass/Control Devices shall:
1. UL924 listed and labeled for connection to both normal and emergency lighting power sources.
2. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
3. Have normally closed dry contacts rated for switching 120-277 volts, 60 Hz. 20 amp loads.
4. Have integral manual test switch.
5. Have auxiliary isolated normally closed contact for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure.
6. Have status indication for presence of normal and emergency power sources and current operational mode (normal or emergency).
7. Utilize zero crossing circuitry to protect relay contacts from the damaging effects of inrush current generated by switching electronic ballast loads.
8. Be forced into the emergency mode upon loss of normal power sense and turn ON the emergency lighting at full output.
9. Automatically switch emergency lighting ON/OFF as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting ON regardless of the state of any external control device until normal power is restored.
10. Operational temperature range shall be -40°F to 140°F.
11. Device shall have universal mounting; surface, above suspended ceiling or recessed.

(e) Exterior Photocells
1) Photocells shall:
1. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
2. Be rated for up to 2,000 watts.
3. Have cadmium sulfide, 1” diameter cell.
4. Have SPST normally closed contacts.
5. Have a minimum delay of 3 minutes to prevent false switching.
6. Operational temperature range shall be -40°F to 140°F.
7. Enclosure shall be die cast zinc, gasketed for maximum weatherproofing.
8. Enclosure shall include positioning lug on top.
9. Mounting shall be for 1/2” conduit nipple.

PART 3 - EXECUTION

3.01 PREPARATION

A. Pre-Construction Meeting: Contractor shall meet with lighting equipment supplier, lighting control equipment supplier, and _____ to establish compatibility requirements prior to submitting shop drawings for review.

(1) Verify luminaire-controller compatibility, review exceptions and alternate compliance associated with Specification Conformance Document, and review installation and wiring methodology for optimal function of the control systems.

(2) Confirm cover plate labeling and button engraving prior to submitting info to the factory.

(3) Confirm matched components and interconnections for optimum performance of lighting control functions and as described in design documents.

B. Site Examination: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.

C. Product Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.02 INSTALLATION

A. General

(1) Contractor shall coordinate, receive, mount, connect, and place into operation all equipment. Contractor shall furnish conduit, wire, connectors, hardware, control interfaces, devices, _____ and other incidental items necessary for properly functioning lighting control as described herein and shown on drawings (including control devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire), as well as interconnect wiring between lighting and BMS devices (if required). Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

(2) Contractor shall test that branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize circuits before installation.

(3) Wiring Methods:

(a) Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4".

(b) Wiring within Enclosures: Comply with NEC & CEC. Separate power-limited and non- power-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, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

B. Control Station Installation

(1) Install devices at heights scheduled, and as indicated on drawings. Verify discrepancies prior to rough in.

(2) Install wall devices vertically located as follows:

(a) Where located at single-leaf entry doors, locate within 6" of latch side of frame.

(b) Where located at double-leaf entry doors or entry doors without sufficient space at latch side, locate in nearest wall within 6" of edge of door swing. Door shall not block access to device.

(c) For unusual entry door configurations or devices not at entry doors, locate per plans.

(3) Where multiple wall stations are collocated, gang and provide single faceplate whenever possible.

(4) Install devices plumb, level with finished surfaces and free from blemishes.

C. Sensor Installation

(1) Adjust sensitivity to cover area installed as appropriate for mounting location.

(2) Set time delay on occupancy sensors that are connected to lighting control system as detailed in Sequence of Operations as shown on plans. Time delays shall be controlled via control software.

(3) Install interior photosensor as appropriate for detection type and daylight aperture.

(4) Adjust photosensors to maintained illuminance levels specified in the Sequence of Operations.

(5) Install sensors a minimum of 6' from HVAC diffusers and chilled beams where possible.

3.03 SYSTEM START-UP AND CONFIGURATION

A. Testing

(1) Requests for start-up or technical services shall be at least fifteen (15) business days prior to date desired for service.

(2) System Start-up: Manufacturer shall supply factory trained representatives to start-up lighting control system.

(3) Upon completion of all line, load and interconnection wiring, and after luminaires are installed and lamped, a qualified factory representative shall completely configure and test system.

(4) Test dimming quality:

(a) Check dimmer preset control for proper operation.

(b) Verify dimmers function without producing flicker or audible noise.

(c) Verify dimmers function without interference of audio and visual equipment.

(5) Perform the following field tests and inspections with assistance of a factory-authorized service representative:

(a) Operational Test: After installing wall stations and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

(b) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

1) Set preset light levels for all areas
2) Set time of day Time Clock events
3) Set Astronomic Time Clock events
4) Set all other items required for full system functionality per design intent

(6) Lighting control devices will be considered defective if they do not pass tests and inspections.

(7) Prepare test and inspection reports.

(8) Extended Service Coverage: Maintenance agreements shall be available from manufacturer to provide service for system both during and after warranty period.

(9) Provide Owner's representatives with system operating manuals.

B. Programming

(1) Scene and Level Tuning:

(a) Configure wall stations, sensor functionality, and set system lighting levels to IES recommended target illuminance levels using a light meter calibrated within last 12 months.

(2) Arrange walk-through visits with Owner to fine-tune and develop appropriate additional scenes for system presets.

(a) User interface devices shall have button configuration and programming complete in accordance with contract documents with revisions per shop drawing review process for initial review by users.

(b) Incorporate revisions following user walk-through and provide final engraved buttons.

(3) Performance Verification:

(a) Walk through systems with commissioning agent to demonstrate control system meets design intent.

(b) Review system settings with Owner and adjust as necessary to optimize system performance.

(c) Provide documentation that systems were thoroughly tested.

C. Operation and Maintenance Manuals:

(1) Contractor shall provide Owner with _____ complete copies of Operations and Maintenance manuals. Each manual shall contain at a minimum:

(a) Detailed as-built shop drawings for system installed

(b) Panel schedules for system installed (if applicable)

(c) Any controls station schedules for system installed

(d) Manufacturers cut sheets for equipment installed

(e) Manufacturers complete installation instructions

(f) Programming manuals

(g) System maintenance requirements and maintenance schedules

(h) Manufacturers contact information

(i) Manufacturer's warranty

3.04 TRAINING:

A. Provider of the service shall train facility staff, or end users, responsible for changing lighting characteristics in building in operation of system and to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain lighting controls and software training.

B. Provide minimum of three 4-hour sessions at times stipulated by Owner

C. Training and programming shall be completed prior to job closeout

D. Provide a follow-up visit _____ months after occupancy

END OF SECTION 26 09 43

SECTION 26 12 19 - PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 00 00 - General Electrical Requirements

B. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems

C. Section 26 05 53 - Electrical Systems Identification

D. Section 26 08 12 - Power Distribution Acceptance Tests

E. Section 26 08 13 - Power Distribution Acceptance Test Tables

1.02 DESCRIPTION OF SYSTEM

A. Specification covers 3-phase, liquid-filled, compartmental type, pad-mounted transformers, including tap changers, fuses, and terminations.

1.03 REFERENCE STANDARDS

A. ANSI C57.12.22 - Standard for Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, 3-Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA and Smaller: High Voltage, 34,500Grd/19,920 V and Below; Low-Voltage, 480 V and Below - Requirements.

B. ANSI C57.12.26 - Standard for Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, 3-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, H-V, 34,500 Grd/19,920 V and below; 2500 kVA and Smaller.

C. ANSI C57.12.28 - Pad-Mounted Equipment - Enclosure Integrity.

D. IEEE C57.12.00 - Standard General; Requirements for Liquid - Immersed Distribution, Power, and Regulating Transformers.

E. UL 340 - Tests for Comparative Flammability of Liquids.

F. 10 CFR 431.196 (b) (2) – Energy Conservation Standards and Their Effective Dates

1.04 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: ABB, Eaton Cooper, ABB-GE Industrial Solutions, RTE, Schneider Square D

B. Rating of transformer(s) shall be _____:

(1) kVA: _____

(2) Primary Voltage: _____ kV _____

(3) BIL: _____ kV

(4) Secondary Voltage: _____ _____

(5) Impedance: _____

(6) Temperature Rise: _____ (over 86°F (30°C) average ambient temperature)

ANSI Standard Insulation Levels kV-BIL					
	5kV	**8kV**	**15kV**	**27kV**	**38kV**
HV	60	75	95	125	150
LV (600V max)	30	30	30	30	30

Base kVA Rating	**Transformer kVA Ratings 3 - Phase**				**Sound Levels Decibels**	
	OA 131°F (55°C)	**OA 149°F (65°C)**	**FA 131°F (55°C)**	**FA 149°F (65°C)**	**OA**	**FA**
300	300	336	NA	NA	55	NA
500	500	560	NA	NA	56	67
750	750	840	862	966	58	67
1000	1000	1120	1150	1288	58	67
1500	1500	1680	1725	1932	60	67
2000	2000	2240	2300	2576	61	67
2500	2500	2800	3125	3500	62	67
3000	3000	3360	3750	4200	63	67

Base kVA Rating	Transformer kVA Ratings 3 - Phase				Sound Levels Decibels	
	OA 131°F (55°C)	OA 149°F (65°C)	FA 131°F (55°C)	FA 149°F (65°C)	OA	FA
3500	3500	4200	4690	5250	64	67

2.02 CONSTRUCTION

A. Transformer(s) shall:
   (1) Be compartmental type, self-cooled, tamper-resistant and weatherproof.
   (2) Include sealed tank construction to withstand pressure of 15 psi (105 kPa).
   (3) Include welded cover.
B. Transformer tank and high and low voltage compartments shall be assembled as integral unit.
C. High and low voltage compartments shall be located side by side, separated by a steel barrier.
D. Cooling panels will be provided on back of tank.
E. High voltage compartment shall not be accessible until low voltage door has been opened.
F. Low voltage door shall have 3-point latching mechanism with vault type handle having provisions for single padlock.
G. Provide lifting eyes and jacking pads.
H. Include tank grounding provisions in each compartment.

2.03 FINISH

A. In accordance with ANSI C57.12.28 – Standard for Pad-mounted Enclosure Integrity.

2.04 INSULATING FLUID

2.05 CORE AND COIL CONSTRUCTION

A. Coils shall be wound with _____ windings.
B. Core shall be high grade, grain oriented silicon steel laminations.
C. Core and coil assemblies shall be _____.
D. Internal leads shall be insulated.
E. Manual Tap Changer:
   (1) Provide tap changer, externally operated.
   (2) Tap changer handle shall have provisions for padlocking.
   (3) Tap changer shall be 4-position with four 2-1/2% full capacity taps, _____.

2.06 HIGH VOLTAGE COMPARTMENT

A. Terminations:
   (1) Terminations shall be dead front construction.
   (2) Provide _____ universal load break type bushing wells and parking stands, for _____ feed and mounting accessory equipment.
   (3) Bushing wells shall be externally clamped and externally removable.
   (4) Provide 1 set of load break bushings and 1 load break feed-thru insert for each phase.
   (5) Mount lightning arrestors to one side and phase conductor elbows to other side.
B. High Voltage Switch:
   (1) Provide load break, gang operated, oil immersed switch, with eye for hot stick operation.
   (2) Switch shall be _____.
   (3) Switch shall be stacked deck, spring loaded cam, rotary operated.
C. High Voltage Fusing:
   (1) Provide internal oil immersed cartridge fuses.
   (2) Provide _____ Bay-O-Net type oil immersed fuses.
   (3) Provide _____ Bay-O-Net type oil immersed fuses in series with oil immersed current limiters.
   (4) Provide Bay-O-Net type current limiting fuses.
   (5) Fuses shall have continuous current ratings sized per manufacturer's recommendations for indicated kVA, impedance, and primary voltage.
D. Surge Arrestors:
   (1) Provide 3 distribution class metal oxide varistor type surge arrestors, installed in high voltage compartment and grounded to structure. Connect to incoming load break bushings.

2.07 LOW VOLTAGE TERMINATIONS AND EQUIPMENT

A. Bushings shall be molded epoxy.

B. Externally clamped, blade type spade terminals with 6 hole NEMA spacing.

C. High voltage neutral on Wye-Wye units shall be connected internally to low voltage neutral with provisions for opening this connection for testing.

D. Low voltage neutral bushing shall be fully insulated.

(1) Connect to adjacent ground pad on tank with detachable strap.

E. Accessories:

(1) Each transformer shall be equipped with the following:

(a) Dial type thermometer for indicating top liquid temperature.

(b) Globe valve to serve as drain valve, bottom filler plug connection, and liquid sampling valve.

(c) Globe valve for top filter plug connection and vacuum pump connection.

(d) Pressure vacuum gauge.

(e) Magnetic liquid-level indicator.

(f) Spare fuse pocket with 1 complete set of fuses.

(2) Pressure relief device.

(3) Stainless steel nameplate mounted in low-voltage compartment with the following information:

(a) Serial number and style number.

(b) Graphic representation of high-voltage and low-voltage connections.

(c) kVA ratings at all cooling class ratings and temperature rises.

(d) Transformer impedance at 131°F (55°C) base kVA rating.

(e) Tap changer positions, voltages and full load currents at each tap setting.

(f) Low voltage rating and full load current.

(g) Gallons of liquid in tank and radiators.

(h) Maximum allowable pressure on tank.

(i) Transformer weight with and without oil.

(j) Listing as non-PCB transformer.

F. Labeling:

(1) Provide warning label on outside high voltage compartment door and danger label on inside low voltage compartment door.

2.08 HARDWARE

A. Provide hardware, including bolts, fasteners, caps, plugs, etc. of corrosion resistant materials or plated with corrosion resistant materials.

2.09 TESTING

A. Report of transformer tests shall be submitted for each transformer:

(1) Standard ANSI tests.

(2) Resistance measurements of windings on rated voltage tap of each transformer and at tap extremes of 1 transformer only of given rating on order.

(3) Ratio tests on rated voltage connections and on tap connections.

(4) Phase-relation and polarity tests on rated voltage connections.

(5) No load losses and excitation current at rated voltage on rated voltage connections.

(6) Impedance and load losses at rated current on rated voltage connections of each transformer and on extremes of 1 unit only of given rating on order.

(7) Applied and induced potential tests.

(8) Regulation and efficiency at rated load and voltage.

(9) Insulation resistance tests (high voltage to ground, low voltage to ground, high voltage to low voltage).

B. Temperature test or tests shall be made on 1 unit only of transformers covered by these specifications of given rating, provided that test data is not available from records of temperature tests on duplicate or essentially duplicate transformer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install components as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install transformer level and plumb.

C. Provide means for lifting complete transformer.

D. Bearing surfaces of lifting means shall be free from sharp edges.

E. Provide facilities for guying transformer.

F. Provide lifting means for untanking transformer.

G. Base shall permit rolling (or sliding) in directions of both center lines of transformer and provision shall be made for pulling transformer in these directions.

H. Locate jacking facilities near extreme ends of junction of base segments.

I. Jack ports or lugs shall be so designed that lifting members of jack can be inserted.

J. If liquid filling of any part of transformer is required at job site, supplier shall furnish liquid and job site supervision, and shall furnish or make available suitable filter press and vacuum pump.

3.02 ACCEPTANCE TESTING

A. Acceptance testing to be performed in accordance with Section 26 08 12 - Power Distribution Acceptance Tests and Section 26 08 13 - Power Distribution Acceptance Test Tables.

END OF SECTION 26 12 19

SECTION 26 13 23 - MEDIUM-VOLTAGE PAD-MOUNTED SWITCHGEAR

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide freestanding, self-supporting, pad-mounted switchgear, complete with switches, fuses, bushings, and bus terminals.

1.02 REFERENCE STANDARDS

A. IEEE C37.20.3 - Standard for Metal-Enclosed Interrupter Switchgear

B. IEEE C37.20.4 - Standard for Indoor AC Switches (1KV-38KV) for use in Metal-Enclosed Switchgear

C. IEEE C57.12.28 – Standard for Pad-Mounted Equipment Enclosure Integrity

1.03 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Manufacturers: Eaton Cooper, G & W, S & C Electric, Model PMH, PME or Vista Series

B. Provide pad-mounted gear in accordance with the one-line diagram.

C. Pad-mounted gear (PMH):

(1) Single self-supporting enclosure, containing interrupter switches and power fuses with accessory components, completely factory-assembled.

(2) Enclose interrupter switches and fuses within inner grounded steel compartment.

(3) Equip fuse terminals and bus terminals with compression terminals rated 400 A continuous.

(4) Provide termination compartments as follows:

(a) One for each 3-phase switch

(b) One for each 3-phase set of fuses

(c) One for each 3-phase set of bus terminals

D. Pad-mounted gear (PME):

(1) Single self-supporting enclosure, containing interrupter switches and power fuses with accessory components, completely factory-assembled.

(2) Enclose interrupter switches and fuses within inner grounded steel compartment.

(3) Equip switch terminals with bushings rated 600 A continuous.

(4) Equip fuse terminals and bus terminals with bushing wells rated 200 A continuous for elbow connection.

(5) Mount bushings and bushing wells on walls of inner compartment and extend into termination compartments.

(6) Provide termination compartments as follows:

(a) One for each 3-phase switch

(b) One for each 3-phase set of fuses

(c) One for each 3-phase set of bus terminals

E. Pad-mounted gear (Vista):

(1) Switchgear shall consist of gas-tight tank containing SF6 gas, load-interrupter switches and re-settable fault interrupters with visible open gaps and integral visible grounds, and microprocessor-based overcurrent control.

(2) Equip load-interrupter switch terminals with bushings rated 600 or 900 A continuous, and fault-interrupter terminals with bushing wells rated 200 A continuous or bushings rated 600 or 900 A continuous to provide for elbow connection.

(3) Locate manual operating mechanism and viewing windows on opposite side of tank from bushings and bushing wells so operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables.

F. Ratings (PMH or PME):

(1) Ratings for integrated pad-mounted gear as shown below:

(a) kV, Nominal _____

(b) kV, Maximum _____

(c) kV, BIL _____

(d) Main Bus Continuous, Amperes _____

(e) Three Pole Interrupter Switches

1) Continuous, Amperes _____

2) Load Dropping, Amperes _____
3) Two Time Duty Cycle Fault Closing
4) Amperes Rms Asymmetrical _____

(f) Fuses Maximum, Amperes _____
_____

(g) Short Circuit Ratings
1) Amperes Rms Symmetrical _____
2) Mva Three Phase Symmetrical at rated Nominal Voltage _____

G. Ratings for integrated switchgear as designated below.
(1) Frequency, Hz: _____
(2) Short-Circuit Rating: _____
(3) Amperes, RMS Symmetrical: _____
(4) kV, Maximum: _____
(5) kV, BIL: _____
(6) Main Bus Continuous, Amperes: _____
(7) Three-Pole Load-Interrupter Switches: _____
(8) Continuous, Amperes: _____
(9) Load Dropping, Amperes: _____
(10) Fault-Closing, Duty-Cycle: _____
(11) Three-Time, Amperes RMS Symmetrical: _____
(12) Three-Time, Amperes, Peak: _____
(13) 10-Time, Amperes RMS Symmetrical: _____
(14) 10-Time, Amperes, Peak: _____
(15) Fault Interrupters: _____
(16) Continuous, Amperes: _____
(17) Load Dropping, Amperes: _____
(18) Fault Interrupting, Duty-Cycle: _____
(19) Three-Time, Amperes RMS Symmetrical: _____
(20) Ten-Time, Amperes RMS Symmetrical: _____
(21) Fault-Closing, Duty-Cycle: _____
(22) Three-Time, Amperes RMS Symmetrical: _____
(23) Three-Time, Amperes, Peak: _____
(24) 10-Time, Amperes RMS Symmetrical: _____
(25) 10-Time, Amperes, Peak: _____

H. Momentary and two-time duty-cycle fault-closing ratings of switches, momentary rating of bus and interrupting ratings of fuses shall equal or exceed short circuit ratings of pad-mounted gear.

I. Enclosure:
(1) 11 ga (3.038 mm) steel sheet.
(2) Weld structural joints and butt joints and grind external seams flush and smooth.
(3) Provide base of continuous 90-degree flanges, turned inward and welded at corners for bolting to concrete pad.
(4) Door openings with 90-degree flanges, facing outward.
(5) Provide gasketing between roof and enclosure.
(6) Provide heavy coat of insulating “no-drip” compound to inside surface of roof to minimize moisture condensation.
(7) Provide interrupter switches with dual-purpose front barriers. Barriers, in normal hanging positions, guard against inadvertent contact with live parts. It shall also be possible to lift barriers out and insert them into open gap when switch is open. Barriers shall meet requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).
(8) Provide interrupter switches with window panels to allow viewing of switch position without removing dual-purpose front barriers. Window panels shall be removable to facilitate phasing and secured to enclosure with stainless-steel or zinc-nickel-plated hardware.
(9) Provide each fuse with dual-purpose front barrier. Barriers, in normal hanging positions, guard against inadvertent contact with live parts. It shall also be possible to lift barriers out and insert them into open gaps when fuses are in disconnect position. Barriers shall meet requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

(10) Provide internal steel-enclosed compartment to encase interrupter switches and fuses.
  (a) Provide galvanized steel sheet floor compartment.
  (b) Provide screened floor drain vents.
(11) Provide Insulating barriers of fiberglass-reinforced polyester for each interrupter switch where required to achieve BIL ratings. Additional insulating barriers of same material shall isolate tie bus (where furnished).
(12) SF6 - Gas Insulation
  (a) SF6 gas shall conform to ASTM D2472.
  (b) Fill switchgear with SF6 gas to a pressure of 7 psig at 68°F (48.3 kPa at 20°C).
  (c) Evacuate gas-tight tank prior to filling with SF6 gas to minimize moisture in tank.
  (d) Switchgear shall withstand system voltage at gas pressure of 0 psig at 68°F (0 kPa at 20°C).
  (e) Provide gas-fill valve.
  (f) Provide temperature-compensated pressure gauge color coded to show operating range. Mount gauge inside gas-tight tank (visible through large viewing window) to provide consistent pressure readings regardless of temperature or altitude at installation site.
(13) Gas-Tight Tank
  (a) Provide submersible tank able to withstand up to 10 ft (3m) of water over base.
  (b) Provide tank of welded construction and made of 7 ga mild steel or Type 304 stainless steel, as specified in Section IV.
  (c) Provide means of lifting tank.
(14) Provide full-length steel barriers to separate adjoining termination compartments.

J. Doors:
(1) 11 ga (3.038 mm) steel sheet.
(2) Door-edge flanges shall overlap with door-opening flanges.
(3) Minimum of 2 extruded-aluminum hinges with stainless-steel hinge pins and interlocking extruded-aluminum hinge supports for full length of door. Stainless steel or zinc-nickel plated steel mounting hardware.
(4) Doors hinges at sides.
(5) Door (or set of double doors) equipped with automatic 3-point latching mechanism.
(6) Spring-loaded latching mechanism shall latch automatically when door is closed.
(7) Pentahead socket wrench or tool required to actuate mechanism to unlatch door and, in same motion, recharge spring for next closing operation.
  (a) Provision latching mechanism for padlocking.
(8) Provisions to store spare fuse units or refill units in doors.

K. Finish:
(1) Provide hardware (including door fittings, fasteners, etc.), operating-mechanism parts, and parts subject to abrasive action from mechanical motion of either nonferrous materials or galvanized or zinc-nickel plated ferrous materials.
(2) Do not use Cadmium-plated ferrous parts.

L. Insulators:
(1) Provide cycloaliphatic epoxy resin interrupter-switch, fuse-mounting insulators and main-bus support insulators.

M. Bus:
(1) Bus supports, bus, and interconnections shall withstand stresses associated with short circuits up through maximum rating of switchgear.
(2) Provide ground bus of short circuit rating equal to integrated assembly. In each bay, bolt ground bus to copper-clad steel bracket welded to steel enclosure.
(3) Copper-clad steel brackets (at least one per bay) shall have short-time current-carrying capability with short circuit rating assembly.
(4) Provide 2 ground cable connectors accommodating #2 AWG through 500 kc mil conductors for connection of ground bus to station ground.
(5) Include utility required grounding provisions.

N. Bushings and Bushing Wells:
(1) Provide cycloaliphatic epoxy resin bushings and bushing wells with characteristics and restrictions as follows:
  (a) Adequate leakage distance for in-air application.
  (b) Adequate strength for short-circuit stress established by test.
  (c) Homogeneity of cycloaliphatic epoxy resin throughout each bushing or bushing well to provide maximum resistance to power arcs.

(2) Mount bushings and bushing wells so semi-conductive coating is solidly grounded to enclosure.

(3) Provide bushings rated 600 A continuous with removable threaded stud.

O. Termination Compartments:

(1) Provide switches with bushings and termination compartments.

(2) Provide busing wells to permit connection of elbows.

(3) Provide adequate depth for bushings rated 600 A continuous to accommodate two 600 A elbows mounted piggyback, encapsulated surge arresters or grounding elbows mounted on 600 A elbows having 200 A interfaces.

(4) Provide adequate depth for bushing wells rated 200 A continuous to accommodate 200 A elbows mounted on portable feedthru or standoff insulators.

(5) Provide 1 parking stand for each bushing or bushing well. Locate parking stand immediately adjacent to associated bushing or bushing well and accommodate standard feedthru and standoff insulators.

(6) Equip switch with viewing window to allow visual inspection of interrupter switch blades and allow positive verification of switch position.

(7) Equip fuses with viewing windows to allow visual inspection of blown-fuse indicators.

P. Interrupter Switches:

(1) Use quick-make quick-break mechanism.

(2) Provide two-time duty-cycle fault-closing rating equal to or exceeding short circuit rating of switch gear.

(3) Enclose in inner steel compartment and provide with bushings rated 600 A continuous.

(4) Operate switch with externally accessible 3/4” (19 mm) hex switch-operating hub.

(5) Provide folding switch-operating handle.

(6) Provide contacts backed up by stainless-steel springs for constant high contact pressure.

(7) Single blade per phase. Spring-loaded auxiliary blades are not permitted.

(8) Circuit interruption shall take place completely within interrupter, with no external arc or flame. Vent exhaust in controlled manner through deionizing vent.

Q. Fuses:

(1) Solid-Material Power Fuses

(a) Provide disconnect style, solid-material power fuses, and shall utilize refill-unit-and-holder or fuse-unit-and-end-fitting construction. Refill unit or fuse unit shall be readily replaceable and low in cost.

(b) Provide non-aging and non-damageable fusing elements.

(c) Provide helically coiled fusible elements for refill units or fuse units rated 10 A or larger to avoid mechanical damage due to stresses from current surges.

(d) Support fusible elements that carry continuous current in air to help prevent damage from current surges.

(e) Each refill unit or fuse unit shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.

(f) Fuses shall have melting time-current characteristics that are permanently accurate to within maximum total tolerance of 10% in terms of current. Time-current characteristics shall be available which permit coordination with source-side and load-side protective relays, automatic circuit reclosers, and other fuses.

(g) Provide fuses capable of detecting and interrupting faults whether large, medium, or small (down to minimum melting current), under realistic conditions of circuitry, with line-to-line or line-to-ground voltage across fuse, and capable of handling full range of transient recovery voltage severity associated with these faults.

(h) Contain arcing accompanying operation of solid-material power fuses within fuse. Contain arc products and gases evolved within exhaust control device during fuse operation.

(i) Equip fuses with a blown-fuse indicator that provides visible evidence of fuse operation while installed in fuse mounting.

(2) Electronic Power Fuses

(a) Use electronic power fuses with expendable interrupting module and reusable control module.

(b) Provide interrupting module with main-current section and fault-interrupting section. Arrange sections coaxially and contain within the same housing.

(c) Main-current section shall carry under normal operating conditions.

(d) Fault-interrupting section shall operate only under fault conditions and not carry current continuously and shall not determine minimum operating time-current characteristic curve shape.

(e) Current-limiting-section fusible element shall not be subject to damage due to current surges.

(f) Contain arcing accompanying operation of electronic power fuse within interrupting module; fuse operation shall be silent, without any exhaust.

(3) Fusible elements:

(a) Non-aging and non-damageable

(b) Helically coiled refill units or fuse units to avoid mechanical damage due to stresses from current surges

(c) Support that carries continuous current elements in air

(4) Contain arcing accompanying fuse operation within fuse. Contain arc products and gases within exhaust control device during fuse operation.

(5) Provide access to fuse sections such that replacement of fuses in one compartment shall not require opening of interrupter switch.

(6) Provide fuse handling tool.

(7) Provide spare set of fuses for each switch.

R. Overcurrent Control

(1) Provide microprocessor-based overcurrent control to initiate fault interruption.

(2) Mount control in watertight enclosure. Control removable in field without taking gear out of service.

(3) Provide field-programmable control settings using a personal computer connected via data port to control. Locate data port accessible from exterior of enclosure.

(4) Provide integral current transformers for power and sensing for control.

(5) Minimum total clearing time (from initiation of fault to total clearing) for fault interruption shall be 40 milliseconds (2.4 cycles) at 60 Hz or 44 milliseconds (2.2 cycles) at 50 Hz.

(6) Control shall feature time-current characteristic (TCC) curves including standard E-speed, K-speed, coordinating-speed tap, coordinating-speed main curves, and relay curves per IEEE C37.112-1996. Coordinating-speed tap curves shall optimize coordination with load-side weak-link/backup current-limiting fuse combinations, and coordinating-speed main curves to optimize coordination with tap-interrupter curves.

(7) Provide standard E-speed curve phase-overcurrent settings ranging from 25E through 400E. Standard K-speed curve phase-overcurrent settings ranging from 25K through 200K. Coordinating-speed tap curve phase-overcurrent and independent ground-overcurrent settings ranging from 50 A through 400 A. Coordinating-speed main curve phase-overcurrent and independent ground-overcurrent settings ranging from 100 A through 800 A.

S. Provide steel _____ base spacer to increase elevation of live parts in pad-mounted gear above mounting pad by _____.

2.02 UTILITY METERING

A. Provide separate utility metering _____ with hinged sealable door. Where shown on drawings.

B. Bus work shall include provisions for mounting utility company current transformers and potential transformers, or potential taps as required by utility company.

C. Provide service entrance label and necessary applicable service entrance features.

2.03 OWNERS METERS

A. Provide separate metering compartment with digital meter per requirements in Section 26 27 13 - Electrical Metering.

2.04 LABELING

A. Provide “Caution – High Voltage – Keep Out” signs on external doors and hinged bolted panels providing access to high voltage.

B. Provide “Danger – High Voltage – Qualified Persons Only” signs on internal doors and screen doors providing access to high voltage.

C. Provide warning signs indicating “Switch Blades may be Energized in any Position” on internal doors and screen doors providing access to interrupter switches.

D. Provide nameplate on Integrated switchgear assembly:

(1) Indicating manufacturer's drawing number

(2) Voltage ratings (kV nominal; kV maximum design; kV BIL)

(3) Main bus continuous rating (amperes)

(4) Short-circuit ratings (amperes, rms symmetrical and MVA 3-phase symmetrical at rated nominal voltage)

(5) Momentary and fault-closing ratings (amperes, rms asymmetrical)

E. Provide nameplate in each bay indicating:

(1) Ratings of interrupter switch (amperes continuous and interrupting)

(2) Maximum rating of power fuse in amperes

(3) Catalog number of fuse units or refill units

F. Submit identification to Owner/Engineer for approval.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment per manufacturer's recommendations and as indicated.

B. Coordinate final locations with General Contractor and review final locations with Engineer prior to setting equipment.

C. Protect equipment during installation to prevent twisting or deformations, exposure to damaging environments, and work of other trades. Maintain protection until completion of construction.

D. Prior to energizing, factory representative shall visually inspect switchgear installation to verify switches are operable and bus connections are complete.

E. Test switch operators at least once after energizing.

3.02 ADJUSTMENTS AND CLEANING

A. Immediately prior to final inspection, make final adjustments and thoroughly clean equipment.

B. Refinish damaged enclosures to original quality.

3.03 CONNECTIONS

A. Provide cable terminations at switchgear - Section 26 05 13 - Medium-Voltage Cables.

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

C. Provide ground equipment - Section 26 05 26 - Grounding and Bonding for Electrical Systems.

D. Provide connect wiring - Sections 26 05 19 - Low-Voltage Electrical Power Conductors and Cables and Section 26 05 13 - Medium-Voltage Cables.

3.04 ACCEPTANCE TESTING

A. Perform acceptance testing - Section 26 08 12 - Power Distribution Acceptance Tests and Section 26 08 13 - Power Distribution Acceptance Test Tables.

B. Adjust or replace equipment as needed to comply with manufacturer's specifications and submit new test reports.

END OF SECTION 26 13 23

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 26 05 33 - Raceway and Boxes for Electrical Systems
E. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
F. Section 26 05 53 - Electrical Systems Identification
G. Section 26 08 12 - Power Distribution Acceptance Tests
H. Section 26 08 13 - Power Distribution Acceptance Test Tables

1.02 DESCRIPTION

A. Section includes dry type distribution and buck-boost transformers rated 600V and less, with capacities up to 300 kVA.

1.03 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting
B. IEEE C57.12.91 – Test Code for Dry Type Distribution and Power Transformers
C. NEMA EN 10250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
D. NEMA ST 1 – Specialty Transformers (except General Purpose Type)
E. NEMA ST 20 – Dry-Type Transformers for General Applications
F. NFPA 70 – National Electrical Code
G. UL 506 – Specialty Transformers
H. UL 1561 – Dry-Type General Purpose and Power Transformers
I. 10 CFR 431, Subpart K (a) (2) – Energy Conservation Standards and Their Effective Dates

1.04 SUBMITTALS

A. Product Data:
   (1) Include rated nameplate data, capacities, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
B. Shop Drawings:
   (1) For each transformer size and type:
      (a) Physical dimensions, including bolting templates, weight, and center of gravity
      (b) Loads, method of field assembly, components, and location and size of each field connection
      (c) Wiring Diagrams: Power, signal, and control wiring
      (d) kVA rating
      (e) Primary taps
      (f) Insulation class and temperature rise
      (g) Efficiency values measured at 0, 25, 50, 75, and 100% load
      (h) Impedance value – X/R and %Z
      (i) Sound level
      (j) “K” factor listing, where applicable
C. Submit 1/4” (1:50) scale electrical room floor plans with transformer locations.
D. Manufacturer’s Installation Instructions:
   (1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
F. Output Settings Report: Record output voltages and tap settings.
G. Closeout Submittals:
   (1) Project Record Documents:

(a) Record actual locations of transformers.

(2) Operation and Maintenance Data:

(a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include manufacturer's Seismic Qualification Certification, Installation Seismic Qualification Certification, manufacturer's Ultra Quiet Transformers Sound Level Certification, where applicable, and Output Settings Report.

1.05 QUALITY ASSURANCE

A. Obtain transformers from one source and by single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70 for components and installation.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Certifications:

(1) Furnish Engineer with manufacturer's Seismic Qualification Certification: Submit certification that transformers, accessories, and components will remain _____ to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems. Include the following:

(a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

(2) Furnish Engineer with manufacturer's Ultra Quiet Transformers Sound Level Certification, where applicable: Submit certification that ultra quiet transformers have sound level not exceeding 35 dB. Submit for each ultra quiet transformer. Include the following:

(3) Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculations.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Square D

B. ABB-GE Industrial Solutions

C. Eaton Cutler-Hammer

D. Siemens

2.02 DISTRIBUTION TRANSFORMERS

A. Fabrication:

(1) NEMA ST 20, UL 1561

(2) Factory assembled and tested

(3) Air-cooled, for 60 Hz service

(4) Two winding dry type

(5) Coils:

(a) Continuous wound construction and impregnated with non-hydroscopic, thermosetting varnish.

(b) Conductors: Continuous windings without splices, except for taps, and encapsulated wire resin compound to seal out moisture and air.

(c) Materials: _____

(d) Separate primary and secondary

(e) Internal Connections: Braised or pressure type

(6) Cores: High-grade silicon steel, non-aging, with high magnetic permeability, low eddy current losses and low hysteresis. Magnetic flux densities below saturation point. Core laminations clamped with steel members, one leg per phase.

(7) Rubber vibration absorbing mounts to isolate base of enclosure from core and coil assembly.

(8) Transformer neutral visibly grounded to enclosures with flexible grounding conductor.

B. Enclosure:

(1) NEMA EN 10250

(2) _____, unless otherwise indicated to comply with environmental conditions at installed location.

(3) Code-gauge steel panel over core and coil.

(4) Ventilated (air-cooled): Louvered openings for convection cooling.

(5) Cooling and terminal chamber access with both sides and rear obstructed.

(6) Manufacturer's lifting eyes or brackets.

(7) Finish: Manufacturer's standard gray enamel over prime coat after being degreased, cleaned, and phosphatized.

C. Ratings:

(1) KVA Rating: 300 kVA maximum

(2) Primary Voltage: _____.

(3) Secondary Voltage: _____.

(4) Insulation Class and Winding Temperature Rise:

(a) Transformers 15kVA and smaller: Class 185°C, with 115°C temperature rise above 40°C ambient temperature, capable of carrying 15% continuous overload without exceeding 150°C rise.

(b) Transformers 25kVA – 112.5kVA: Class 220°C, with 115°C temperature rise above 40°C ambient temperature, capable of carrying 15% continuous overload without exceeding 150°C rise.

(c) Transformers above 112.5kVA: Class 220°C, with 80°C temperature rise above 40°C ambient temperature, capable of carrying 30% continuous overload without exceeding 150°C.

(5) Top of Enclosure Temperature: Maximum 35°C above 40°C ambient temperature at warmest point at full load.

(6) K-Factor Rating: UL 1561, as indicated.

D. Primary Taps:

(1) Transformers rated less than 3kVA: _____.

(2) Transformers rated 3kVA - 15kVA: _____.

(3) Transformers rated 15kVA and larger: Two 2.5% above and two 2.5% below normal full capacity, minimum of four taps.

E. Energy Efficiency:

(1) Transformers rated 15kVA and larger, except K-rated, quiet type and ultra quiet type:

(a) 10 CFR 431, Subpart K .196 (a) (2) compliant

F. Sound Levels:

(1) NEMA ST 20, maximum average sound levels as follows:

(a) 45 dB for general-purpose transformer sizes less than 51kVA.

(b) 50 dB for general-purpose transformer sizes 51-150kVA.

(c) 55 dB for general-purpose transformer sizes 151-300kVA.

(2) Minimum of 3 dB less than NEMA ST 20. Maximum average sound levels when factory tested according to IEEE C57.12.91 as follows:

(a) 42 dB for quiet type transformer sizes less than 51kVA.

(b) 47 dB for quiet type transformer sizes 51-150kVA.

(c) 52 dB for quiet type transformer sizes 151-300kVA.

(3) Maximum average sound levels, when factory tested according to IEEE C57.12.91, as follows:

(a) 35 dB for ultra quiet transformers, for all sizes through 300kVA.

G. Electrostatic Shielding, where indicated: Each winding with an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

(1) Coil leads and terminal strips arranged to minimize capacitive coupling between input and output terminals.

(2) Special terminal included for grounding the shield.

(3) Shield Effectiveness:

(a) Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

(b) Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.

(c) Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

2.03 BUCK-BOOST TRANSFORMERS

A. Description: NEMA ST 1, UL 506, UL 1561, same as distribution transformers, except rated for continuous duty and with wiring terminals suitable for connection as autotransformer.

B. Enclosure: Ventilated, NEMA EN 10250, Type 2.

(1) Finish Color: _____.

2.04 LUGS

A. Manufacturer's primary and secondary bolted lugs: labeled for 75°C copper and aluminum conductors for ventilated enclosures and labeled for 90°C copper and aluminum conductors for non-ventilated enclosures.

B. Connections at sides near bottom, accessible from front of cabinet.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.

B. Examine areas and surface to receive transformers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify space indicated for transformers' mounting meets code-required working clearances.

D. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

E. Verify that ground connections are in place and requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems have been met.

F. Verify with manufacturer that "touch-up" paint kit is available for repainting.

3.02 INSTALLATION

A. Install transformers in accordance with ANSI/NECA 1.

B. Install level and plumb within 1/2 degree, and at least 6" (150 mm) from the adjacent wall or structure to ensure proper ventilation, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices.

C. Transformer mounting, seismic restraints, and vibration control:

(1) Install transformer anchorage devices, seismic restraints and vibration control based on design by an Engineer registered and licensed in the _____ of _____, and to comply with Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems for seismic criteria.

(2) Mount transformers _____.

(3) Floor mounting:

(a) Secure to floor via isolation pads between floor brackets (per manufacturer recommendations) and transformer.

(b) Mount on spring isolator.

(4) Wall mounting:

(a) Secure to concrete-and-block wall via isolation pads between wall brackets (fabricated by manufacturer) and transformer.

(b) Secure to gypsum walls with independent steel slotted channel supports, secured to floor via isolation pads between wall brackets (fabricated by manufacturer) and transformer.

(c) Mount on spring isolator.

(5) Suspended mounting:

(a) Suspend transformer enclosures designed for floor mounting, where suspended from structural ceiling, via trapeze constructed of steel slotted channel support system hung via 3/8" (9 mm) minimum steel threaded hanger rods attached to structural members or inserts in structural slab. Each rod to contain spring isolator ceiling hanger. Use locking type nuts in assembly.

(b) Install restraint cables sway bracing sized to resist a horizontal force of 162% of the operating weight acting in any direction for normal power transformers and 212% of the operating weight for emergency/standby power transformers.

(c) Anchor and fasten transformers and their supports to building structural elements by the methods described in Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification. Attach nameplate to transformer using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.

(1) Indicate kVA rating, voltage/phase rating, taps, insulation class and temperature rise, impedance value, sound level, and K-factor listing.

E. Install conduit per requirements in Section 26 05 33 - Raceway and Boxes for Electrical Systems.

F. Install transformer in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

3.03 CONNECTIONS

A. Ground transformers according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.04 FIELD QUALITY CONTROL

A. Inspect transformers for physical damage, proper alignment, anchorage, grounding, connections, and installation.

B. Test transformers per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

D. Output Settings Report: Prepare a written report recording output voltages and tap settings and submit to Engineer.

3.05 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.06 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 h of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10% and not being lower than nameplate voltage minus 3% at maximum load conditions.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5%, at secondary terminals.

3.07 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

SECTION 26 23 00 - LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
E. Section 26 05 53 - Electrical Systems Identification
F. Section 26 05 73 - Power System Studies
G. Section 26 08 12 - Power Distribution Acceptance Tests
H. Section 26 08 13 - Power Distribution Acceptance Test Tables
I. Section 26 09 13 - Electrical Power Monitoring and Control
J. Section 26 25 00 - Enclosed Bus Assemblies
K. Section 26 27 13 - Electrical Metering
L. Section 26 28 13 - Fuses
M. Section 26 43 00 - Surge Protective Devices

1.02 DESCRIPTION

A. Section includes free-standing, dead-front type, metal-enclosed, low-voltage distribution switchgear.

1.03 REFERENCE STANDARDS

A. ANSI/IEEE C37.13 – Low-Voltage AC Power Circuit Breakers Used in Enclosures
B. IEEE C37.20.1 – Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
C. IEEE C37.90 – Relay and Relay Systems Associated with Electric Power Apparatus
D. IEEE C62.41.1 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
E. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
F. NFPA 70 – National Electrical Code
G. NEMA EN 10250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
H. UL 486A-486B – Wire Connectors
I. UL 869A – Reference Standard for Service Equipment
J. UL 1066 – Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures
K. UL 1558 – Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

1.04 SUBMITTALS

A. Product Data: For each switchgear, components and accessories indicated:
   (1) Include data on features and components and complete description; submit catalog cut sheets showing voltage, size, rating and size of surge protective devices, switching and overcurrent protective devices.
   (2) Features, characteristics, factory settings and time-current curves of individual protective devices, auxiliary components and ground fault relaying.
B. Shop Drawings:
   (1) For each switchgear specified in this Section:
      (a) General Arrangement:
         1) Indicate front, plan, and side views of switchgear; access requirements; overall dimensions and components list; shipping splits and weights.
         2) Front elevation indicating location of devices and instruments.
         3) Sections through switchgear showing space available for conduits.
      (b) Conduit entrance locations and requirements
      (c) Nameplate legends
      (d) Configuration, size and number of bus bars for each phase and current rating of buses
      (e) Ground bus
      (f) Neutral bus

(g) Short circuit ratings of switchgear and overcurrent protective devices, and bus withstand rating

(h) Instrument details; enclosure types and details

(i) Wiring diagrams: power, signal and control wiring

(j) Utility company's metering provisions with indication of approval by utility company

(2) Submit 1/4" (1:50) scale floor plans with switchgear location(s) and required clearances and service space around equipment.

C. Manufacturer's Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Complete review of this specification noting for each paragraph whether proposed equipment complies with project specifications or deviates. Justification must be given for each deviation.

F. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual locations, configurations, and ratings of switchgear and major components on single-line diagrams and plan layouts.

(2) Operation and Maintenance Data:

(a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.

(c) Include spare parts data listing, source, and current prices of replacement parts and supplies.

(d) Include Manufacturer Seismic Qualification Certification and Installation Seismic Qualification Certification.

(e) Include time-current curves, including selectable ranges for each type of overcurrent protective device.

1.05 QUALITY ASSURANCE

A. Obtain switchgear from one source and by single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70 for components and installation.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Certifications:

(1) Furnish Engineer with Manufacturer Seismic Qualification Certification: Submit certification that switchgear, accessories, and components will remain _____ to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems. Include the following:

(a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchgear as required to prevent condensation.

B. Deliver switchgear in _____, individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Use factory-installed lifting provisions. Handle carefully to avoid damage to switchgear internal components, enclosure, and finish.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.

(1) Potential Transformer Fuses: Equal to 10% of amount installed for each size and type, but no fewer than 2 of each size and type.

(2) Control-Power Fuses: Equal to 10% of amount installed for each size and type, but no fewer than 2 of each size and type.

(3) Fuses for Fused Switches and for Fused Circuit Breakers: Equal to 10% of amount installed for each size and type, but no fewer than 3 of each size and type.

(4) Indicating Lights: _____

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Square D

B. ABB

C. Eaton Cutler-Hammer

D. Siemens

2.02 RATINGS

A. Nominal system voltage: _____.

B. Main bus continuous amperes: ____

C. Short circuit current rating: _____.

D. Brace switchgear components to withstand mechanical forces for symmetrical fault current shown.

2.03 CONSTRUCTION

A. IEEE C37.20.1, UL 1558.

B. Free-standing, dead-front type; metal-enclosed; side, front and rear panels of one-piece welded or bolted construction; compartments with ventilation louvers in top and bottom sections of front and rear panels; supporting frame: steel _____ rigidly fastened together, with same outside dimensions as the enclosure.

C. Adequate strength and rigidity necessary to resist conditions of use to which it may be subjected and to support equipment, devices and appurtenances contained therein.

D. Incoming lug locations: _____, as applicable per drawings.

E. Barriers shall be placed such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations

F. _____.

G. Environmental Limitations:

(1) Ambient temperatures: not exceeding 40°C

(2) Altitude: Not exceeding 6600 ft (2 km) _____

(3) Temperature rise: Not to exceed 65°C over a 40°C ambient environment, with no derating required.

H. Device Mounting and Type:

(1) Front and rear accessible switchgear: _____.

(a) Main and tie device and feeder devices: Drawout and _____.

I. Bus:

(1) Material: _____; copper: 98% conductivity.

(2) Connections: Accessible from rear only for maintenance.

(a) Bolted:

1) Not fewer than 4 bolts for each 4” x 4” (100 mm x 100 mm) contact

2) Not fewer than 2 bolts for each 2” x 2” (50 mm x 50 mm) contact

3) Grade 5 bolts and conical spring-type washers

(3) Sizing: Standard size, based on 65°C over 40°C; full capacity of the breaker frame size, not the trip setting; fully rated vertical and horizontal bus sections.

(4) Main Phase Buses: Three phase, _____ wire; uniform capacity for entire length of switchgear; ampacity as indicated on drawings; rated for the main protective device frame size or main incoming conductors.

(5) Bus Arrangement: A-B-C (left to right, top to bottom, front to rear).

J. Ground Bus: Insulated, extend length of switchgear.

(1) _____ amp, hard-drawn copper of 98% conductivity, equipped with pressure connectors for feeder ground conductors.

K. Neutral Bus: _____% of the ampacity of phase buses, as indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

L. Hinged Front Doors: Allow access to metering, accessory, and blank compartments, with latch and padlocking provisions.

M. Removable, Hinged Rear Doors and Compartment Covers: Secured by _____, for access to rear interior of switchgear, with latch and padlocking provisions.

N. Circuit breaker compartment: Equipped to house drawout type circuit breakers, fitted with hinged outer doors, and segregated from adjacent compartments by steel barriers; equipped with drawout rails, levering out mechanism, primary and secondary contacts; The following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

O. Section barriers between main and tie circuit breakers compartments: Extended to rear of section; rear compartment barrier between the cable compartment and the main bus; glass polyester barrier between adjacent vertical structures in the cable compartment.

P. Bus isolation barriers: Arranged to isolate line bus from load bus at each main and tie circuit breaker; separate barriered compartment for current and potential transformers; main and riser buses fully isolated from breaker instrument and auxiliary compartments.

Q. Bus bars connect: Between vertical sections and between compartments. Cable connections are not permitted.

R. Safety shutter: To automatically cover line and load stubs to protect against accidental contact.

S. Utility Metering Compartment: Fabricated compartment barriered from the rest of the section, with a hinged lockable front cover and removable bus links, complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchgear. Metering equipment: Provisions for mounting current transformers and potential transformers; meter base(s), metering conductors and miscellaneous appurtenances required by serving utility.

T. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchgear.

   (1) Pull Section: _____ Arrange _____

U. Pull Box on Top of Switchgear:

   (1) Adequate ventilation to maintain temperature in pull box within same limits as switchgear.

   (2) Removable top, front, and sides, same construction as switchgear.

   (3) Insulating, fire-resistive bottom with separate holes for cable drops into switchgear.

   (4) Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

   (5) _____

V. Spare circuit breakers and spaces for future circuit breakers: Allowance in vertical section bus size.

W. Future Provisions: Fully equip spaces for future devices with bussing, bus connections, rails, mounting brackets, supports, and appurtenances, insulated and braced for short circuit currents, with continuous current rating _____. Extension of phase, neutral, and ground buses from both ends by means of predrilled bolt-holes and connecting links.

X. Adequate lifting means.

Y. Dimensions: _____ maximum height, excluding floor sills, lifting members and pull boxes. Length and depth indicated _____ on the drawing are maximums allowed.

Z. Line and Load Terminations: _____ type, labeled for 75°C copper and aluminum conductors; suitable for number, sizes and trip ratings; feeder load terminals: silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.

AA. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation, or fluidized epoxy coating. No live connections shall be accessible from the rear, except the breaker load side terminals.

   (1) Sprayed Insulation Thickness: 3 mils (0.075 mm), minimum.

   (2) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

BB. Relays: IEEE C37.90; types and settings as indicated; with test blocks and plugs.

CC. Enclosure: Steel, NEMA EN 10250, Type _____:

   (1) Outdoor Non-walk-in Enclosure: Lifting plates at base of structure, hinged aisle doors with rubber gaskets and padlocking provision, asphalt base undercoating on exterior bottom, interior lights, space heater per vertical section, outlets, light switch and space heater switch.

      (a) Space Heater: Factory-installed electric space heater of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

      (b) Space-Heater Power Source: _____.

(2) Walk-in Enclosure:

(a) Outdoor sections: Same width as indoor sections except end sections shall be wider to allow for opening of inner door; designed to withstand wind velocities of _____

(b) A minimum of 42" (1070 mm) front aisle depth in front for walk-in structures.

(c) Rear hinged padlockable doors with wind stops for each section.

(d) Aisle doors shall be equipped with provisions for padlocking.

(e) Steel floor in walk-in aisle space and under each vertical section.

(f) Anti-skid floor strip in aisle way.

(g) Panic hardware on aisle doors at each end of line-up.

(h) Exterior padlocking of doors shall not prevent operation of panic hardware from interior of enclosure.

(i) Enclosure: Rear sloping roof.

(j) Overhead circuit breaker lifter.

(k) Ventilating louvers with insect and rodent screen and replaceable fiberglass filters; filters: removable from exterior of enclosure.

(l) Interior aisle vaporproof fluorescent lights with low-temperature ballasts, 3-way switches at each entrance and GFCI protected receptacles, a minimum of two.

(m) Space heaters with thermostatic controls for breaker, bus and cable compartments.

(n) Power for lights, receptacles and space heaters shall be obtained from _____; supply voltage: 120 VAC.

(3) Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

(4) Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, undersurfaces treated with corrosion-resistant undercoating.

2.04 SERVICE ENTRANCE

A. UL 869A

B. Switchgear labeled as suitable for use as service entrance equipment, where applicable, with incoming line isolation barriers, and a removable neutral bond to switchgear ground for solidly grounded wye systems.

C. Barriers shall be placed such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.

D. Surge arrestors on all phases per requirements in Section 26 43 00 - Surge Protective Devices (SPD).

2.05 SHORT CIRCUIT CURRENT RATING

A. Each switchgear with minimum short circuit current rating as indicated on drawings.

B. Switchgear: Marked with their maximum short circuit current rating at supply voltage.

C. Switchgear: Fully rated

2.06 SURGE PROTECTIVE DEVICES (SPD)

A. _____

B. IEEE C62.41.1; integrally mounted, plug-in style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

C. Per requirements in Section 26 43 00 - Surge Protective Devices.

2.07 OVERCURRENT PROTECTIVE DEVICES

A. Power Circuit Breaker and Accessories: ANSI/IEEE C37.13; UL 1066; metal frame; field interchangeable electrical accessories, including shunt trip, spring release, electrical operator, auxiliary contacts and trip unit.

(1) Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.

(2) Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

(a) Normal Closing Speed: Independent of both control and operator.

(b) Slow Closing Speed: Optional with operator for inspection and adjustment.

(c) Store-Energy Mechanism: _____.

(d) Means for manual opening and closing.

(e) Operation counter.

(3) Trip Devices: Electronic (solid-state, microprocessor-based), overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

(a) Functions: Long-time pickup and delay, short-time pickup and delay, ground-fault pickup and delay and instantaneous-trip functions, independent of each other in both action and adjustment.

(b) Temperature Compensation: Ensures accuracy and calibration stability from 23°F to 104°F (-5°C to 40°C).

(c) Field-adjustable time-current characteristics.

(d) Current Adjustability: Dial settings and ratings plugs on trip units or sensors on circuit breakers, or a combination of these methods.

(e) Three bands, minimum, for long-time- and short-time-delay functions; marked “minimum,” “intermediate,” and “maximum.”

(f) Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I2t operation.

(g) Pickup Points: Five minimum, for instantaneous-trip functions.

(h) Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

(4) Auxiliary Contacts: For interlocking or remote indication of circuit breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit breaker operation. Each consists of two type “a” and two type “b” contacts wired through secondary disconnect devices to a terminal block in stationary housing; “a” contacts mimic circuit breaker contacts, “b” contacts operate in reverse of circuit breaker contacts.

(5) Drawout Features: Circuit breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:

(a) Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.

(b) Circuit Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:

1) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.

2) Disconnected Position: Primary and secondary devices and ground contact disengaged.

(6) Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

(7) Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

(8) Operating Handle: One for each circuit breaker capable of manual operation.

(9) Electric Close Button: One for each electrically operated circuit breaker.

(10) Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

(11) Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key interlock devices is indicated.

(12) Shunt-Trip Devices: Where indicated.

(13) Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked wither with each other or with exterior devices.

(14) Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 - Electrical Power Monitoring and Control.

(15) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground fault protection function, and/or short time function.

(16) Control Voltage: _____.

(17) Trip Voltage: _____, close and charge.

(18) Listed for 100% of breaker’s continuous ampere rating.

B. Circuit Breaker Electronic Trip Units general characteristics:

(1) Circuit breakers, with solid-state microprocessor based trip units:

(a) Unit shall consist of current sensors, solid-state trip device, and solid-state adjustable time/current curve shaping elements.

(b) Trip units shall be removable to allow for field upgrades.

(c) Trip units shall incorporate “True RMS Sensing.”

(2) Solid-state elements shall provide functions as indicated above.

(3) Adjustments shall be made using non-removable, discrete steps.

(4) Sealable transparent cover shall be provided over adjustments.

(5) Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is UL listed as field-replaceable. Adjustable rating plug shall allow for five minimum long-time pickup settings from 0.4 to 1.0 times the sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be at least three bands.

(6) Short-time pickup shall allow for five minimum settings from 1.5 to 10 times Ir. Short-time delay shall be at least three bands with I2t ON and OFF.

(7) Instantaneous settings on the trip units shall be available in five minimum bands from 2 to 15 times In. The instantaneous settings shall also have an OFF setting when short-time pickup is provided.

(8) Trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be one ampere. Fine increments for delay adjustments are to be one second.

(9) Trip unit shall indicate:

(a) Long-time fault

(b) Short-time fault

(c) Instantaneous fault

(d) Ground fault, where provided

(10) Trip unit shall provide local trip indication and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.

(11) Trip unit shall contain means to conduct circuit breaker tests, or via separate test kit.

(12) Breaker shall be equipped with externally accessible test points to be used for field testing.

(13) Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency.

(14) Trip units shall be provided with the following standard features:

(a) True RMS sensing

(b) LI

(c) LSI

(d) LSIG/Ground-fault trip

(e) Ground Fault Alarm (no trip), with external relay, where required

(f) Adjustable rating plugs

(g) LCD or LED – Long-time pickup

(h) LCD or LED – Trip indication

(i) Digital Ammeter

(j) Communications

(k) LCD dot matrix display

(l) Advanced user interface

(m) Protective relay functions

(n) Neutral protection

(o) Incremental fine tuning of settings

(p) Selectable long-time delay bands

(q) Power measurement

(r) Maximum peak demand (measure of average power over a 15-minute period) continuously recorded over a one-year period

C. Fused Power Circuit Breakers: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:

(1) Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker, per requirements in Section 26 28 13 - Fuses.

(2) Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on a common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.

(3) Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.

(4) Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when a fuse opens. Open-fuse status is indicated at front of circuit breaker or fuse drawout element.

D. Ground Fault protection equipment on breakers, where indicated: _____ relay and trip unit, push-to-test feature and ground fault indicator:

(1) Ground-fault protection with at least three adjustable short-time-delay settings and three trip-time-delay bands; adjustable current pickup with maximum setting of 1200 A. Arrange to provide protection for the following:

(a) Three-wire circuit or system

(b) Four-wire circuit or system

(c) Four-wire, double-ended substation

(2) Trip units shall be capable of the following types of ground-fault protection: _____. Ground-fault sensing systems shall be changed in the field.

(3) Neutral current transformers shall be provided for 4-wire system.

(4) Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times In. The ground-fault settings for circuit breakers above 1200 A shall be in minimum three bands up to 1200 A.

(5) Ground-Fault Relay: UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and 3-phase current transformer/sensor.

2.08 CONTROL POWER, COMPONENTS IDENTIFICATION, AND CONTROL WIRING

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer: Dry-type transformers in separate compartments for units larger than 3 KVA, including primary and secondary fuses.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120 V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control components mounted within assembly, such as relays, pushbuttons, switches etc.: Suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

E. Control Wiring: Factory installed, with bundling, lacing, and protection included; flexible conductors for #8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units; insulated locking spade terminals for control connections, except where saddle type terminals, integral to a device; current transformer secondary leads, connected to short circuit terminal blocks; terminal blocks with suitable numbering strips for group of control wires leaving switchgear, with wire markers at each end of control wiring.

2.09 ACCESSORY COMPONENTS AND FEATURES

A. Furnish portable test set to test functions of circuit breakers and solid-state trip devices without removal from switchgear. Include relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

B. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

C. Furnish one portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Furnish overhead circuit-breaker lifting devices, mounted at top front of switchgear, with hoist and lifting yokes matching each drawout circuit breaker.

E. Furnish set of tools for manually charging circuit breaker stored energy device.

F. Furnish racking handle to manually move circuit breaker between connected and disconnected positions.

G. Lockout Devices: Circuit breakers with integral, lockout/tagout devices.

H. Provide energy-reducing maintenance switching with local status indicator for all breakers 1200A and higher per NEC 240.87.

2.10 CUSTOMER METERING

A. Per requirements in Section 26 27 13 - Electrical Metering.

PART 3 - EXECUTION

3.01 COORDINATION

A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:

(1) Concrete: Per requirements in Division 03 – Concrete.

(2) Dimensions: Per requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

D. Coordinate utility company metering equipment requirements.

E. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.02 EXAMINATION

A. Examine areas and surface to receive switchgear for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for switchgear mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.03 INSTALLATION

A. Install switchgear in accordance with applicable portions of ANSI/NECA 400.

B. Switchgear mounting and seismic restraints:

(1) Install switchgear anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the _____ of _____, and to comply with Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems for seismic criteria.

(2) Bolt switchgear to concrete housekeeping pads, using anchor bolts in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems. Cast anchor bolt inserts into pads.

(3) Install bushing assemblies for anchor bolts for seismic restraints per requirements in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems.

C. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification for switchgear, every instrument, overcurrent protective device and disconnect device. Attach nameplate to exterior of switchgear using small corrosion-resistant metal screws and rivets. Do not use contact adhesive. Indicate switchgear manufacturer’s name and drawing number, name, amperage, voltage, phase, number of wires, short circuit current rating (amp, RMS symmetrical and MVA 3-phase symmetrical) and momentary and fault-closing ratings (amp, RMS asymmetrical). For each overcurrent protective device and disconnect device, include circuit, load and area served, voltage/phase rating, and fuse size and type, when applicable.

D. Provide framed, printed operating instructions for switchgear, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of switchgear.

E. Install switchgear in dedicated electrical space per NFPA 70, and as indicated on drawings.

F. Tighten electrical connectors and terminal according to equipment manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

G. Install fuses in fusible switch at job site per requirements in Section 26 08 13 - Power Distribution Acceptance Test Tables.

H. Install surge arrestors in cable termination compartments and connect to each phase of circuit, per requirements in Section 26 43 00 - Surge Protective Devices (SPD)

I. Connect surge protective devices to switchgear bus per requirements in Section 26 43 00 - Surge Protective Devices (SPD).

J. Install utility company metering equipment, devices and wiring in conformance with serving utility requirements.

K. Apply temporary heat to maintain temperature according to manufacturer’s written instructions.

3.04 CONNECTIONS

A. Ground switchgear according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Connect power and control wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

A. Inspect switchgear for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.

B. Test continuity of each circuit.

C. Test switchgear per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.

D. Interpret test results in writing and submit to Engineer.

3.06 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.07 ADJUSTING

A. Set field-adjustable circuit breakers trip settings, to values indicated on drawings or recommended by the overcurrent protective device coordination study per Section 26 05 73 - Power System Studies.

B. Field adjustments of trip setting and adjustment or replacement of equipment to comply with Section 26 05 73 - Power System Studies; no additional cost to Owner.

3.08 CLEANING

A. Clean switchgear during construction phase, prior to initial testing and energization, and prior to final punch list, after other trades have departed. Cleaning procedures shall be as follows:

(1) Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

(2) Rack out circuit breakers and remove arc chutes.

(3) Wipe down surfaces, including arc chutes and circuit breakers with Endust or equivalent.

(4) Use paintbrush to dust small, hard-to-reach crevices.

3.09 DEMONSTRATION

A. Provide training session by manufacturer for one workday at a job location, to train the Owner’s personnel in the operation and maintenance of switchgear.

END OF SECTION 26 23 00

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
E. Section 26 05 53 - Electrical Systems Identification
F. Section 26 05 73 - Power System Studies
G. Section 26 08 12 - Power Distribution Acceptance Tests
H. Section 26 08 13 - Power Distribution Acceptance Test Tables
I. Section 26 09 13 - Electrical Power Monitoring and Control
J. Section 26 25 00 - Enclosed Bus Assemblies
K. Section 26 27 13 - Electrical Metering
L. Section 26 28 13 - Fuses
M. Section 26 43 00 - Surge Protective Devices (SPD)

1.02 DESCRIPTION

A. Section includes free-standing, dead-front type low-voltage distribution switchboards.

1.03 REFERENCE STANDARDS

A. ANSI/IEEE C37.13 – Low-Voltage AC Power Circuit Breakers Used in Enclosures
B. ANSI/NECA 400 – Recommended Practice for Installing and Maintaining Switchboards
C. IEEE C62.41.1 - Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
D. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
E. NFPA 70– National Electrical Code
F. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
G. NEMA AB 3 – Molded-Case Circuit Breakers and Their Applications
H. NEMA FU 1 – Low-Voltage Cartridge Fuses
I. NEMA BS 31047 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
J. NEMA PB 2 – Dead-Front Distribution Switchboards
K. NEMA PB 2.1 – General Instructions for Proper Handling, Installation and Maintenance of Dead-Front Distribution Switchboards Rated 600 Volts or Less
L. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
M. UL 98– Enclosed and Dead-Front Switches
N. UL 486A-486B – Wire Connectors
O. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
P. UL 869A – Reference Standard for Service Equipment
Q. UL 891 – Dead-Front Switchboards
R. UL 1053 – Ground-Fault Sensing and Relaying Equipment
S. UL 1066 – Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.04 SUBMITTALS

A. Product Data: For each switchboard, components and accessories indicated:
   (1) Include data on features and components and complete description; submit catalog cut sheets showing voltage, size, rating and size of surge protective devices, switching and overcurrent protective devices.
   (2) Features, characteristics, factory settings and time-current curves of individual protective devices, auxiliary components and ground fault relaying.
B. Shop Drawings:
   (1) For each switchboard specified in this Section:

(a) General Arrangement:

1) Indicate front, plan, and side views of switchboards; access requirements (front, side, rear); overall dimensions and components list; shipping splits and weights.

2) Front elevation indicating location of devices and instruments.

3) Sections through switchboard showing space available for conduits.

(b) Conduit entrance locations and requirements.

(c) Nameplate legends.

(d) Configuration, size and number of bus bars for each phase and current rating of buses.

(e) Ground bus.

(f) Neutral bus.

(g) Short circuit ratings of switchboards and overcurrent protective devices, and bus withstand rating.

(h) Instrument details; enclosure types and details.

(i) Wiring diagrams: power, signal and control wiring.

(j) Utility company's metering provisions with indication of approval by utility company.

(k) Descriptive documentation of optional barriers specified for electrical insulation and isolation.

(l) UL listing for series rating of installed devices.

(2) Contractor to submit 1/4" (1:50) scale floor plans with switchboard locations and required clearances and service space around equipment.

C. Manufacturer's Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Complete review of this specification noting for each paragraph whether proposed equipment complies with project specifications or deviates. Justification must be given for each deviation.

F. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual locations, configurations, and ratings of switchboard and major components on single-line diagrams and plan layouts.

(2) Operation and Maintenance Data:

(a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.

(c) Include spare parts data listing, source, and current prices of replacement parts and supplies.

(d) Include Manufacturer Seismic Qualification Certification and Installation Seismic Qualification Certification.

(e) Include time-current curves, including selectable ranges for each type of overcurrent protective device.

1.05 QUALITY ASSURANCE

A. Obtain switchboards from one source and by single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70 for components and installation.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Certifications:

(1) Furnish Engineer with Manufacturer Seismic Qualification Certification: Submit certification that switchboards, accessories, and components will remain _____ to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems. Include the following:

(a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchboards as required to prevent condensation.

B. Deliver switchgear in _____, individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Handle switchboards in accordance with NEMA PB 2.1 and ANSI/NECA 400. Use factory-installed lifting provisions. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.

(1) Potential Transformer Fuses: Equal to 10% of amount installed for each size and type, but no fewer than 2 of each size and type.

(2) Control-Power Fuses: Equal to 10% of amount installed for each size and type, but no fewer than 2 of each size and type.

(3) Fuses for Fused Switches and for Fused Circuit Breakers: Equal to 10% of amount installed for each size and type, but no fewer than 3 of each size and type.

(4) Indicating Lights: _____

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Square D

B. ABB

C. Eaton Cutler-Hammer

D. Siemens

2.02 RATINGS

A. Nominal system voltage: _____.

B. Main bus continuous amp: _____.

C. Short circuit current rating: _____.

D. Brace switchboard components to withstand mechanical forces for symmetrical fault current shown.

2.03 CONSTRUCTION

A. NEMA PB 2, UL 891

B. Free-standing, dead-front type; vertical sections bolted together; sides and rear covered with removable bolt-on covers; adequate ventilation within enclosure; supporting frame: steel _____ rigidly fastened together, with same outside dimensions as the enclosure.

C. Adequate strength and rigidity necessary to resist conditions of use to which it may be subjected and to support equipment, devices and appurtenances contained therein.

D. Barriers shall be placed such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations

E. Incoming lug locations: _____, as applicable per drawings.

F. _____

G. Environmental Limitations:

(1) Ambient temperatures: Not exceeding 40°C.

(2) Altitude: Not exceeding _____

(3) Temperature rise: Not to exceed 65°C over a 40°C ambient environment, with no derating required.

H. Device Mounting and Type:

(1) Front accessible switchboard: _____ for placement against the wall:

(a) Main and tie device: _____.

(b) Feeder devices: Panel mounted _____.

(c) Devices: Front removable; load connections: Front accessible.

(2) Front and side accessible switchboard: _____ for placement against the wall:

(a) Main and tie device: _____.

(b) Feeder devices: Panel mounted _____.

(c) Devices: Front removable; load connections: Front accessible.

(3) Front and rear accessible switchboard: _____.

(a) Main and tie device: _____.

(b) Feeder devices: _____.

(c) Devices: Front removable; load connections: Front and rear accessible.

I. Bus:

(1) Material: _____; copper: 98% conductivity. The bus bars shall have sufficient cross-sectional area to meet UL 891 temperature rise requirements through actual tests. The bus bars shall be _____.

(2) Connections:

(a) Bolted:

1) Not fewer than 4 bolts for each 4” x 4” (100 mm x 100 mm) contact.

2) Not fewer than 2 bolts for each 2” x 2” (50 mm x 50 mm) contact.

3) Grade 5 bolts and conical spring-type washers.

4) Clamp joints are not allowed.

(3) Sizing: Standard size, based on 65°C over 40°C.

(4) Main Phase Buses: Three phase, _____ wire; fully rated; uniform capacity for entire length of switchboard; ampacity as indicated on drawings; rated for the main protective device frame size or main incoming conductors.

(5) All feeder device line and load connection straps: Rated to carry current rating of device frame (not trip rating).

(6) Support for Buses: Mounted on high-impact, non-tracking insulated supports; joints in the vertical bus are not permitted.

(7) Bus arrangement: A-B-C (left to right, top to bottom, front to rear).

J. Ground Bus: Insulated, extend length of switchboard.

(1) 1/4” x 2” (6 mm x 50 mm) minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection.

K. Neutral Bus: _____ of the ampacity of phase buses, as indicated on drawings, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

L. Main incoming compartment.

M. Hinged Front Doors: Allow access to metering and accessory compartments; concealed hinges; fastened by head bolts.

N. Cable Supports: For each vertical section.

O. Vertical Insulating Barrier: Between the device compartment and bus compartment.

P. Vertical Insulating Barrier: Between the bus compartment and cable compartment.

Q. Barriers: Between adjacent sections.

R. Hinged Front Doors: Over device compartments, with concealed hinges and fastened by hex head bolts.

S. Hinged Rear Doors and Compartment Covers: With concealed hinges and fastened by hex head bolts.

T. Bus Connections: Extend from load side of devices into rear compartment for connections to outgoing cables.

U. All buswork shall have 30 cycles withstand rating.

V. Utility Metering Compartment: Fabricated compartment barriered from rest of the section, with a hinged lockable front cover and removable bus links, complying with utility company’s requirements. If separate vertical section is required for utility metering, match and align with basic switchboard. Metering equipment: Provisions for mounting current transformers and potential transformers; meter base(s), metering conductors and miscellaneous appurtenances required by serving utility.

W. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

(1) Pull Section: _____ Arrange _____

X. Pull Box on Top of Switchboard:

(1) Adequate ventilation to maintain temperature in pull box within same limits as switchboard.

(2) Removable top, front, and sides, same construction as switchboard.

(3) Insulating, fire-resistive bottom with separate holes for cable drops into switchboard.

(4) Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

(5) _____.

Y. Future Provisions: Fully equip spaces for future devices with bussing, mounting brackets, supports, and appurtenances, insulated and braced for short circuit currents, with continuous current rating _____. Extension of phase, neutral, and ground buses from both ends.

Z. Adequate lifting means.

AA. Dimensions: _____ maximum height, excluding floor sills, lifting members and pull boxes. Length and depth indicated _____ on the drawing are maximum allowed.

BB. Line and Load Terminations: _____ type accessible from _____ of switchboard, _____; suitable for number, size and trip ratings.

CC. Enclosure: Steel, NEMA EN 10250, Type _____:

(1) Outdoor Non-walk-in Enclosure: Lifting plates at base of structure, hinged aisle doors with rubber gaskets and padlocking provision, asphalt base undercoating on exterior bottom, interior lights, space heater per vertical section, outlets, light switch and space heater switch.

(a) Space Heater: Factory-installed electric space heater of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1) Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.

2) Space-Heater Power Source: _____.

(2) Outdoor Walk-in Enclosure:

(a) Outdoor sections: Same width as indoor sections except end sections shall be wider to allow for opening of inner door; designed to withstand wind velocities of _____ .

(b) A minimum of 42” (1070 mm) front aisle depth in front for walk-in structures.

(c) Rear hinged padlockable doors with wind stops for each section.

(d) Aisle doors shall be equipped with provisions for padlocking.

(e) Steel floor in walk-in aisle space and under each vertical section

(f) Anti-skid floor strip in aisle way

(g) Panic hardware on aisle doors at each end of line-up

(h) Exterior padlocking of door shall not prevent operation of panic hardware from interior of enclosure.

(i) Enclosure: Rear sloping roof

(j) Overhead circuit breaker lifter

(k) Ventilating louvers with insect and rodent screen and replaceable fiberglass filters; filters: removable from exterior of enclosure.

(l) Interior aisle vaporproof fluorescent lights with low-temperature ballasts, 3-way switches at each entrance and GFCI protected receptacles, a minimum of two.

(m) Space heaters with thermostatic controls for breaker, bus and cable compartments.

(n) Power for lights, receptacles and space heaters shall be obtained from _____; supply voltage: 120 VAC

(3) Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer’s standard gray finish over a rust-inhibiting primer on treated metal surface.

(4) Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer’s standard color, undersurfaces treated with corrosion-resistant undercoating.

2.04 SERVICE ENTRANCE

A. UL 869A

B. Switchboards labeled as suitable for use as service entrance equipment, where applicable, with incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wye systems.

C. Surge arrestors on all phases: per requirements in Section 26 43 00 - Surge Protective Devices (SPD).

2.05 SHORT CIRCUIT CURRENT RATING

A. Each switchboard with minimum short circuit current rating as indicated on drawings.

B. Switchboards: Marked with their maximum short circuit current rating at supply voltage.

C. Switchboards: _____.

2.06 SURGE PROTECTIVE DEVICES (SPD)

A. _____.

B. IEEE C62.41.1; integrally mounted, plug-in style, solid-state, parallel-connected, suppression and filtering modules

C. Per requirements in Section 26 43 00 - Surge Protective Devices (SPD)

2.07 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, NEMA AB 3, UL 489; lockable handle; interrupting capacity to meet available fault current.

(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 trip ratings _____ and below.

(2) Electronic (solid-state microprocessor based) trip unit circuit breakers: digital true RMS sensing trip units; interchangeable in the field within the frame size (field-replaceable rating plug to determine the breaker trip rating), field-adjustable settings and the following trip functions for circuit breaker trip ratings ___ - 1200 A:

(a) Instantaneous trip

(b) Long- and short-time pickup levels

(c) Long- and short-time time delay adjustments with I2t response

(d) Ground-fault pickup level, time delay, and I2t response

(3) Current-Limiting Circuit Breakers: No fusible element, frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

(4) Integrally Fused Circuit Breakers: Thermal-magnetic trip element with current-limiting fuses; trip activation on fuse opening or on opening of fuse compartment door.

B. Molded-Case Circuit Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

(1) Communication Capability: _____ communication module with functions and features compatible with power monitoring and control system, specified in Section 26 09 13 - Electrical Power Monitoring and Control.

(2) Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at _____ of rated voltage.

(3) Undervoltage Trip: 120 V, set to operate at 35 to 75% of rated voltage _____ time delay.

(4) Auxiliary Contacts: _____ with “a" and “b“ contacts; “a“ contacts mimic circuit breaker contacts, “b“ contacts operate in reverse of circuit breaker contacts.

(5) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

(6) Position: ON and OFF, clearly marked on escutcheon; trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.

C. Enclosed, Insulated-Case Circuit Breaker and Accessories: NEMA AB 1, UL 489; fully rated circuit breaker with interrupting capacity rating to meet available fault current.

(1) _____ circuit breaker mounting. Drawout design: Circuit breaker to be withdrawn from an engaged position, to a test position, and to a disengaged position.

(2) Two-step, stored-energy closing; _____ operated.

(3) A charging handle, closed pushbutton, open pushbutton and Off/On/Charge indicator located on the breaker escutcheon and visible with the breaker compartment closed.

(4) Electronic (solid-state microprocessor-based) trip units with interchangeable rating plug, trip indicators, field-adjustable settings and the following trip functions:

(a) Instantaneous trip.

(b) Long- and short-time pickup levels.

(c) Long- and short-time time delay adjustments with I2t response.

(d) Ground-fault pickup level, time delay, and I2t response.

(5) Local and remote trip indication and control.

(6) Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at _____ of rated voltage, where indicated.

(7) Undervoltage Trip: 120 V, set to operate at 35 to 75% of rated voltage _____ time delay.

(8) Auxiliary Contacts: _____ with “a“ and “b“ contacts; “a“ contacts mimic circuit breaker contacts, “b“ contacts operate in reverse of circuit breaker contacts.

(9) Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 - Electrical Power Monitoring and Control.

(10) Key Interlock Kit: Externally mounted to prohibit circuit breaker operation; key shall be removable only when circuit breaker is in OFF position.

(11) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground fault protection function and/or short time function.

(12) Control Voltage: _____ V _____.

(13) Listed for 100% of breaker’s continuous ampere rating.

D. Power Circuit Breaker and Accessories: ANSI/IEEE C37.13; UL 1066; metal frame; field interchangeable electrical accessories, including shunt trip, spring release, electrical operator, auxiliary contacts and trip unit.

(1) Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchboard.

(2) Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

(a) Normal Closing Speed: Independent of both control and operator.

(b) Slow Closing Speed: Optional with operator for inspection and adjustment.

(c) Store-Energy Mechanism: _____.

(d) Means for manual opening and closing

(e) Operation counter

(3) Trip Devices: Electronic (solid-state, microprocessor-based) overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

(a) Functions: Long-time pickup and delay, short-time pickup and delay, ground-fault pickup and delay and instantaneous trip functions, independent of each other in both action and adjustment.

(b) Temperature Compensation: Ensures accuracy and calibration stability from 23°F to 104°F (-5°C to 40°C).

(c) Field-adjustable time-current characteristics.

(d) Current Adjustability: Dial settings and ratings plugs on trip units or sensors on circuit breakers, or a combination of these methods.

(e) Three bands, minimum, for long-time- and short-time-delay functions; marked “minimum,” “intermediate,” and “maximum.”

(f) Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I2t operation.

(g) Pickup Points: Five minimum, for instantaneous-trip functions.

(h) Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

(4) Auxiliary Contacts: For interlocking or remote indication of circuit breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit breaker operation. Each consists of two type “a” and two type “b” contacts wired through secondary disconnect devices to a terminal block in stationary housing; “a” contacts mimic circuit breaker contacts, “b” contacts operate in reverse of circuit breaker contacts.

(5) Drawout Features: Circuit breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:

(a) Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.

(b) Circuit Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:

1) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.

2) Disconnected Position: Primary and secondary devices and ground contact disengaged.

(6) Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position and arranged to permit inspection of contacts without removing circuit breaker from switchboard.

(7) Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

(8) Operating Handle: One for each circuit breaker capable of manual operation.

(9) Electric Close Button: One for each electrically operated circuit breaker.

(10) Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

(11) Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key interlock devices is indicated.

(12) Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage.

(13) Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.

(14) Shunt-Trip Devices: Where indicated.

(15) Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked with each other or with exterior devices.

(16) Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 - Electrical Power Monitoring and Control.

(17) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground fault protection function, and/or short time function.

(18) Control Voltage: _____ V _____

(19) Trip Voltage: _____ V _____, close and charge

(20) Listed for 100% of breaker’s continuous ampere rating.

E. Circuit Breaker Electronic Trip Units general characteristics:
   (1) Circuit breakers, with solid-state microprocessor based trip units:
      (a) Unit shall consist of current sensors, solid-state trip device, and solid-state adjustable time/current curve shaping elements.
      (b) Trip units shall be removable to allow for field upgrades.
      (c) Trip units shall incorporate “True RMS Sensing.”
   (2) Solid-state elements shall provide functions as indicated above.
   (3) Adjustments shall be made using non-removable, discrete steps.
   (4) Sealable transparent cover shall be provided over adjustments.
   (5) Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is UL listed as field replaceable. Adjustable rating plug shall allow for five minimum long-time pickup settings from 0.4 to 1.0 times the sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be at least three bands.
   (6) Short-time pickup shall allow for five minimum settings from 1.5 to 10 times Ir. Short-time delay shall be at least three bands with I2t ON and OFF.
   (7) Instantaneous settings on the trip units shall be available in five minimum bands from 2 to 15 times In. The instantaneous settings shall also have an OFF setting when short-time pickup is provided.
   (8) Trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be one ampere. Fine increments for delay adjustments are to be one second.
   (9) Trip unit shall indicate:
      (a) Long-time fault
      (b) Short-time fault
      (c) Instantaneous fault
      (d) Ground fault, where provided
   (10) Trip unit shall provide local trip indication and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.
   (11) Trip unit shall contain means to conduct circuit breaker test, or via separate test kit.
   (12) Breaker shall be equipped with externally accessible test points to be used for field testing.
   (13) Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency.
   (14) Trip units shall be provided with the following standard features:
      (a) True RMS sensing
      (b) LI
      (c) LSI
      (d) LSIG/Ground-fault trip
      (e) Ground Fault Alarm (no trip), with external relay, where required
      (f) Adjustable rating plugs
      (g) LCD or LED – Long-time pickup
      (h) LCD or LED – Trip indication
      (i) Digital Ammeter
      (j) Communications
      (k) LCD dot matrix display
      (l) Advanced user interface
      (m) Protective relay functions
      (n) Neutral protection
      (o) Incremental fine tuning of settings
      (p) Selectable long-time delay bands
      (q) Power measurement
      (r) Maximum peak demand (measure of average power over a 15-minute period) continuously recorded over a one-year period
F. Ground Fault protection equipment on breakers, where indicated: _____ relay and trip unit, push-to-test feature and ground fault indicator:
   (1) Ground-fault protection with at least three adjustable short-time delay settings and three trip-time delay bands; adjustable current pickup with maximum setting of 1200 amps. Arrange to provide protection for the following:
      (a) Three-wire circuit or system

(b) Four-wire circuit or system

(c) Four-wire, double-ended substation

(2) Trip units shall be capable of the following types of ground-fault protection: _____. Ground fault sensing systems shall be changed in the field.

(3) Neutral current transformers shall be provided for 4-wire system.

(4) Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times In. The ground-fault settings for circuit breakers above 1200 A shall be in minimum three bands up to 1200 A.

(5) Ground-Fault Relay: UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and 3-phase current transformer/sensor.

G. Arc Energy Reduction on breakers rated or adjustable to 1200A or larger.

(1) Provide one of the following methods to reduce clearing time to less than the available arcing current:

(a) _____

H. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.

I. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

(1) Main Contact Interrupting Capability: 12 times the switch current rating, minimum.

(2) Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for closing and opening.

(a) Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control devices, causes switch to open.

(b) Mechanical Trip: Operation of mechanical lever, push button, or other devices causes switch to open.

(3) Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.

(4) Service-Rated Switches: Labeled for uses as service equipment.

(5) Ground-Fault Relay: UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

(a) Configuration: _____ relay and trip unit with adjustable pickup and time delay settings, push-to-test feature, and ground fault indicator.

(b) Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.

(c) No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.

(d) Test Control: Simulates ground fault to test relay and switch (or relay only if “no-trip” mode is selected).

(6) Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

J. Fused Switch: NEMA BS 31047, UL 98; enclosed knife switch _____ type, external lockable operable handle, clips or pads to accommodate specified fuses:

(1) Rejection clips for Class R fuses

(2) Provision for Class J or Class L fuses, as applicable

(3) Fuses per requirements in Section 26 28 13 - Fuses

2.08 CONTROL POWER, COMPONENTS IDENTIFICATION, AND CONTROL WIRING

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120 V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control components mounted within assembly, such as relays, pushbuttons, switches, etc.: Suitably marked for identification, corresponding to appropriate designations on manufacturer’s wiring diagrams.

E. Control Wiring: Factory installed, with bundling, lacing, and protection included; flexible conductors for #8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units; insulated locking spade terminals for all control connections, except where saddle type terminals, integral to a device; current transformer secondary leads, connected to short circuit terminal blocks; terminal blocks with suitable numbering strips for group of control wires leaving switchboard, with wire markers at each end of control wiring.

2.09 ACCESSORY COMPONENTS AND FEATURES

A. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

B. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

C. Furnish one portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Furnish overhead circuit breaker lifting devices, mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Furnish set of tools for manually charging circuit breaker stored energy device.

F. Lockout Devices: Circuit breakers with integral, lockout/tagout devices.

G. Provide energy-reducing maintenance switching with local status indicator for all breakers 1200A and higher.

2.10 CUSTOMER METERING

A. Per requirements in Section 26 27 13 - Electrical Metering.

PART 3 - EXECUTION

3.01 COORDINATION

A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:

(1) Concrete: Per requirements in Division 03 – Concrete.

(2) Dimensions: Per requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

D. Coordinate with busway system manufacturer factory installation of termination fittings.

E. Coordinate utility company metering equipment requirements.

F. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.02 EXAMINATION

A. Examine areas and surface to receive switchboards for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for switchboard mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.03 INSTALLATION

A. Install switchboard in accordance with NEMA PB 2.1 and ANSI/NECA 400.

B. Switchboard mounting and seismic restraints:

(1) Install switchboard anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the _____ of _____, and to comply with Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems for seismic criteria.

(2) Bolt switchboards to concrete housekeeping pads, using anchor bolts in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems. Cast anchor bolt inserts into pads.

(3) Install bushing assemblies for anchor bolts for seismic restraints per requirements in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems.

C. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification for each switchboard, every instrument, overcurrent protective device and disconnect device. Attach nameplate to exterior of each switchboard using small corrosion-resistant metal screws and rivets. Do not use contact adhesive. Indicate switchboard manufacturer’s name and drawing number, name, amperage, voltage, phase, number of wires, short circuit current rating (amp, RMS symmetrical and MVA 3-phase symmetrical) and momentary and fault-closing ratings (amp, RMS asymmetrical). For each overcurrent protective device and disconnect device, include circuit, load and area served, voltage/phase rating, and fuse size and type, when applicable.

D. Provide framed, printed operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install switchboards in dedicated electrical space per NFPA 70, and as indicated on drawings.

F. Tighten electrical connectors and terminal according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

G. Install fuses in fusible switch at job site per requirements in Section 26 28 13 - Fuses.

H. Install surge arrestors in cable termination compartments and connect to each phase of circuit, per requirements in Section 26 43 00 - Surge Protective Devices (SPD).

I. Connect surge protective devices to switchboard bus per requirements in Section 26 43 00 - Surge Protective Devices (SPD).

J. Install utility company metering equipment, devices and wiring in conformance with serving utility requirements.

K. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

L. Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.04 CONNECTIONS

A. Ground switchboards according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Connect power and control wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

A. Inspect switchboards for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.

B. Test continuity of each circuit.

C. Test switchboards per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.

D. Interpret test results in writing and submit to Engineer.

E. Test switch operators _____ after energizing.

3.06 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.07 ADJUSTING

A. Set field-adjustable circuit breakers trip settings or change the trip settings to values indicated on drawings or recommended by the overcurrent protective device coordination study per Section 26 05 73 - Power System Studies.

B. Field adjustments or changing of trip setting and adjustment or replacement of equipment to comply with Section 26 05 73 - Power System Studies; no additional cost to Owner.

3.08 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

3.09 DEMONSTRATION

A. Provide training session by manufacturer for one workday at a job location, to train the Owner's personnel in the operation and maintenance of switchboards.

END OF SECTION 26 24 13

SECTION 26 24 16.13 - LIGHTING AND APPLIANCE PANELBOARDS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 26 05 33 - Raceway and Boxes for Electrical Systems
E. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
F. Section 26 05 53 - Electrical Systems Identification
G. Section 26 05 73 - Power System Studies
H. Section 26 08 12 - Power Distribution Acceptance Tests
I. Section 26 08 13 - Power Distribution Acceptance Test Tables
J. Section 26 27 13 - Electrical Metering

1.02 DESCRIPTION

A. Section includes circuit breaker type lighting and appliance branch circuit panelboards as shown on drawings and as scheduled.

1.03 REFERENCE STANDARDS

A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards
B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
D. NEMA PB 1 - Panelboards
E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less
F. NFPA 70 - National Electrical Code
G. UL 50 - Enclosures for Electrical Equipment
H. UL 67 - Panelboards
I. UL 486A-486B - Wire Connectors
J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
K. UL 869A - Reference Standard for Service Equipment

1.04 SUBMITTALS

A. Product Data:
   (1) Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.
B. Shop Drawings:
   (1) Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
   (2) Submit 1/4” (1:50) scale electrical room floor plans with panelboard locations.
C. Partial Submittals:
   (1) Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.
D. Manufacturer’s Installation Instructions:
   (1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
E. Test Reports:
   (1) Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
F. Closeout Submittals:
   (1) Project Record Documents:
      (a) Record actual locations of panelboards and record actual circuiting arrangements.

(2) Operation and Maintenance Data:

(a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.

(c) Include time-current curves and selectable ranges for each type of overcurrent protective device.

(d) Include spare parts data listing, source, and current prices of replacement parts and supplies.

(e) Include manufacturer's Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.05 QUALITY ASSURANCE

A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Certifications:

(1) Furnish Engineer with manufacturer's Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will remain _____ to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems. Include the following:

(a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

A. Extra Materials:

(1) Furnish Owner with two keys per panelboard.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Square D

B. ABB

C. Eaton Cutler Hammer

D. Siemens

2.02 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. NEMA PB 1, UL 67 [98]

B. Fabrication:

(1) Factory assembled.

(2) Branch mains: _____ .

(3) _____.

(4) Incoming feeder lugs: _____ conductors.

(5) Multiple lugs to match number of conductors per phase.

(6) Sub-feed (double) lugs, or feed-through lugs where indicated.

(7) Filler plates.

(8) Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

(9) Unless otherwise noted on plans, panelboards fed from below shall have mains located at the bottom of the panel and panelboards fed from above shall have mains located at the top of the panel.

C. Panelboard Buses:

(1) _____
(2) Ampere rating as scheduled
(3) Ground bus: uninsulated, bonded to panelboard cabinet
(4) Insulated neutral bus: _____% of phase bus rating

D. Molded-Case Circuit Breakers:
(1) NEMA AB 1, UL 489
(2) _____ type, labeled for 75°C copper and aluminum conductors
(3) Quick-make, quick-break, with thermal-magnetic trip.
(4) Common internal trip on multi-pole breakers. Handle-ties are not permitted.
(5) Ampere rating as scheduled
(6) Listed as Type SWD for lighting circuits
(7) Listed as Type HACR for air conditioning equipment circuits
(8) Bussing, device mounting hardware, and steel knockouts in dead front where “space” is indicated
(9) Tandem circuit breakers are not acceptable
(10) For trip ratings below _____ : thermal magnetic trip
(11) For trip ratings _____ and above: electronic trip units interchangeable in the field within the frame size and field adjustable _____ and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of all other adjustments.
(12) Ground fault equipment protection (GFEP), rated 30 mA trip, to provide equipment protection for branch circuits feeding electrical heat tracing, where indicated
(13) Ground fault circuit interrupter (GFCI), rated at 4-6 mA trip for protection of personnel, where indicated

E. Cabinet
(1) NEMA EN 10250, UL 50
(2) NEMA Type 1, Type 3R (outdoor locations) _____ enclosure.
(3) Front (trim) _____ mounted with door in front with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch.
(4) Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
(5) All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
(6) Boxes and fronts made of code-gauge galvanized steel.
(7) _____.

2.03 METERS

A. Provide separate metering compartments with digital meter in accordance with Section 26 27 13 - Electrical Metering.

2.04 SERVICE ENTRANCE

A. UL 869A.
B. Panelboards labeled as suitable for use as service entrance equipment where applicable and must include connection for bonding and grounding of neutral conductor.

2.05 SHORT CIRCUIT CURRENT RATING

A. Each panelboard with minimum short circuit current rating as indicated on drawings.
B. Panelboards marked with their maximum short circuit current rating at supply voltage.
C. Panelboards: _____.

2.06 SURGE PROTECTIVE DEVICES (SPD)

A. _____.

2.07 SPARE CONDUITS

A. Spare conduits per requirements in Section 26 05 33 - Raceway and Boxes for Electrical Systems.

PART 3 - EXECUTION

3.01 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of additional wiring gutter space when required (i.e., top, bottom, right, left, or combination).
B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).

C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.

D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.

E. Verify that “touch-up” paint kit is available for repainting.

3.02 EXAMINATION

A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.

B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.03 INSTALLATION

A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.

C. Panelboard mounting and seismic restraints:

(1) Install panelboard anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the _____ of _____, and to comply with Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems for seismic criteria.

(2) Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.

(3) Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 05 29 - Hangers and Supports for Electrical Systems.

(4) Install two rows of steel slotted channel, with a minimum of 4 attachment points, for each panelboard section.

(5) When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

D. Install top breaker handle a maximum of 6’-7” (2 m) above finished floor or working platform with handle in its highest position.

E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads) mounted inside each panelboard door. Include description of connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic. Coordinate with Owner and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner.

G. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small metal screws or rivets. Do not use contact adhesive.

(1) Include panelboard name, amperage, voltage, phase, and number of wires.

H. Label spare circuits as SPARE. Leave spare breakers in OFF position.

I. Room numbers used shall be those used by Owner except as otherwise directed by Architect.

J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

K. Install filler plates in unused spaces.

L. Install three 3/4” (21 mm) spare conduits stubbed into accessible ceiling space or space designated to be ceiling space in the future for all flush-mounted panelboards. Install conduits in accordance with requirements in Section 26 05 33 - Raceway and Boxes for Electrical Systems.

M. Install three 3/4” (21 mm) spare conduits stubbed into ceiling space above and below for panelboards that serve loads on levels other than that where the panelboard is located. Install conduits in accordance with requirements in Section 26 05 33 - Raceway and Boxes for Electrical Systems.

3.04 CONNECTIONS

A. Ground panelboards according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding.

B. Maintain proper phasing for multi-wire circuits.

C. Test main circuit breakers in accordance with requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.

3.06 REPAINTING

A. Remove paint splatters or other marks from surface of panelboards.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.07 ADJUSTING

A. Adjust fronts, covers, hinges, and locks.

3.08 CLEANING

A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION 26 24 16.13

SECTION 26 24 16.16 - DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
E. Section 26 05 53 - Electrical Systems Identification
F. Section 26 05 73 - Power System Studies
G. Section 26 08 12 - Power Distribution Acceptance Tests
H. Section 26 08 13 - Power Distribution Acceptance Test Tables
I. Section 26 27 13 - Electrical Metering
J. Section 26 28 13 - Fuses

1.02 DESCRIPTION

A. Section includes circuit breaker type and fusible switch type power distribution panelboards as shown on drawings and as scheduled.

1.03 REFERENCE STANDARDS

A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards
B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
D. NEMA FU 1 - Low-Voltage Cartridge Fuses
E. NEMA BS 31047 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
F. NEMA PB 1 - Panelboards
G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less
H. NFPA 70 - National Electrical Code
I. UL 50 - Enclosures for Electrical Equipment
J. UL 67 - Panelboards
K. UL 486A-486B - Wire Connectors
L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
M. UL 512 - Fuseholders
N. UL 869A - Reference Standard for Service Equipment

1.04 SUBMITTALS

A. Product Data:
   (1) Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.
B. Shop Drawings:
   (1) Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker fusible switch arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
   (2) Submit 1/4” (1:50) scale electrical room floor plans with panelboard locations.
C. Partial Submittals:
   (1) Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.
D. Manufacturer’s Installation Instructions:
   (1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
E. Test Report:
   (1) Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual locations of panelboards and record actual circuiting arrangements.

(2) Operation and Maintenance Data:

(a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.

(c) Include time-current curves and selectable ranges for each type of overcurrent protective device.

(d) Include spare parts data listing, source, and current prices of replacement parts and supplies.

(e) Include manufacturer's Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.05 QUALITY ASSURANCE

A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by a single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Certifications:

(1) Furnish Engineer with manufacturer's Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, and components will remain _____ to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems. Include the following:

(a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

A. Extra Materials:

(1) Furnish Owner with two keys per panelboard.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Square D

B. ABB

C. Eaton Cutler Hammer

D. Siemens

2.02 POWER DISTRIBUTION PANELBOARDS

A. NEMA PB 1, UL 67.

B. Fabrication:

(1) Factory assembled

(2) Individualized breaker fusible switch dead-front cover _____

(3) Incoming feeder lugs: _____ conductors

(4) Multiple lugs to match number of conductors per phase

(5) Sub-feed (double) lugs, or feed-through lugs where indicated

(6) Filler plates

(7) Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

(8) Barriers shall be placed such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.

(9) Unless otherwise noted on plans, distribution panelboards fed from below shall have mains located at the bottom of the panel and distribution panelboards fed from above shall have mains located at the top of the panel.

C. Panelboard Buses:

(1) _____

(2) Ampere rating as scheduled

(3) Ground bus: uninsulated, bonded to panelboard cabinet

(4) Insulated neutral bus where applicable: _____ of phase bus rating

D. Molded-Case Circuit Breakers:

(1) NEMA AB 1, UL 489

(2) Bolt-on or I-line type, labeled for 75°C copper and aluminum conductors

(3) Quick-make, quick-break, with _____.

(4) Equipped with individually insulated, braced, and protected connectors

(5) Common internal trip on multi-pole breakers. Handle-ties are not permitted.

(6) Ampere rating as scheduled

(7) Front face flush with each other

(8) Large, permanent, individual circuit numbers affixed to each breaker in uniform position

(9) Tripped indication clearly shown by breaker handle taking position between “ON” and “OFF.”

(10) Listed as Type HACR for air conditioning equipment circuits

(11) Bussing, device mounting hardware, and steel knockouts in dead front where “space” is indicated

(12) For trip ratings below _____ : thermal-magnetic trip

(13) For _____ trip ratings and above: electronic trip units interchangeable in the field within the frame size and field-adjustable _____, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of all other adjustments.

(14) Provide energy-reducing maintenance switching with local status indicator for all breakers 1200A and higher.

E. Fusible Switches:

(1) NEMA BS 31047, NEMA FU 1, UL 512

(2) Labeled for 75°C conductors

(3) Quick-make quick-break with visible blades, externally operable handle and dual horsepower ratings.

(4) Handles to physically indicate “ON” and “OFF” position.

(5) Lockable only in “OFF” position and accept three industrial type heavy-duty padlocks.

(6) Covers and handles be interlocked to prevent opening in “ON” position, with means to permit release of interlock.

(7) Large permanent individual circuit numbers affixed to each fusible switch in uniform position.

(8) Rejection clips for Class R fuses specified.

(9) Provisions for Class J or Class L fuses, as applicable.

(10) Fuses: Per requirements in Section 26 28 13 - Fuses.

F. Cabinet

(1) NEMA EN 10250, UL 50

(2) NEMA Type 1, Type 3R (outdoor locations) enclosure.

(3) Four-piece front (trim) _____ mounted _____.

(4) Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.

(5) All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.

(6) Boxes and fronts made of code-gauge galvanized steel

(7) _____.

2.03 METERS

A. Provide separate metering compartments with digital meter in accordance with Section 26 27 13 - Electrical Metering.

2.04 SERVICE ENTRANCE

A. UL 869A

B. Panelboards labeled as suitable for use as service entrance equipment where applicable and must include connection for bonding and grounding of neutral conductor.

2.05 SHORT CIRCUIT CURRENT RATING

A. Each panelboard with minimum short circuit current rating as indicated on drawings.

B. Panelboards marked with their maximum short circuit current rating at supply voltage.

C. Panelboards: _____

PART 3 - EXECUTION

3.01 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of additional wiring gutter space when required, i.e. top, bottom, right, left, or combination.

B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).

C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.

D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.

E. Verify that “touch-up” paint kit is available for repainting.

F. Coordinate painting of cabinets in finished areas with work performed under Division 09 - Finishes

3.02 EXAMINATION

A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.

B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.03 INSTALLATION

A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.

C. Panelboard mounting and seismic restraints:

(1) Install panelboard anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the _____ of _____, and to comply with Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems for seismic criteria.

(2) Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.

(3) Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 05 29 - Hangers and Supports for Electrical Systems.

(4) Install two rows of steel slotted channel, with a minimum of four attachment points, for each panelboard section.

(5) When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

D. Install top breaker handle a maximum of 6’-7” (2 m) above finished floor or working platform, with handle in its highest position.

E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads before completing load balancing) _____. Include description of connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic. Coordinate with Owner and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner.

G. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.

(1) Indicate panelboard name, amperage, voltage, phase, and number of wires.

H. Label spare circuits as SPARE. Leave spare breakers in OFF position.

I. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

J. Install filler plates in unused spaces.

K. Install fuses in fusible switches, per requirements in Section 26 28 13 - Fuses.

3.04 CONNECTIONS

A. Ground panelboards according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding.

B. Test circuit breakers per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

3.06 REPAINTING

A. Remove paint splatters or other marks from surface of panelboards.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint to Owner.

3.07 ADJUSTING

A. Adjust fronts, covers, hinges, and locks.

B. Circuit Breakers: Set field-adjustable trip settings or change the trip settings recommended by the overcurrent protective device coordination study per Section 26 05 73 - Power System Studies.

3.08 CLEANING

A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION 26 24 16.16

SECTION 26 27 13 - ELECTRICAL METERING

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
E. Section 26 05 53 - Electrical Systems Identification
F. Section 26 08 12 - Power Distribution Acceptance Tests
G. Section 26 08 13 - Power Distribution Acceptance Test Tables
H. Section 26 11 16 - Secondary Unit Substations
I. Section 26 13 16 - Medium-Voltage Fusible Interrupter Switchgear
J. Section 26 13 19 - Medium-Voltage Vacuum Interrupter Switchgear
K. Section 26 13 23 - Medium-Voltage Pad-Mounted Switchgear
L. Section 26 23 00 - Low-Voltage Switchgear
M. Section 26 24 13 - Switchboards
N. Section 26 28 13 - Fuses

1.02 DESCRIPTION

A. Section includes equipment for energy and demand metering _____. It also includes options that provide for monitoring or automatic control of demand at a remote location.

1.03 REFERENCE STANDARDS

A. ANSI C12.1 – Code for Electricity Metering
B. ANSI C12.7 – Requirements For Watthour Meter Sockets
C. NEMA C12.9 – Test Switches For Transformer-Rated Meters
D. ANSI C12.10 – Watthour Meters
E. ANSI C12.11 – Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV BIL (0.6 kV NSV Through 69 kV NSV)
F. ANSI C12.18 – Protocol Specification For ANSI Type 2 Optical Port
G. ANSI C12.19 – Utility Industry End Device Data Tables
H. ANSI C12.20 – Electricity Meters-0.2 and 0.5 Accuracy Classes
I. ANSI C39.1 – Requirements, Electrical Analog Indicating Instruments
J. IEEE C37.90.1 – Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
K. IEEE C57.13 – Standard Requirements for Instrument Transformers
L. IEEE C62.11 – Metal-Oxide Surge Arresters for Alternating Current Power Circuits
M. IEEE C62.41.1 – Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits
N. IEEE C62.41.2 – Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
O. IEEE C62.45 – Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
P. NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting
Q. NECA 400 – Recommended Practice for Installing and Maintaining Switchboards
R. NEMA EN 10250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
S. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
T. NEMA AB 3 – Molded-Case Circuit Breakers and Their Applications
U. NEMA EI 21.1 – Instrument Transformers for Revenue Metering (110KV BIL and Less)
V. NEMA BS 31047 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

W. NEMA LA 1 – Surge Arresters

X. NEMA PB 2 – Dead-Front Distribution Switchboard

Y. NFPA 70 – National Electrical Code

Z. UL 50 – Standard for Enclosures for Electrical Equipment (1995)

AA. UL 98 – Enclosed and Dead-Front Switches

BB. UL 414 – Standard for Meter Sockets (1999)

CC. UL 467 – Grounding and Bonding Equipment

DD. UL 486A-486B – Wire Connectors

EE. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

FF. UL 891 – Dead-Front Switchboards

GG. ASTM D1535 – Standard Practice for Specifying Color by the Munsell System

1.04 SUBMITTALS

A. Product Data: For metering equipment, components and accessories indicated:

(1) Include data on features, components, and complete description; submit catalog cut sheets showing electrical characteristics and ratings.

(2) Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe operating sequences, both automatic and manual.

B. Shop Drawings:

(1) Dimensioned plans and sections or elevation layouts.

(2) Wiring Diagrams: Power, signal, and control wiring. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field installed wiring, and show circuit protection features.

C. Manufacturer's Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual locations and ratings of metering equipment on single-line diagrams and plan layouts.

(2) Operation and Maintenance Data:

(a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include manufacturer's written instructions for testing.

(c) Include spare parts data listing, source, and current prices of replacement parts and supplies.

(d) Include manufacturer's Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.05 QUALITY ASSURANCE

A. Obtain metering equipment from one source and by single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70 for components and installation.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Certifications:

(1) Furnish Engineer with manufacturer's Seismic Qualification Certification: Submit certification that metering equipment, accessories, and components will remain _____ to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems. Include the following:

(a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center as specified in NECA 400. Use factory installed lifting provisions. Handle carefully to avoid damage to assembly internal components, enclosure, and finish.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.

(1) Potential Transformer Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.

(2) Control-Power Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.

(3) Fuses for Fused Switches: Equal to 10% of amount installed for each size and type, minimum of 3 of each size and type.

PART 2 - PRODUCTS

2.01 EQUIPMENT FOR UTILITY COMPANY ELECTRICAL METERING

A. Utility metering compartments in _____ per requirements in section _____.

B. Cabinets and Sockets:

(1) Current Transformer Cabinets: Comply with requirements of electrical power utility company.

(2) Meter Cabinets: Comply with requirements of electrical power utility company.

(3) Meter Sockets: Comply with requirements of electrical power utility company.

C. Modular Meter Center: Utility approved assembly of main service _____, wireways, tenant meter socket modules, and tenant feeder overcurrent protective devices, complete with interconnecting buses and other features as specified below:

(1) Manufacturers:

(a) General Electric

(b) Cutler-Hammer

(c) Siemens

(d) Square D

(2) Ratings:

(a) Nominal system voltage: _____.

(b) Main bus continuous amp: _____

(c) Short circuit current rating: _____.

(d) Components braced to withstand mechanical forces for symmetrical fault current shown.

(3) Construction:

(a) Free-standing, dead-front type; vertical sections bolted together; sides and rear covered with removable bolt-on covers; adequate ventilation within enclosure.

(b) Incoming lug locations: _____, as applicable per drawings.

(c) Environmental Limitations:

1) Ambient temperatures: Not exceeding 104°F (40°C).

2) Altitude: Not exceeding 6600 ft (2010 m) _____.

3) Temperature rise: Not to exceed 149°F (65°C) over a 104°F (40°C) ambient environment, with no derating required.

(d) Device Mounting and Type: Front accessible assembly for placement against the wall

1) Main disconnect device: Fixed individually mounted _____.

2) Tenant feeder devices: _____ _____.

3) Devices: Front removable; load connections: Front accessible.

(e) Bus:

1) Material: _____; copper: 98% conductivity.

2) Sizing: Standard size, based on 149°F (65°C) over 104 °F (40 °C).

3) Main Phase Buses: 3 phase, _____ wire; fully rated; uniform capacity for entire length of assembly; ampacity as indicated on drawings; rated for the main protective device frame size or main incoming conductors.

4) Bus arrangement: A-B-C (left to right, top to bottom, front to rear).

(f) Ground Bus: Insulated, extend full length of assembly.

1) 1/4” by 2” (6 mm by 50 mm) minimum-size, hard-drawn copper of 98% conductivity, equipped with pressure connectors for feeder ground conductors.

(g) Neutral Bus: 100% of the ampacity of phase buses, as indicated on drawings, equipped with pressure connectors for outgoing feeder neutral cables.

(4) Line and Load Terminations: _____ type, labeled for 167°F (75°C) over a 104 °F (40 °C) copper or aluminum conductors.

(5) Housing: NEMA EN 10250, Type _____ enclosure.

(6) Enclosure Finish: Factory-applied finish in manufacturer’s standard gray finish over a rust-inhibiting primer on treated metal surface.

(7) Overcurrent Protective Devices:

(a) Main disconnect device: _____

(b) Tenant feeder disconnects: _____.

(c) Molded-Case Circuit Breaker: NEMA AB 1, NEMA AB 3, UL 489 lockable handle; interrupting capacity to meet available fault current.

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 225 A and below.

2) Electronic (solid-state microprocessor based) trip unit circuit breakers: digital true RMS sensing trip units; interchangeable in the field within the frame size (field-replaceable rating plug to determine the breaker trip rating), field-adjustable settings and the following trip functions for circuit breaker frame sizes 250 A - 1200 A:

1. Instantaneous trip
2. Long- and short-time pickup levels
3. Long- and short-time delay adjustments with I2t response
4. Ground-fault pickup level, time delay, and I2t response

(d) Fused Switch: NEMA BS 31047, UL 98; enclosed knife switch _____ type, external lockable operable handle, clips or pads to accommodate specified fuses:

1) Rejection clips for Class R fuses.

2) Provision for Class J or Class L fuses, as applicable.

3) Fuses per requirements in Section 26 28 13 - Fuses.

(8) Meter Sockets: Type as approved by utility company, with rating coordinated with indicated tenant feeder circuit rating.

(a) EUSERC service areas:

1) Self-contained ring-type, with test bypass/disconnect block, rated 200 A continuous.

2) Transformer-rated 400 A and above, with provisions for mounting current transformers.

(b) Non-EUSERC service areas:

1) Self-contained ringless-type, with manual level bypass, rated 200 or 400 A continuous.

2) Transformer-rated 400 A and above, with provisions for mounting current transformers.

3) Internal wireway barriers.

4) Individual compartments with covers and sealing provisions.

(c) Completely prewired and shipped ready for installation of meters.

(9) Control Wiring: Factory installed, with bundling, lacing, and protection included; insulated locking spade terminals for all control connections, except where saddle type terminals, integral to a device; current transformer secondary leads, connected to short circuit terminal blocks; terminal blocks with suitable numbering strips for group of control wires leaving modular meter center, with wire markers at each end of control wiring.

2.02 EQUIPMENT FOR OWNER ELECTRICAL METERING

A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

(1) Manufacturers:

(a) Square D

(b) General Electric

(c) Siemens

(d) Cutler-Hammer

(e) Approved equal

(2) Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

(a) Phase Currents, Each Phase: +/-0.5%

(b) Phase-to-Phase Voltages, Three Phase: +/-1%
(c) Phase-to-Neutral Voltages, Three Phase: +/-1%
(d) Megawatts: +/-2%
(e) Megavars: +/-2%
(f) Power Factor: +/-2%
(g) Frequency: +/-0.5%
(h) Megawatt Demand: +/-2%; demand interval programmable from 5 to 60 minutes
(i) Accumulated Energy, Megawatt Hours: +/-2%. Accumulated values unaffected by power outages up to 72 hours
(j) Maximum demand (measure of average power demand over a 15-minute period) continuously recorded over a one-year period.
(k) Total Harmonic Distortion, Amperes
(l) Total Harmonic Distortion, Volts
(m) Individual Amperage Harmonics through the 63rd
(n) Integral Communications Port

(3) Mounting: Display and control unit flush or semiflush, mounted in instrument compartment door.

B. Analog Meters (Ammeters, Voltmeters, and Power Factor Meters): ANSI C39.1:

(1) Manufacturers:
(a) Square D
(b) General Electric
(c) Siemens
(d) Cutler-Hammer
(e) Approved equal

(2) Meters: Taut-band, indicating type, switchboard class; 4” (100 mm) diameter or _____ square, flush or semiflush, with anti-parallax 250-degree scales and external zero adjustment.
(a) Ammeters: 5 A, full-scale movement, with a scale of zero to the primary rating of the CTs.
(b) Voltmeters: Direct reading where PTs are not shown or have a 150V, full-scale movement where PTs are shown; cover and expanded-scale range of nominal voltage plus 10 percent.
(c) Feeder Ammeters: 2-1/2” (65 mm) minimum size with 90- or 120-degree scale. Meter and transfer device with an off position, located on overcurrent device door for indicated feeder circuits only.

(3) Instrument Switches: Rotary type with off position:
(a) Ammeter Switches: Permit reading of current in each phase and maintain current transformer secondaries in a closed-circuit condition at all times.
(b) Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.

(4) Watt-Hour Meters: Flush or semiflush type, rated 5 A, 120 V, 3 phase, 3 wire, 2-1/2 elements on 3-phase, 4-wire wye systems and 2 elements on 3-phase, 3-wire delta systems; _____ minute-indicating-demand register; and provision for testing and adding pulse initiation.

(5) Recording Demand Meters: Usable as totalizing relay or as indicating and recording maximum-demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semiflush mounting.

C. Instrumentation:

(1) Manufacturers:
(a) Square D
(b) General Electric
(c) Siemens
(d) Cutler-Hammer
(e) Approved equal

(2) Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
(a) Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
1) 600 V and below: external PTs not required; fused potential connection.
(b) Current Transformers: _____ type; ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments; shorting test blocks: 10 poles – 4 potential and 6 current, mounted with meter or in accessible location.
(c) Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

(d) Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit breaker ground-fault protection.

D. Data Communications:

(1) Means to transmit data to central control and monitoring system.

(a) Keypad and scrollable display for local reading of measured values.

E. Kilowatt-Hour Meters:

(1) Manufacturers:

(a) E-MON L.P

(b) National Meter Industries, Inc.

(c) Osaki Meter Sales, Inc.

(d) Power Measurement

(e) Square D

(f) Cutler-Hammer

(g) General Electric

(h) Siemens

(i) Approved equal

(2) Kilowatt-Hour Meter: Electronic _____ phase meters, measuring electricity used.

(a) Voltage and Phase Configuration: Designed for use on circuits with voltage rating and phase configuration indicated for its application.

(3) Kilowatt-Hour/Demand Meter: Electronic _____-phase meters, measuring electricity use and demand.

(a) Voltage and Phase Configuration: Designed for use on circuits with voltage rating and phase configuration indicated for its application.

(b) Demand Signal Communication Interface: Match signal to _____ input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

(c) Programmable Contact Module: Unit shall have push-button switches and a display for setting the demand level at which an integral set of Form C contacts shall be operated to initiate indicated action.

(d) Enclosure: NEMA EN 10250, Type _____ minimum, with hasp for padlocking or sealing.

(e) Identification: Comply with Section 26 05 53 - Electrical Systems Identification.

(f) Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.

(g) Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.

1) Type: ___ core.

(h) Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.

(i) Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

2.03 OUTDOOR SOCKET-TYPE METERS

A. Solid-State Polyphase Energy and Demand Meters:

(1) Manufacturers:

(a) Elster Electricity, LLC, Alpha Plus Series

(b) Landis+Gyr AXS4 Series

(c) Itron (Schlumberger) Vectron SVX Series

(d) General Electric kV Series

(e) Approved equal

(2) Description: Solid-state programmable polyphase energy and demand meter, _____

(3) Applicable Standards: ANSI C12.1, ANSI C12.10, ANSI C12.18, ANSI C12.19, ANSI C12.20, IEEE C37.90.1, IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

(4) Features:

(a) Digital display

(b) Measurement of energy (kWh) and demand (kW)

(c) Meter reading multiplier indication on meter face

(d) Polycarbonate cover, lockable

(e) Push-type demand reset on meter face

(f) 9600 baud optical communications port

(g) KYZ pulse initiator output compatible with building automation system (BAS). KYZ module: Cable for field wiring connection in meter socket.

(5) Configuration and Electrical Ratings:

(a) Mounting arrangement: Detachable socket Type S

(b) Meter Form: _____

(c) Elements: 3

(d) Voltage and Frequency: 120 to 480 VAC, 3 phase, 4 wire wye, 60 Hz

(e) Accuracy Class: 0.2

(6) Programming Capability: Field programming device and software necessary for programming of meters by Owner in the post-contract period.

B. Transformer-Rated Meter Sockets:

(1) Manufacturer:

(a) Meter Devices Company, Inc., Series 3000

(b) Approved equal

(2) Description: Transformer-rated meter socket, pre-wired, with manual circuit closing devices and test switches, designed for application with underground service feeders.

(3) Applicable Standards: ANSI C12.7, NEMA C12.9, NEMA EN 10250, UL 50, and UL 414.

(4) Features:

(a) Two-piece cover, ring type

(b) Supplied with screw-type ring

(c) Lock-ring guard

(d) 16 ga (1.621 mm) galvannealed steel construction with plain top

(e) 5/8” (16 mm) diameter knockout mounting embossments

(f) Conduit knockouts in bottom, sides, and back

(g) Upper cover locks with internal sliding latch and meter-sealing ring

(h) Lower cover locks with stainless steel swing-latch and hasp

(i) Provisions for sealing wire or padlock

(j) Ground stud

(k) 10-pole color-coded test switch assembly with clear Lexan cover:

1) Standard switch assembly for Meter Form 9S; molded insulating base, four (4) single-pole potential switches, four (4) voltage barriers, and three (3) right hand load test jack double-pole current elements.

2) Switch assembly mounting: To enable the socket cover to be re-installed with the switches in the open position.

(l) Pre-wired with wiring harness:

1) Current transformer wiring: #12 AWG (4.00 mm2).

2) Potential wiring: #14 AWG (2.50 mm2).

3) Color coding: Same for current and potential wiring. A phase – black; B phase – red; C phase – blue; Neutral – white; Ground – green. All wiring identified with plastic sleeve wire markers. Cloth markers are not acceptable.

(m) Enclosure finish: Durable baked power epoxy.

(n) Finish color: Industry standard outdoor green color (to match pad mounted transformer), Munsell 7GY 3.29/1.5, in accordance with ASTM D1535.

(5) Configuration and Electrical Ratings:

(a) Socket arrangement: Type S

(b) Number of Terminals: 13

(c) Meter Form: 9S

(d) Elements: 3

(e) Transformer-rated, 20 A

(f) Voltage: 600 VAC, 3 phase, 4 wire wye

(g) Enclosure: NEMA 3R

(6) Accessories:

(a) 3-pole fuse block with clear Lexan cover for fusing of potential wiring inputs to watthour meter (fuse block mounting: in low-voltage compartment of pad mounted transformer).

1) Fuse clip rating: 30 A

2) Fuses: Current limiting, sized as recommended by the meter manufacturer.

(7) Current Transformers:

(a) Manufacturers:

1) General Electric Type JAB-0
2) ABB Type CMV
3) GEC Durham Industries, Inc., Type AP
4) Itron (Schlumberger) Type R6P
5) Approved equal

(b) Description: Current transformer, window-type, designed for mounting on secondary spade terminals of pad-mounted transformer.

(c) Applicable Standards: ANSI C12.11 and IEEE C57.13.

(d) Features:

1) 3-1/2” x 4-1/2” (90 mm x 115 mm) window with molded bus bar slots (“grabber” feature) designed for stable mounting on secondary spade terminals of pad mounted transformers (terminal pads with standard NEMA two-hole spacing).
2) Tin-plated, clamp-type secondary terminals.
3) Clear polycarbonate terminal cover.
4) Polarity markings.
5) Primary rating marking.
6) Shorting device.
7) Nameplate.

(e) Electrical Ratings:

1) Insulation Class: 600 V Indoor/Outdoor
2) Basic Impulse Level: 10 kV
3) Frequency: 60 Hz
4) Current Ratio: As indicated on drawings
5) Accuracy Class: 0.3 through Burden B0.2
6) Rating Factors: _____

C. Single-Position Socket Meters:

(1) Manufacturers:

(a) Siemens (Landis & Gyr brand).
(b) Milbank Manufacturing Company.
(c) Square D.
(d) Approved equal.

(2) Description: Single-position meter socket for self-contained type watthour meter, ringless type, lever bypass, designed for application with underground service feeders.

(3) Applicable Standards: ANSI C12.7, NEMA EN 10250, UL 50, and UL 414.

(4) Features:

(a) 14 ga (2.0 mm) galvanized steel panel with 16 ga (1.621 mm) galvanized steel cover
(b) Conduit knockouts in sides and bottom, hub opening and cover plate on top
(c) Cover lock with stainless steel swing-latch and hasp
(d) Provisions for sealing wire or padlock
(e) Insulated neutral bus
(f) Ground lug
(g) Enclosure finish: Durable baked powder epoxy
(h) Finish color: Industry standard Light Munsell gray in accordance with ASTM D1535

(5) Configuration and Electrical Ratings:

(a) Socket arrangement: Type S
(b) Number of Terminals: 7
(c) Meter Form: 16S
(d) Elements: 3
(e) Continuous current rating: As indicated on drawings.
(f) Voltage: 600 VAC, 3 phase, 4 wire wye, with insulated neutral bus.
(g) Enclosure: NEMA 3R

PART 3 - EXECUTION

3.01 COORDINATION

A. Coordinate adjustment and programming of metering equipment with manufacturer.

B. Instruct manufacturer about the location of incoming lugs (i.e., top or bottom feed based on incoming feeder entrance location).

C. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:

(1) Concrete: Per requirements in Division 03 – Concrete.

(2) Dimensions: Per requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Coordinate with miscellaneous trades for equipment foreign to electrical installation to be outside of dedicated electrical space.

E. Verify with manufacturer that “touch-up” paint kit is available for repainting.

F. Coordinate utility company metering equipment requirements.

G. Coordinate meter data transmission with campus power monitoring system (CPMS) Building Management System (BMS) Supervisory Control and Data Acquisition (SCADA) System to integrate metering components with system architecture.

3.02 EXAMINATION

A. Examine areas and surface to receive modular meter center for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for modular meter center mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.03 INSTALLATION

A. Comply with installation requirements in NECA 1.

B. Install utility company metering equipment per requirements in Section(s) _____.

C. Install current transformer cabinets, meter cabinets or meter sockets to comply with requirements of electrical power utility company. Install empty conduits for metering leads and extend grounding connections as required by utility company.

D. Install modular meter center in accordance with NECA 400.

E. Modular meter center mounting and seismic restraints:

(1) Install modular meter center anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the _____ of _____, and to comply with Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems for seismic criteria.

(2) Bolt modular meter center to concrete housekeeping pad, using anchor bolts in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems. Cast anchor bolt inserts into pad.

(3) Install bushing assemblies for anchor bolts for seismic restraints per requirements in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems.

F. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification for modular meter center, every instrument, overcurrent protective device, and disconnect device. Attach nameplate to exterior of modular meter center using small corrosion-resistant metal screws and rivets. Do not use contact adhesive. Indicate modular meter center manufacturer’s name and drawing number, name, amperage, voltage, phase, number of wires, short circuit current rating (amp, RMS symmetrical and MVA three-phase symmetrical), and momentary and fault-closing ratings (amp, RMS asymmetrical). For each overcurrent protective device and disconnect device, include tenant name, load served, voltage/phase rating, and fuse size and type, when applicable.

G. Install modular meter center in dedicated electrical space per NFPA 70, and as indicated on drawings.

H. Tighten electrical connectors and terminal according to equipment manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

I. Install fuses in fusible switch at job site per requirements in Section 26 28 13 - Fuses.

J. Mount meters in the locations indicated on the drawings. Mounting height: 5’-6” (1.68 m) or less from finished floor.

K. Transformer-Rated Meter:

(1) Install electricity metering equipment in or on pad-mounted transformers provided under Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers:

(a) Install current transformers on secondary spade terminals.

(b) Install fuse block inside low-voltage compartment (for potential wiring inputs to watthour meter).

(c) Install meter socket on exterior of low-voltage compartment.

(d) Install solid-state electricity meter in meter socket.

(e) Install fuses in fuse block, one for each phase.

(f) Connect meter KYZ pulse output to BAS panel in building.

L. Self-Contained Meter:

(1) Install meter socket on _____ as indicated.

(2) Install solid-state electricity meter in meter socket.

(3) Connect meter KYZ pulse output to BAS panel in building.

3.04 FIELD WIRING

A. Install field wiring to complete the electricity metering installation.

(1) Transformer-rated meter:

(a) Current transformer wiring shall be #12 AWG (4 mm2) minimum size. Where distance to meter exceeds 22 ft (6.7 m), increase wire size to #10 AWG (6 mm2) to reduce the burden on the metering circuit.

(b) Potential wiring shall be #14 AWG (2.5 mm2).

(c) Color coding: Same for current and potential wiring. A phase – black; B phase – red; C phase – blue; Neutral – white; Ground – green. Identify all wiring with plastic sleeve wire markers. Cloth markers are not acceptable.

(d) Neatly train and lace wiring for metering installation within pad-mounted transformer compartment and meter socket enclosure using nylon cable ties.

(2) _____ meter:

(a) Field wiring for building automation system (BAS) connection to solid-state electricity meter:

1) Conduit: Install a 3/4” (19 mm) conduit routed underground from _____ to BAS panel in the building; terminate conduit within 12" (300 mm) of BAS panel.

2) Communications Wiring: In the 3/4” (19 mm) conduit, install a 3-conductor communications cable as recommended by meter manufacturer. Connect one end to cable lead from meter KYZ pulse initiator module. Leave 4 ft (1.22 m)excess cable coiled at opposite end for connection to BAS panel.

3.05 CONNECTIONS

A. Ground metering equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Connect power and control wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

C. Bond meter socket enclosure to grounding facilities _____. Grounding equipment per UL 467 requirements.

3.06 FIELD QUALITY CONTROL

A. Test continuity of each circuit.

B. Test metering equipment per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

D. Test Owner’s electricity-metering installation for proper operation, accuracy, and usability of output data.

(1) Connect a load of known kilowatt rating, _____ hp (kW) minimum, to a circuit supplied by metered feeder.

(2) Turn off circuits supplied by metered feeder and secure them in off condition.

(3) Run test load continuously for 8 h, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.

(4) Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.

(5) Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

E. Inspect modular meter center for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.

F. Verify that correct multiplier is indicated on face of meter.

G. Verify that current transformer secondary circuits are intact.

H. Inspect indicating devices for proper operation.

3.07 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.08 ADJUSTING

A. Adjustment and programming of metering equipment: By factory-authorized representative.

B. Compare meter display readings with readings taken with clamp on ammeter and handheld volt-meter.

C. Make adjustments as necessary.

3.09 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

3.10 DEMONSTRATION

A. Provide training session by manufacturer for up to 4 h at a job location, to train the Owner's personnel in the operation and maintenance of metering equipment.

END OF SECTION 26 27 13

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems

B. Section 26 05 53 - Electrical Systems Identification

1.02 DESCRIPTION

A. Section includes general-use snap switches, wall-box dimmers, fan speed controls, receptacles, hazardous (classified) location receptacles, pendant cord-connector devices, cord and plug sets and device cover plates.

1.03 REFERENCE STANDARDS

A. IEEE C62.41.2 – Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits

B. IEEE C62.45 – Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits

C. NECA 1 – Good Workmanship in Electrical Contracting

D. NFPA 70 – National Electrical Code

E. NFPA 99 –Health Care Facilities

F. NEMA FB 11 – Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations

G. NEMA WD 1 – General Color Requirements for Wiring Devices

H. NEMA WD 6 – Wiring Devices - Dimensional Requirements

I. NEMA EN 10250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

J. UL 20 – General-Use Snap Switches

K. UL 498 – Attachment Plugs and Receptacles

L. UL 943 – Ground-Fault Circuit-Interrupters

M. UL 1203 – Safety Explosion-Proof and Dust-Ignition Proof Electrical Equipment for Use in Hazardous (Classified) Locations

N. UL 1436 – Outlet Circuit Testers and Similar Indicating Devices

O. UL 1449 – Transient Voltage Surge Suppressors

P. UL 1472 – Solid-State Dimming Controls

Q. UL 1917 – Solid-State Fan Speed Controls

1.04 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Manufacturer's Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual locations and ratings of wiring devices.

(2) Operation and Maintenance Data:

(a) Include in manufacturers' packing label warnings and instruction manuals with labeling conditions.

(b) Include source and current prices of replacement parts and supplies.

1.05 QUALITY ASSURANCE

A. Obtain wiring devices from one source and by single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70 for components and installation.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match products installed, are packaged with protective covering for storage and are identified with labels describing contents.

(1) TVSS Receptacles: _____ of each type installed, but no fewer than _____.

B. Furnish _____ _____ for each switch.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Cooper Wiring Devices; a division of Cooper Industries, Inc.

B. Hubbell Incorporated; Wiring Device-Kellems

C. Leviton Manufacturing Company, Inc.

D. Pass & Seymour/Legrand; Wiring Devices & Accessories

2.02 GENERAL-USE SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches: _____; back and side wired; flush or surface mounting; Body and Handle: thermoplastic with _____ handle; for connection to copper or copper-clad conductors:

(1) Ratings:

(a) Voltage: _____ AC

(b) Current: _____ A

(2) Single pole

(3) Double pole

(4) Three-way

(5) Four-way

(6) Locator Light: Lighted handle type switch (single pole with _____ neon-lighted handle, illuminated when switch is “OFF.”)

(7) Pilot Light: Indicator light switch (single pole with _____ neon-lighted handle, illuminated when switch is “ON.”

(8) Locking Type: Designed to prevent tampering and unauthorized switching.

(9) Key-Operated: Single pole, with factory-supplied key in lieu of switch handle.

(10) Single-Pole, Double-Throw, Momentary Contact, Center-Off: For use with mechanically held lighting contactors.

(11) Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off: For use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

(12) Pendant and Through-cord: For field installation on flexible cord and provided with one “ON’ and one “OFF” position.

(13) Switches for Connections to Aluminum Conductors: Comply with UL 1567.

(14) Weatherproof: _____.

(15) Dimmers are permitted to control lighting fixtures but not motorized loads or receptacles. Fan speed controls are listed for that application.

(16) Special devices may be desirable to minimize buzzing at lights, radio frequency interference, or in the case of multiwire circuits with dimmers on multiple phases, and variation in brightness due to interaction through the grounded conductor.

(17) Fluorescent luminaires, unless specifically marked otherwise, require special dimmers and dimming ballasts.

2.03 WALL-BOX DIMMERS

A. Comply with NEMA WD 1 and UL 1472.

B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

(1) Power Rating: _____ watts _____

(2) Body: Thermoplastic

(3) Control: Continuously adjustable _____; with single-pole or three-way switching.

(4) Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

(5) Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20% of full brightness; _____277 V.

2.04 FAN SPEED CONTROLS

A. Comply with UL 1917

B. Modular, 120V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.

(1) Continuously adjustable _____, _____.

(2) Three-speed adjustable _____, 1.5A.

2.05 RECEPTACLES

A. Comply with NEMA WD 1, NEMA WD 6 configuration _____, and UL 498.

B. Receptacles: 125 V, _____, _____; back and side wired; flush or surface mounted; straight blade; 2 pole, 3 wire grounding; thermoplastic body; _____ as indicated on drawings.

(1) Ground Fault Circuit Interrupter (GFCI):

(a) Additional compliance with UL 943 Class A.

(b) Leakage current trip level: 4 to 6 mA.

(c) Trip time: .025 seconds nominal.

(d) _____ through type

(e) Reverse line-load function to prevent GFCI from functioning if wired incorrectly.

(f) Indicator Light: Lighted when device is tripped.

(g) Due to numerous issues with nuisance tripping, Hubbell model# GFRST83W / GFRST83R analog self-test GFCI receptacles shall not be approved. Hubbell model # GFR83W will be acceptable.

(2) Isolated Ground (IG):

(a) Ground strap isolated from mounting strap.

(b) Ground screw connected directly to ground contacts.

(3) Transient Voltage Surge Suppression (TVSS):

(a) Additional compliance with UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.

(b) TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.

(c) Active TVSS Indication: Visual and audible, with light visible in face of device to indicate devise is “active” or “no longer in service.”

(4) Tamper Resistant (TR):

(a) Requires insertion of object in both left and right contacts to energize.

(b) 2- or 3-prong plug.

(5) Twist-locking:

(a) NEMA WD 6 configuration _____

(6) Switched: Upper half switched and lower half not switched.

(7) Dedicated: Labeled “Dedicated.”

(8) Special Purpose Receptacles: Specification grade, rated for voltage, amperage and NEMA configuration as noted on drawings.

2.06 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Comply with NEMA FB 11 and UL 1203

B. Manufacturers:

(1) Cooper Crouse-Hinds

(2) EGS/Appleton Electric

(3) Killark; a division of Hubbell, Inc.

2.07 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configuration L5-20P and L5-20R, heavy-duty grade.

(1) Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

(2) External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.08 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

(1) Cord: Thermoset-insulated, stranded-copper conductors, with Type SOOW jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30%.

(2) Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.09 DEVICE COVER PLATES

A. Single and combination types to match corresponding wiring devices:

(1) Attachment: Metal screws with head color to match plate finish.

(2) Material for Finished Spaces: _____.

(3) Material for Unfinished Spaces: _____.

(4) Material for Damp Locations: _____ with while-in-use hinged cover and listed and labeled for use in “wet locations”.

B. Weatherproof Cover Plates: NEMA EN 10250, complying with type 3R weather-resistant_____ with weatherproof while-in-use hinged cover.

C. Lockable Cover:

(1) Hinged steel cover with cylinder lock.

(2) Keyed _____.

D. Tamper Resistant (TR):

(1) Slide cover over receptacle.

2.10 FINISHES

A. Color:

(1) Switch handles, receptacle faceplates, and device cover plates: _____, except as follows:

(a) Switch handles and receptacle faceplates connected to Emergency or Standby Power System: Red; labeled “Emergency.”

(b) TVSS Receptacles: Blue

(c) Isolated-Ground Receptacles: _____.

(d) UPS Receptacles: Gray

PART 3 - EXECUTION

3.01 COORDINATION

A. Special Purpose Receptacles: Coordinate final selections of NEMA configuration (locking, straight, blade, etc.) with configuration of plug on utilization equipment.

B. Receptacles for Owner-furnished equipment and equipment furnished under other divisions of specifications: Match plug configurations.

C. Cord and Plug Sets: Match equipment requirements.

D. Coordination with Other Trades:

(1) Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers guided by riding against outside of the boxes.

(2) Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

(3) Install device boxes in brick or block walls so that the device cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

3.02 EXAMINATION

A. Verify location of wiring devices with architectural interior elevation drawings, prior to rough-in.

B. Verify outlet boxes are installed at proper height.

C. Verify wall openings are neatly cut and completely covered by wall plates.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.03 PREPARATION

A. Clean debris from outlet boxes.

3.04 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise scheduled or indicated on drawings. Indicated dimensions are to center of device.

B. Conductors:

(1) Do not strip insulation from conductors until just before they are spliced or terminated on devices.

(2) Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

(3) Length of free conductors at outlets for devices shall meet provisions of NFPA 70 , Article 300, without pigtails.

(4) Do not place bare stranded conductors directly under device screws. Use crimp on fork terminals for device terminations.

C. Device Installation:

(1) Replace all devices that have been in temporary use during construction or show signs of installation prior to completion of building finishing operations.

(2) Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

(3) Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.

(4) Connect devices to branch circuits using pigtails that are not less than 6” (150 mm) in length.

(5) When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

(6) Use a torque screwdriver when a torque is recommended or required by the manufacturer.

(7) When conductors larger than #12 AWG are installed on 15A or 20A circuits, splice #12 AWG pigtails for device connections.

(8) Tighten unused terminal screws on the device.

(9) When mounting into metal boxes, remove fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

(10) Install devices plumb, level with finished surfaces and free from blemishes.

(11) Install lighting switches vertically on latch side of door within 6” (150 mm) of frame edge.

(12) Install devices above counters, 2” (50 mm) to the bottom of device above countertop or backsplash. Install all devices at same height above any one counter or fixed cabinet.

(13) Install special purpose receptacles and switches according to shop and rough-in drawings furnished by trade(s) producing such equipment. Verify locations prior to rough-in.

(14) Install weatherproof GFCI receptacles:

(a) Within 25’-0” (7.6 m) of roof-mounted mechanical equipment

(b) Outdoors

(c) As indicated on drawings

(15) Install GFCI receptacles within 6' (1.8 m)of a sink, in any direction.

(16) Group adjacent switches under single, multigang wall plates.

(17) Connect wiring device grounding terminal to _____. Ground per requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

D. Installation Orientations:

(1) Install ground pin of vertically mounted receptacles _____, and on horizontally mounted receptacles to the _____.

(2) Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

(3) Install switches with handle operating vertically, with “ON” position up.

(4) Unless otherwise indicated or where space problem occurs, mount devices flush, with long dimension vertical.

E. Device Cover Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Wall-Box Dimmers:

(1) Install dimmers within terms of their listing.

(2) Verify that dimmers used for fan speed control are listed for that application.

(3) Install unshared neutral conductors on line and load side of dimmers according to manufacturers’ device listing conditions in the written instructions.

G. Arrangement of Devices:

(1) Unless otherwise indicated or where space problem occurs, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.05 IDENTIFICATION

A. Comply with Section 26 05 53 - Electrical Systems Identification.

(1) Switches and Receptacles: Use hot, stamped or engraved machine printing with _____-filled lettering on face of cover plate, and durable wire markers or tags inside outlet boxes.

(a) Receptacles: Label shall indicate receptacle voltage, phase, and amperage _____at top of cover plate, and panel and circuit number at bottom of cover plate.

(b) Switches: Label shall indicate switch voltage, phase, and amperage at top of cover plate, and panel, circuit number and switch designation at bottom of cover plate.

(2) Engrave cover plates on all Owner-furnished equipment and equipment furnished under other divisions of these specifications with panelboard, circuit number and “emergency” (where applicable) as specified in this section. This includes headwalls, gas columns and booms, patient consoles, medical rail systems, custom casework with electrical devices, etc. _____.

3.06 FIELD QUALITY CONTROL

A. Inspect wiring devices for defects.

B. Operate wall switches with circuits energized and verify proper operation.

C. Verify receptacle device is energized.

D. Perform tests and prepare test reports:

(1) Test receptacle devices for proper polarity:

(a) Test every receptacle with receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest.

(2) Test each GFCI receptacle device for proper operation:

(a) Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. “TEST” button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shut off power with 5/1000 A within 1/40 second and retest.

(3) In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.

(4) Test Instruments: Use instruments that comply with UL 1436.

(5) Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

E. Tests for Convenience Receptacles:

(1) Line Voltage: Acceptable range is 105 V to 132 V.

(2) Percent Voltage Drop under 15A Load: A value of 5% or higher is not acceptable.

(3) Ground Impedance: Values of up to 2 ohms are acceptable.

(4) GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

(5) Using the test plug, verify that the device and its outlet box are securely mounted.

(6) The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

F. Test straight blade _____ for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz (113 g).

G. Operational Tests: Demonstrate the operation of each switch with the systems fully energized and operating. Each switch shall be demonstrated three times.

H. Interpret test results in writing and submit to Engineer.

3.07 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.08 CLEANING

A. Remove excess plaster from interior of outlet boxes.

B. Clean devices and cover plates after painting is complete. Replace stained or improperly painted devices and cover plates.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 73 - Power System Studies
B. Section 26 23 00 - Low-Voltage Switchgear
C. Section 26 24 13 - Switchboards
D. Section 26 24 16.16 - Distribution Panelboards
E. Section 26 24 19 - Motor-Control Centers
F. Section 26 28 16 - Enclosed Switches and Circuit Breakers
G. Section 26 29 13 - Enclosed Controllers

1.02 DESCRIPTION

A. Section includes nonrenewable cartridge fuses, rated 600V and less, for use in low-voltage power distribution system and spare fuse cabinet.

1.03 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses
B. UL 248-1 - Low Voltage Fuses - Part 1: General Requirements
C. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses
D. UL 248-5 - Low-Voltage Fuses - Part 5: Class G Fuses
E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses
F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses
G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses
H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses
I. UL 512 - Fuseholders

1.04 SUBMITTALS

A. Product Data:
   (1) Submit the following for each fuse type and size indicated:
      (a) Manufacturer's technical data on features, performance, electrical characteristics, ratings, and dimensions.
      (b) Time-current curves, coordination charts and tables, and related data.
      (c) Let-through current curves for fuses with current-limiting characteristics.
      (d) Fuse size for each elevator disconnect switch.
B. Closeout Submittals:
   (1) Project Record Documents:
      (a) Record actual class, size, and location of fuses.

1.05 QUALITY ASSURANCE

A. Obtain fuses from one source and by single manufacturer.
B. Comply with NFPA 70 for components and installation.

1.06 MAINTENANCE

A. Extra Materials:
   (1) Furnish to the Owner a quantity of spare fuses equal to _____% of the total quantity of each fuse class and size installed, minimum of 3 of each fuse class and size.
   (2) Furnish _____ fuse pullers for each size fuse.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Cooper Bussmann
B. Mersen
C. Littelfuse
D. Edison Fusegear

2.02 CARTRIDGE FUSES

A. NEMA FU 1, UL 248-1.

B. Characteristics: nonrenewable current-limiting cartridge fuse; current rating and class, as specified or indicated, and voltage rating consistent with circuit voltage.

C. Miscellaneous data:

UL Standard	Class	Volts	Amperage	Interrupting Rating (Amp RMS Sym.)
248-4	CC	600	0-30	200,000
248-5	G	600	0-20	100,000
248-5	G	480	25-60	100,000
248-8	J	600	0-600	200,000
248-10	L	600	601-6000	200,000
248-12	RK1	250 or 600	0-600	200,000
248-12	RK5	250 or 600	0-600	200,000
248-15	T	300	0-1200	200,000
248-15	T	600	0-800	200,000

2.03 FUSEBLOCKS

A. UL 512

B. Thermoplastic base with UL flammability 94VO

C. Clip reinforcing springs – 100A and above

D. 200,000 A RMS Sym withstand rating

E. Copper or aluminum connections

2.04 TOUCH SAFE FUSEHOLDERS

A. UL 4248

B. Thermoplastic base with UL flammability 94VO

C. Cover over fuses

D. Neon indicator lamp: “ON” when fuse opens

2.05 SPARE FUSE CABINET

A. Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified with 10% capacity minimum.

B. Doors shall be hinged, with hasp for Owner’s padlock.

C. Finish shall be _____.

D. Cabinet shall have nameplate engraved “Spare Fuses” in 1/2” (13 mm) letters on door.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

3.02 INSTALLATION

A. Verify proper fuse locations, sizes, and characteristics.

B. Install fuses in fusible devices (specified in Sections 26 23 00 - Low-Voltage Switchgear, 26 24 13 - Switchboards, 26 24 16.13 - Lighting and Appliance Panelboards, 26 24 16.16 - Distribution Panelboards, 26 24 19 - Motor-Control Centers, 26 28 16 - Enclosed Switches and Circuit Breakers, and 26 29 13 - Enclosed Controllers at job site.

C. Arrange fuses so manufacturer, class, and size are readable without removing fuse.

D. Install typewritten labels on inside door of each fused device, indicating fuse replacement information.

E. Install spare fuse cabinet ____.

3.03 APPLICATION

A. Main Service: _____.

B. Main Feeders: _____.

C. Motor Branch Circuits: _____.

D. Other Branch Circuits: _____.

3.04 CLEANING

A. Clean fuses and tighten connections prior to energizing of equipment.

END OF SECTION 26 28 13

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
E. Section 26 05 53 - Electrical Systems Identification
F. Section 26 05 73 - Power System Studies
G. Section 26 08 12 - Power Distribution Acceptance Tests
H. Section 26 08 13 - Power Distribution Acceptance Test Tables
I. Section 26 28 13 - Fuses

1.02 DESCRIPTION

A. Section includes fusible and non-fusible disconnect switches and circuit breakers in individual enclosures.

1.03 REFERENCE STANDARDS

A. ANSI//NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting
B. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures
C. NEMA BS 31047 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
D. NFPA 70 - National Electrical Code
E. UL 98 - Enclosed and Dead Front Switches
F. UL 486A-486B - Wire Connectors
G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
H. UL 869A - Reference Standard for Service Equipment

1.04 SUBMITTALS

A. Product Data:
   (1) Submit catalog cut sheet indicating voltage, amperage, HP ratings, enclosure type, and dimension, fuse clip features, terminal lugs and all accessories including interlock devices, short circuit current ampere rating and factory settings of individual protective devices.
B. Manufacturer’s Installation Instructions:
   (1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
C. Test Reports:
   (1) Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
D. Closeout Submittals:
   (1) Project Record Documents:
      (a) Record actual locations of disconnect switches and ratings of installed fuses.
      (b) Record actual locations and continuous current ratings of enclosed circuit breakers.
   (2) Operation and Maintenance Data:
      (a) Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      (b) Include spare parts data listing, source, and current prices of replacement parts and supplies.
      (c) Include Manufacturer’s Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.05 QUALITY ASSURANCE

A. Obtain disconnect switches and enclosed circuit breakers from one source and by single manufacturer.
B. Regulatory Requirements:
   (1) Comply with NFPA 70 for components and installation.
   (2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Certifications:

(1) Furnish Engineer with Manufacturer's Seismic Qualification Certification: Submit certification that disconnect switches and enclosed circuit breakers, accessories, and components will remain _____ to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems. Include the following:

(a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with manufacturer's written instructions.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Square D

B. ABB-GE Industrial Solutions

C. Eaton Cutler-Hammer

D. Siemens

2.02 DISCONNECT SWITCHES

A. NEMA BS 31047, UL 98

B. Load interrupter enclosed knife switch, _____ type.

C. Fusible or non-fusible type as indicated.

D. Switch Interiors:

(1) Switch blades that are visible in "OFF" position when switch door is open.

(2) Plated current carrying parts.

(3) Removable arc suppressors to permit easy access to line side lugs.

E. Switch Mechanism:

(1) Quick-make, quick-break, with visible blades and externally operable handle.

(2) Lockable only in "OFF" position and accept three industrial type, heavy-duty padlocks.

(3) Dual cover interlock to prevent unauthorized opening of switch door when handle is in "ON" position, and to prevent closing of switch mechanism with door open.

(4) Defeater mechanism to bypass interlock.

(5) Operating handle integral part of enclosure.

(6) Handle to physically indicate "ON" and "OFF" position.

F. Ratings:

(1) Ampacity as indicated on drawings.

(2) Horsepower rated.

G. Fusible Switches:

(1) Rejection clips for Class R fuses specified.

(2) Provisions for Class J or Class L fuses, as applicable.

(3) Fuses: Per requirements in Section 26 28 13 - Fuses.

2.03 ENCLOSED CIRCUIT BREAKERS

A. NEMA AB 1, UL 489.

B. Enclosed molded-case circuit breakers:

(1) Tripped indication clearly shown on breaker handle taking position between "ON" and "OFF".

(2) 225A frame size and below: thermal-magnetic trip.

(3) 250A frame size and above: electronic (solid-state microprocessor-based) trip units interchangeable in the field within the frame size and field-adjustable ____ current settings. Each adjustment shall have discrete settings and shall be independent of other adjustments.

C. Breaker Mechanism:
   (1) Quick-make, quick-break.
D. Ratings:
   (1) Ampacity as indicated on drawings.
   (2) Listed as Type HACR for air conditioning equipment circuits.
   (3) Listed as Type SWD for lighting circuits.

2.04 LUGS

A. Front removable lugs.
B. Labeled for 75°C copper and aluminum conductors.
C. Multiple lugs to match number of conductors per phase.
D. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

2.05 ACCESSORIES:

A. Solid neutral assembly, where required.
B. Equipment ground kit.

2.06 ENCLOSURES

A. NEMA BS 31047, NEMA AB 1, UL 98, UL 489, as applicable.
B. NEMA Type 1, Type 3R (outdoor locations) ____ enclosure.
C. Code-gauge galvanized steel.
D. Manufacturer's standard gray enamel finish over prime coat.
E. Surface-mounted. ____.

2.07 SERVICE ENTRANCE

A. UL 869A
B. Switches and circuit breakers identified for use as service entrance equipment are to be labeled for this application, provided with solid neutral assembly and equipment ground bar, and must include connection for bonding and grounding of neutral conductor.

2.08 SHORT CIRCUIT CURRENT RATING

A. Each circuit breaker shall have minimum short circuit current rating as indicated on drawings.

PART 3 - EXECUTION

3.01 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.
B. Verify that "touch-up" paint kit is available for repainting.

3.02 EXAMINATION

A. Examine areas and surface to receive disconnect switches and enclosed circuit breakers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
B. Verify that space indicated for disconnect switches and enclosed circuit breakers mounting meets code-required working clearances.
C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.03 INSTALLATION

A. Install disconnect switches and/or enclosed circuit breakers in accordance with ANSI/NECA 1.
B. Install disconnect switches and/or enclosed circuit breakers level and plumb, in accordance with manufacturer's written instruction.
C. Disconnect switches and enclosed circuit breakers mounting and seismic restraints:
   (1) Install disconnect switches and enclosed circuit breakers anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the _____ of _____, and to comply with Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems for seismic criteria.
   (2) Fasten disconnect switches and enclosed circuit breakers firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.

(3) Anchor and fasten disconnect switches and enclosed circuit breakers and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 05 29 - Hangers and Supports for Electrical Systems.

(4) Install two rows of steel slotted channel, with a minimum of four attachment points, for each disconnect switch and enclosed circuit breaker.

(5) When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.

D. Do not support disconnect switches and/or enclosed circuit breakers by raceway.

E. Install top disconnect switch and/or enclosed circuit breaker handle a minimum of 3’-6” (1 m) and maximum of 6' 6" (2 m) above finished floor.

F. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

G. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification. Attach nameplate to exterior of each switch and/or enclosed circuit breaker using small corrosion-resistant metal screws or rivets. Do not use contact adhesive.

(1) Include switch and/or enclosed circuit breaker name, amperage, voltage, phase, and number of wires.

H. Install fuses in fusible switches at job site per requirements in Section 26 28 13 - Fuses.

3.04 CONNECTIONS

A. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment connections, anchorage, and grounding.

B. Correct malfunctioning units on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

C. Test disconnect switches and/or enclosed circuit breakers per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests.

D. Interpret test results in writing and submit to Engineer.

3.06 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.07 ADJUSTING

A. Circuit Breakers: Set field-adjustable trip settings or change the trip settings recommended by the overcurrent protective device coordination study per Section 26 05 73 - Power System Studies.

3.08 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 26 28 16

SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 25 05 53 - Instrumentation Tagging
E. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
F. Section 26 05 53 - Electrical Systems Identification
G. Section 26 08 12 - Power Distribution Acceptance Tests
H. Section 26 08 13 - Power Distribution Acceptance Test Tables
I. Section 26 28 13 - Fuses

1.02 DESCRIPTION

A. Section includes enclosed manual and magnetic motor controllers and enclosed contactors.
B. Motors shown on the drawings or specified in other Divisions of these specifications shall be provided with motorized equipment and connected under this section. Provide motor controllers and power circuit disconnect devices for all motors, unless shown or specified to be furnished with motorized equipment under other Divisions of these specifications, and by others, for installation by this contract.
C. Variable-frequency controllers furnished by Division 23 for installation by Division 26.
D. Motor Voltage Information:
   (1) Voltages available are: _____ and 480 V, 3-phase and 120, 208 and 277V single phase. Circuits are designed for motors with voltage ratings as follows:
      (a) Smaller than 1/2 hp (0.37 kW) motors: 115 V, single phase.
      (b) 1/2 hp (0.37 kW) motors and larger: _____ and 460 V, 3-phase.

1.03 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting
B. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures
C. NEMA EN 10250 – Enclosures for Electrical Equipment (1000 V Maximum)
D. NEMA ICS 2 – Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 VAC or 750 VDC
E. NEMA ICS 4 – Industrial Control and Systems: Terminal Blocks
F. NEMA IA 10039 – Industrial Control and Systems: Control Circuit and Pilot Devices
G. NEMA IA 10030 – Industrial Control and Systems: Enclosures
H. NEMA BS 31047 – Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
I. NEMA MG 00001 – Motors and Generators
J. NFPA 70 – National Electrical Code
K. UL 98 – Enclosed and Dead Front Switches
L. UL 486A-486B – Wire Connectors
M. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures
N. UL 508 – Industrial Control Equipment

1.04 SUBMITTALS

A. Product Data:
   (1) Motor controllers: Submit catalog cut sheets showing voltage, size, rating and size of switching and overcurrent protective devices, dimensions, and enclosure details.
   (2) Contactors: Submit catalog cut sheets showing voltage, size, current rating, dimensions, and enclosure details.
   (3) Factory settings and time-current curves of individual protective devices.
   (4) Confirm motor sizes and voltages with submittals of other Divisions of specifications, and/or by others, prior to Section submittals.
B. Manufacturer’s Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and/or starting of product.

C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:

(1) Project Record Documents:

(a) Record actual locations and ratings of enclosed motor controllers and enclosed contactors.

(2) Operation and Maintenance Data:

(a) Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

(b) Include spare parts data listing, source, and current prices of replacement parts and supplies.

(c) Include Manufacturer Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.05 QUALITY ASSURANCE

A. Obtain motor controllers, and contactors from one source and by single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70 for components and installation.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Certifications:

(1) Furnish Engineer with Manufacturer Seismic Qualification Certification: Submit certification that motor controllers, contactors, accessories and components will remain _____ to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems. Include the following:

(a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

(2) Certification shall bear the seal and signature of an Engineer registered and licensed in the _____ of _____.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.08 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.

(1) Spare pilot lights: Furnish 1 spare lamp for every 5 installed units, but not less than 1 set of 3 of each kind.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Square D

B. ABB-GE Industrial Solutions

C. Eaton Cutler-Hammer

D. Siemens

E. Allen Bradley

2.02 MANUAL MOTOR CONTROLLERS

A. Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for small motors, with ____ type overload relay, ____ and ____ operator.

2.03 FRACTIONAL-HORSEPOWER MANUAL CONTROLLERS

A. Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with _____ type overload relay, _____ pilot light, and _____ operator.

2.04 MOTOR STARTING SWITCHES

A. Description: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with ____ pilot light, and ____ operator.

2.05 FULL-VOLTAGE NON-REVERSING MAGNETIC MOTOR CONTROLLERS

A. Description: NEMA ICS 2, AC general-purpose, Class A, magnetic controller for induction motors rated in horsepower, three-phase and single-phase, as scheduled, except where single-phase motors scheduled to be provided with built-in overload elements:
   (1) Size _____ minimum
   (2) Control Voltage: 120 V, 60 Hz
   (3) Overload Relays: NEMA ICS 2, solid-state _____, 1 overload relay per phase:
      (a) Solid-state type:
         1) Class _____ inverse-time tripping characteristics.
         2) Non-volatile operating memory.
         3) 3:1 current adjustment range.
         4) Phase loss/phase unbalance protection.
         5) Ambient temperature insensitive.
         6) Self-powered.
         7) Manual reset. Automatic recent not acceptable.
         8) Manual trip.
         9) Visible trip indication.
      (b) _____ type:
         1) Class _____ inverse-time tripping characteristics.
         2) Manual reset.
   (4) Features:
      (a) Auxiliary Contacts: NEMA ICS 2, ____ each ____ contacts in addition to seal-in contact.
      (b) Pushbuttons: ____ type.
      (c) Pilot Lights NEMA IA 10039: push-to-test LED _____, _____ type.
      (d) Hand-Off-Auto (H-O-A) Selector Switches: _____
      (e) Control Power Transformers: 120V secondary, adequate capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity in each motor controller, but not less than 100VA. Fused primary and secondary, and unfused leg of secondary bonded to enclosure.
      (f) Terminals: NEMA ICS 4.
      (g) Other accessories detailed or required by drawings.

2.06 COMBINATION CONTROLLERS

A. Factory-assembled motor controllers with externally operable disconnect, _____ type, in common enclosure; means for locking disconnect handle and means for defeating cover interlock.

2.07 FULL VOLTAGE NON-REVERSING MULTI-SPEED MAGNETIC MOTOR CONTROLLERS

A. Description: Same as full voltage non-reversing single-speed magnetic motor controllers with addition of the following:
   (1) Speed selector switch
   (2) Auto-Off-Low-High selector switch

2.08 REDUCED VOLTAGE MOTOR CONTROLLERS

A. Motor controllers for NEMA rated _____ V motors 25 hp (18.4 kW) ____ and above.
B. Motor controllers for NEMA rated 460 V motors 60 hp (44.1 kW) ____ and above.

2.09 AUTOTRANSFORMER REDUCED-VOLTAGE CONTROLLERS

A. Description: NEMA ICS 2, closed transition.

2.10 MOTOR CONTROLLER ACCESSORIES

A. Factory installed devices in controller enclosure, unless otherwise indicated, as follows:
   (1) “On-Off” and “Start-Stop” pushbutton stations, pilot lights, selector switches: NEMA ICS 2, _____ duty, oiltight type.
   (2) 120 V control circuits and pilot light, unless otherwise noted.
   (3) Red pilot light to indicate motor operation.
   (4) Green pilot light to indicate motor stopped.
   (5) Minimum wire size for control circuits: #14 AWG.

(6) Stop and Lockout Pushbutton Station: Momentary-break pushbutton station with a factory-applied hasp arranged so a padlock can be used to lock pushbutton in depressed position with control circuit open, where indicated.

B. Control services: As scheduled on motor schedule or indicated.

2.11 GENERAL PURPOSE MAGNETIC CONTACTORS

A. Description: NEMA ICS 2, same as magnetic controllers, except without overload protection.

B. Poles: To match circuit configuration and control function.

C. Configuration: _____

D. Contact Rating: Match branch circuit overcurrent protection.

2.12 LIGHTING MAGNETIC CONTACTORS

A. Description: NEMA ICS 2, same as magnetic controller, except without overload protection.

B. Poles: To match circuit configuration and control function.

C. Configuration: _____

D. Contact Rating: Match branch circuit overcurrent protection.

2.13 LUGS

A. Labeled for 75°C copper and aluminum conductors.

B. Multiple lugs to match number of conductors per phase.

C. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

D. For equipment specified in this section and for equipment furnished under other Divisions of this specification and/or by others.

2.14 MOTOR CONTROLLERS AND CONTACTOR ENCLOSURES

A. NEMA EN 10250, NEMA IA 10030.

B. NEMA Type 1, Type 3R (outdoor locations) _____ enclosure.

C. Code-gauge galvanized steel.

D. Manufacturer’s standard gray enamel finish over prime coat.

E. Surface-mounted. Flush-mounted where indicated.

PART 3 - EXECUTION

3.01 COORDINATION

A. Coordinate motor control wiring with Division 23 of these specifications.

B. Coordinate motor sizes and voltages with submittals of other Divisions of these specifications and/or by others.

C. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.02 EXAMINATION

A. Examine areas and surface to receive motor controllers and contactors for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for motor controllers and contactors mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data.

3.03 INSTALLATION

A. Install motor controllers and contactors in accordance with ANSI/NECA 1.

B. Install level and plumb, in accordance with manufacturer’s written instruction.

C. Motor controllers and contactors mounting and seismic restraints:

(1) Install motor controllers and contactors anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the _____ of _____, and to comply with Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems for seismic criteria.

(2) Fasten motor controllers and contractors firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.

(3) Anchor and fasten motor controllers and contactors and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 05 29 - Hangers and Supports for Electrical Systems.

(4) Install two rows of steel slotted channel, with minimum of four attachment points, for each motor controller and contactor.

(5) When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.

(6) Do not support motor controllers and contactors only by raceway.

D. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening valves. Where manufacturer's torque valves are not indicated, use those specified in UL 486A-486B.

E. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification. Attach nameplate to exterior of each motor controller and contactor, using small corrosion resistant metal screws or rivets. Do not use contact adhesive:

(1) Indicate motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating, and fuse size and type, when applicable.

F. Connect each motor terminal box to rigid conduit system with maximum 18" (450 mm) of flexible liquid-tight metal conduit. Install conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

G. Check for proper rotation and phase relationship of each motor.

H. Install fuses in fusible switch at job site pre requirements in Section 26 28 13 - Fuses.

I. Control Wiring Installation:

(1) Install wiring between motor control devices according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

(2) Install motor control wiring in accordance with control wiring diagrams and in raceways where indicated or required by contract drawings.

(3) Bundle, train, and support wiring in enclosures.

(4) Connect hand-off-automatic switch and other automatic-control devices where applicable.

(a) Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

(b) Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 APPLICATION

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, and configuration of pilot device and control circuit affecting controller functions.

3.05 CONNECTIONS

A. Provide green wire ground through flexible conduit to interconnect motor frame and rigid conduit system.

B. Ground and bond motor controller and contactor enclosures according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Connect power and control wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

D. Connect control wiring for operation, control and supervision of motorized equipment as shown on drawings and/or specified in this and other Divisions of these specifications.

3.06 FIELD QUALITY CONTROL

A. Inspect motor controllers and contactors for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.

B. Correct malfunctioning motor controllers and contactors on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

C. Test continuity of each circuit.

D. Test motor controllers per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables

E. Interpret test results in writing and submit to Engineer.

3.07 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.08 ADJUSTING

A. Set field-adjustable circuit breakers trip settings or change the trip settings as indicated on drawings.

B. Adjust motor circuit protectors.

3.09 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 26 29 13

SECTION 26 32 13 - ENGINE GENERATORS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 22 07 00 - Plumbing Insulation
B. Section 23 12 14 - Liquid Fuel Systems
C. Section 23 21 18 - Valves
D. Section 23 31 14 - Ductwork
E. Section 23 33 14 - Ductwork Specialties
F. Section 26 00 00 - General Electrical Requirements
G. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
H. Section 26 05 26 - Grounding and Bonding for Electrical Systems
I. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems
J. Section 26 08 12 - Power Distribution Acceptance Tests
K. Section 26 08 13 - Power Distribution Acceptance Test Tables
L. Section 26 23 13 - Paralleling Low-Voltage Switchgear
M. Section 26 36 23 - Automatic Transfer Switches

1.02 DESCRIPTION OF SYSTEM

A. Section describes complete package generator set, unit-mounted radiator cooling system, , microprocessor based control and monitoring panel, battery and charger, remote annunciator and drop over sound attenuated enclosure .
B. Package generator set rated for emergency.
C. Engine fuel system:

1.03 REFERENCE STANDARDS

A. NEMA MG 00001 – Motors and Generators
B. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
C. NFPA 37 - Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines
D. NFPA 110 – Standard for Emergency and Standby Power Systems
E. UL 2200 – Stationary Engine Generator Assemblies
F. IEC8528 Part 4 – Control Systems for Generator Sets
G. UL 142 – Steel Aboveground Tanks for Flammable and Combustible Liquids
H. UL 2085 – Protected Aboveground Tanks for Flammable and Combustible Liquids

1.04 SUBMITTALS

A. Shop Drawings
   (1) Submit for engineering review and approval prior to production release. Include the following for engine-generator:
      (a) Outline drawings of equipment showing weights
      (b) Overall dimensions including bolting template and earthquake restraints
      (c) Right hand, left hand, end, and top views of proposed assembly
      (d) Battery, battery rack, battery charger, and wiring diagrams
      (e) Vibration isolation bases, mounts, and hangers
      (f) Exhaust silencer and flexible fittings
      (g) Stub ups for fuel
      (h) Power and control wiring entrance locations
      (i) Main circuit breaker size, location, and required clearance
      (j) Lug sizes and locations
      (k) Engine-generator control panel drawings showing devices to be provided, with each device referenced to material list with complete description for device.
      (l) Weather protective enclosure installation drawings, structural calculations, lighting fixture catalog cut, conduit, and wiring.

(m) Enclosure sound performance data
(n) Muffler characteristics
(o) Calculations for starting based on step loads outlined in Paragraph 2.2, B.5.
(p) Factory certified prototype test report indicating fuel efficiency and emission levels

(2) Information on engine characteristics:
(a) Make, type, and number of cylinders
(b) Brake horsepower (bhp) available
(c) Jacket water heat rejection
(d) Cooling pump characteristics
(e) Exhaust flow rate and temperature at 25, 50, 75, and 100% rated load
(f) Ventilation requirements
(g) Combustion air requirements
(h) Fuel consumption rates at 25, 50, 75, and 100% rated load
(i) Liquid refill capacities
(j) Exhaust backpressure limitation
(k) Type and manufacturer of governor
(l) Alternator size to limit voltage dip to 10%

(3) Information on generator characteristics:
(a) Make and type
(b) Type of construction and overspeed capabilities
(c) Temperature rise
(d) Regulation characteristics
(e) Ventilation requirements
(f) Type of winding insulation
(g) KW power factor
(h) Type of exciter and voltage regulator

(4) Manufacturer seismic qualifications: Submit certification that _____, engine-generator set, batteries, battery rack, accessories, and components will withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems.

B. Interconnection detail drawing showing control and power connections in complete standby system. Control connections between components are to be labeled with identical nomenclature. Coordinate with generator manufacturer.

C. Accessories including fuel lines, flexible exhaust couplings, exhaust flange, and other exhaust system components.

D. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

E. Complete test specification detailing testing procedures to be used to verify performance of equipment provided and aligning with NFPA 110 testing requirements. Provide written documentation of testing to be completed to engineer of record and owner for review and approval prior to starting testing.

F. Recommended spare parts lists.

G. Test Reports:

(1) Submit certified factory tests report on engine-generator delivery. Alarms, sensors, and meters must be tested and certified.

(2) Submit, upon completion of installation and testing of engine-generator sets, certified test reports from required NFPA 110 testing for each engine-generator.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Handle equipment in accordance with manufacturer's written instructions. One copy of instructions is to be included with equipment at time of shipment. Maintain factory bracing, packaging, and wrapping.

1.06 OPERATION AND MAINTENANCE MANUALS

A. Refer to Section 01 77 00 - Closeout Procedures and herein below.

B. Submit Operation and Maintenance (O&M) manuals to Engineer for review 60 days prior to acceptance of unit.

C. Installation, maintenance, and operating instruction manuals shall include the following:

(1) 100% accurate system “as-installed” drawings, interconnect diagrams, schematic diagrams, wiring diagrams, individual sub-system component manuals, operation procedures, system description with theory of operation, maintenance schedules and procedures, original programmed settings and parameters, and other information necessary for the Owner to maintain, operate, test, and troubleshoot system.

(2) The O&M manual shall contain step-by-step instructions for startup and shutdown. The first page shall contain name, address, and phone number of local representative to be called for service or parts. Follow with complete parts lists by actual ordering catalog numbers. O&M manual also shall contain four copies each of test record forms and service record forms for Owner use. Forms shall show proper interval for testing, servicing, and replacing of components, lubrication, filters, antifreeze, etc., including recommended specifications and fluid levels for lubricants.

(3) Recommended spare parts list (with pricing) for 2 yrs of operation.

D. O&M manuals shall not solely rely on sub-component manuals. Thorough consolidation of operating and maintenance information shall be available in system overview guide. Include major components of system in overview.

E. Turn final reviewed manuals over to Owner prior to conducting training of Owner personnel.

F. Seal single copy of service record forms, recommended operation and service practices for unit in plastic and wall mount in weather-protective enclosure.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable Manufacturers:

(1) Engine Generator Set - Caterpillar, Cummins, MTU, Rehlko

(2) Exhaust Silencer – Maxim, Nelson, or approved equal

(3) Isolation equipment

(4) Battery charger – Sens, La Marche, Charles Industries

2.02 RATINGS AND PERFORMANCE

A. Engine Generator Set

(1) Generator kW Output: ____

(2) Altitude _____ above sea level in ambient temperature of _____.

(3) Stable frequency regulation

B. Alternator

(1) _____ kVA, .8 Power Factor

(2) ____ V, ____ Ph, 60 Hz, ____

(3) Stable voltage regulation 0-full load less than or equal to ± .5%.

C. Transient Performance

(1) Engine

(a) Start and load in 10 seconds per NFPA 110

(b) Accept 100% block load per NFPA 110

(2) Frequency regulation _____ no load to full load. _____.

(3) Alternator

(a) AC waveform output contains <5% total harmonic distortion (THD) at full linear load when measured from line to neutral with <3% in any single harmonic, and no third-order harmonics or their multiples.

(b) Telephone influence factor < 40

(c) Telephone harmonic factor < 3

(d) _____ Fault current capability

D. Factory Prototype Test Certified

(1) Harmonic Distortion Levels

(a) Demonstrate

(2) Airflow Restriction tests

(a) Demonstrate controlled shutdown after overheating

(3) Unit tested with enclosure

(a) UL 2200 listed

(4) 30 Degree Water Spray Unit Rain Test

(a) Demonstrate no water leakage into electrical boxes

(5) Air Filter Test

(a) Demonstrate engine contains engine backfire explosion

E. Factory Production Test Certified

(1) Alternator Impedance to Ground

(2) Dielectric Testing

(a) At 1000 V and 2 times rated voltage

(3) Maximum kW Rating

(4) Engine Response Time

(5) Alternator Construction Testing

(a) Impedance Balance Tested

(6) Alternator Insulation Testing

(a) Surge Tested

2.03 FABRICATION AND MANUFACTURER

A. Engine:

(1) Type: Inline or vee

(2) Four-stroke cycle _____ at _____ RPM consistent with engine durability.

(3) Aspiration: _____

(4) Horsepower

(a) Brake Horsepower _____

(5) Displacement: _____ cylinders with maximum cubic inch displacement of _____ and a maximum BMEP consistent with engine durability.

(6) _____

(7) Fuel Type: No. 2 domestic diesel fuel oil.

(8) Engine accessories:

(a) Fuel filter

(b) Lube oil filter

(c) Intake air filter

(d) Lube oil cooler

1) Suitable for operation of generator set at full rated load in ambient temperature specified.

(e) Fuel transfer pump

(f) Fuel priming pump

1) Engine driven positive displacement, mechanical, full pressure

(g) Gear driven water pump

(h) Electronic direct fuel injection or have suitable emission control equipment

(i) Electric speed sensing governor capable of isochronous regulation.

(j) Safety-shut-offs for:

1) High water temperature

2) Low oil pressure

3) Overspeed

4) Overcranking

(9) EPA Certified Tier _____

B. Cooling System:

(1) Engine skid mounted, engine-driven radiator with blower type fan, sized to maintain safe operation at 122°F (50°C) ambient temperature.

(2) _____ discharge remote mounted radiator sized to maintain safe operation at 122°F (50°C) ambient temperature.

(3) Arrange liquid-cooled prime movers for NFPA level 1 applications for closed-loop cooling.

(4) Provide radiator with:

(a) Motor-driven fan with voltage same as generator

(b) Motor Starter

(c) Initiating contacts to actuate on generator startup

(d) Connect to generator distribution system

(e) Core guard

(f) Fan guard

(g) Mounting hardware

(h) Direct adapter flange. Ductwork with flexible connection between radiator and exhaust plenum to be provided by Division 23. Coordinate with Division 23.

(i) Flexible pipe connections at engine and radiator.

(j) Supply power for fans and pumps on remote radiators from a tap at generator output terminals or ahead of first load circuit overcurrent protective device.

(k) Heat exchangers

(5) Block Heater

(a) Water Jacket Heater: ____

(b) Maintain engine jacket water to 110°F (43°C) in ambient temperature of 30°F (-1°C)

(c) Heater to be equipped with thermostatic switch.

(d) Single phase _____ V

(e) Provide two heaters, 4500 W each minimum.

(6) Fill engine cooling system with solution of 50/50 mix ethylene glycol at initial fill.

(7) Ductwork/pipe with flexible connection between radiator and exhaust dampers to be provided by others. Refer to Section 23 51 00 - Breechings, Chimneys, and Stacks

C. Exhaust System:

(1) Furnish _____ type exhaust silencer:

(a) Sized according to manufacturer's recommendations

(b) Mount so weight is not supported by engine

(c) Flexible exhaust fitting

(d) Installation _____

(e) Refer to Section 23 51 00 - Breechings, Chimneys, and Stacks

(2) Condensate Traps

(a) Drain plug at low point of muffler

(3) Thermal Expansion

(a) Stainless steel exhaust flex to accommodate thermal growth and vibration isolation

(4) Exhaust Blankets

(a) 1" (25 mm) high temperature fiberglass cloth wrap

(b) Coordinate with weather protective enclosure.

(5) Thimble

(a) Pipe and wall of compatible construction

(6) Acceptable Back Pressure

(a) Size silencer and exhaust pipe so exhaust back pressure does not exceed maximum limitations specified by generator set manufacturer.

(7) Exhaust clearing area

D. Starting System

(1) Provide DC electric starting system with positive engagement drive. Provide DC voltage recommended by manufacturer.

(2) Provide fully automatic start-stop controls.

(3) Provide cycle cranking to open and lock out start circuit after 3 attempts to start failed engine start.

(4) Batteries

(a) Provide _____ lead-acid storage battery set:

1) Heavy duty diesel starting type

2) Voltage compatible with starting system voltage

3) Capacity to provide for 1-1/2 minutes total cranking time at 0°F (-17°C) without recharging. In accordance with NFPA Level 1.

(b) Provide vinyl coated steel battery rack.

(c) Provide starting battery heater:

1) Heater plate under battery

2) Heater type blanket around battery case

3) Thermal switch - heater control relay

4) 120 VAC input

(d) Battery cables and clamps

(5) Battery Charger
  (a) Four Rate Battery Charger
    1) Constant current, constant voltage, high-rate taper, and float equalized.
  (b) Dual Rate Battery Charger
    1) Constant current, and float equalized
  (c) Charger Accessories:
    1) Overload protection
    2) _____ line and load regulation
    3) Electronic current limit output 105%
    4) DC ammeter and voltmeter _____.
    5) UL 1236 listed and meets NFPA 110 requirements
    6) Output protection
    7) Temperature compensation
    8) Enclosed in NEMA 1 aluminum or stainless-steel enclosure
    9) Form C contacts for the following alarms
      1. AC fail
      2. Low battery volts
      3. High battery volts
      4. Charger fail
      5. Battery fault
(6) AC input voltage: _____ V
(7) When installed on the engine generator set, mount on vibration isolators.

E. Speed Control
(1) Mechanical: _____% droop
(2) Electronic: Isochronous

F. Alternator:
(1) Maximum temperature rise 275°F (135°C) at 104°F (40°C) ambient
(2) Synchronous type
(3) Self-ventilated
(4) Drip-proof construction
(5) Directly connected to engine flywheel housing with a flex coupling
(6) Capable of sustaining _____ overcurrent for 10 seconds under a 3 Ph symmetrical short circuit
(7) 120 V Anti-Condensation heater
(8) Subtransient Reactance limited to 12%
(9) Insulation
  (a) Complies with NEMA (MG1-33.4)
  (b) Class H Insulation Systems
    1) UL 1449 recognized
    2) Vacuum impregnated with epoxy varnish
    3) Fungus resistant
(10) _____.
  (a) PMG shall derive excitation current from pilot exciter mounted on the rotor shaft. It is to be able to sustain 300% of rated current for ten seconds during a fault condition.
  (b) Self-excited system to be brushless and consist of a 3 Ph armature and a 3 Ph full wave bridge rectifier mounted on the rotor shaft. Include surge suppressors to protect the diodes from voltage spikes.
(11) Rotor
  (a) _____
  (b) Winding
    1) ____
  (c) Varnish process
    1) Epoxy based material applied to each layer of magnet wire
  (d) Coil supports
    1) Driven through flexible coupling to ensure permanent alignment.

(e) End winding spacing
(f) Amortisseur windings
(g) Bearings
1) _____
2) _____

(12) Stator
(a) _____
(b) Laminations
(c) Cooling air passages and fan
1) Provide space heater to keep alternator free of moisture. Space heater to be 1500 W, 120 VAC, 1 Ph.
(d) Welded laminations to prevent cutting of wires
(e) Skewed stack to minimize slot ripple on output voltage and produce smooth voltage waveform.
(f) Pitch – Skewed design to optimize efficiency and minimize total harmonic distortion.
(g) Varnish process
1) 2 dips and bakes using Class A impregnating varnish

(13) Alternator Components
(a) Output Circuit Breaker(s)
1) _____ 100% _____ rated circuit breaker
2) Adjustable long time, long time delay, short time, and short time delay curve shaping elements
3) Shunt Trip for integration with load bank controls
4) Solid state trip fixed mounted insulated case _____ circuit breaker
5) NEC required access in front of breaker
6) Ground fault alarm only: Monitoring relay for breaker 1000A and above. Relay to be adjustable from 3.8 – 1200A and include an adjustable time delay of 0-10S.

G. Controls:
(1) NFPA 110 listed
(2) Micro-processor based solid state controls to automatically start, protect and monitor engine-generator set with panel illuminating lighting and digital display.
(3) Control panel includes:
(a) Solid state trip main circuit breaker
(b) Motor starting switch
(c) Electrically operated fuel control
(d) Relay to disconnect battery charger during cranking
(e) Switching lamps and meters to be oil tight and dust tight. All active components to be installed within a NEMA _____ enclosure. There shall be no exposed components with door open operating 750 V.
(f) Protective relays to open main circuit breaker and shut down and lockout engine on abnormal conditions including:
1) Overspeed
2) Operation of Remote Stop
3) Overcrank _____
4) Low lube oil pressure _____
5) High Engine Temp _____
6) _____
7) _____
8) _____
(g) Monitoring items shall include but is not limited to the following items and control:
1) Coolant temperature
2) Oil pressure
3) Battery voltage
4) RPM
1. Voltmeter, 3-1/2" (90 mm) dual type, 0.5% accuracy with selector switch
2. Ammeter, 3-1/2" (90 mm) dual type, .05% accuracy with selector switch
5) Frequency meter, 55-65 Hz ±0.125 Hz.

6) Running Time Meter (hours and 1/10 hours)
7) AC power metering to be 0.5% accuracy and include frequency, phase, selector switch with real time power metering including, kW, kVA, kVAR, kWh, PF, % of rated load.

(h) Control Items:
1) Voltage level adjustment rheostat
2) Overspeed level adjustment
3) Overvoltage level adjustment
4) Undervoltage level adjustment
5) Overfrequency level adjustment
6) Underfrequency level adjustment
7) Position function switch(es) marked AUTO, MANUAL RUN, OFF/RESET and STOP
8) 4 NO and 4 NC dry contacts for local and remote alarms, wired to terminal strips.
9) Emergency off mushroom button
10) Automatic remote start capability. Engine cranking system to permit minimum 4 cranking attempts of 10 seconds (adjustable) duration with rest of periods of 10 seconds (adjustable).
1. Overcrank lockout shall occur after 4 cranking attempts.

(i) In accordance with NFPA 110, Level 1, control panel shall furnish battery-powered individual visual alarm indicator functions at battery voltage and visual and audible pre-alarm:
1) Overcrank
2) Low water temperature
3) High engine temperature pre-alarm
4) High engine temperature
5) Low lube oil pressure pre-alarm
6) Low lube oil pressure
7) Overspeed
8) Low fuel main tank
9) Low coolant level
10) EPS supplying load
11) Control switch not in automatic position
12) High battery voltage
13) Low cranking voltage
14) Low voltage in battery
15) Battery charger ac failure
16) Lamp test
17) Contacts for local and remote common alarm
18) Low starting air pressure
19) Low starting hydraulic pressure

(j) Engine shut down, with audible alarm:
1) Low oil pressure
2) High engine temperature
3) Overcrank
4) Overspeed

(k) Status report:
1) Engine running
2) Circuit breaker open
3) Circuit breaker closed

(4) Visual alarm resettable only after fault condition has been corrected.

(5) Audible alarm shall include silencing circuit, which, after activation, will permit annunciation of subsequent failures.

(6) Control Panel mounting:
(a) Mounted on engine generator set in NEMA 1 enclosure on shock isolators
(b) Wall mounted in NEMA 1 enclosure
(c) Free standing in NEMA 1 enclosure

(7) Provide remote annunciator panel

(a) Compliant with NFPA Level 1 requirements.

H. Isolate engine generator set from building structure and from connecting services.

(1) Separately derived grounding system. Connect generator ground as shown on drawings to grounding electrode system.

I. Termination Bars and Connections:

(1) Silver- or tin-plated copper bus bars for terminating cables.

(2) Standard NEMA standard bolt hole spacing, for 3 Ph and neutral, within generator connection box with gasketed bolt on cover.

(3) Engine-generator set control interfaces to other system components to be made on a permanently labeled terminal block assembly. Provide labels describing connection points.

(4) Connections to engine-generator set: Flexible or isolation type connections. Include electrical, fuel, exhaust, and ventilation connections.

J. Equipment Bases:

(1) Mount complete unit on a structural steel sub-base, rectangular in shape, with sufficient rigidity to maintain alignment of generator set. Provide perimeter beams with minimum depth equal to 1/10 of longest dimension of base, except beam depth need not exceed 14" (350 mm) provided that deflection and misalignment are kept within acceptable limits as determined by manufacturer. Engine-generator set to be statically and dynamically balanced at factory. Peak-to-peak amplitude of vibration velocity in horizontal, vertical, and axial direction shall not exceed 0.65" (17 mm) per second at main structural components.

(2) Engine-generator set weight distribution is to be considered to provide uniform deflections.

(3) Bases shall provide equipment alignment and assure uniform weight distribution. Provide side brackets on bases to contain isolating mounts and reduce total installed heights of equipment.

K. Vibration Isolators:

(1) Prevent equipment vibrations from being transmitted to enclosure.

(2) Required between the structural steel sub-base and concrete housekeeping pad.

(3) Steel or cast-iron top and bottom housings incorporating 1 or more steel springs with built-in leveling bolts and built-in resilient chocks to control oscillation and withstand lateral forces in all directions.

L. Custom Walk-in Weather Protective Enclosure

(1) Include sub-base tank as described in this specification.

(2) NEMA 3R rated

(a) Sound attenuated enclosure to reduce sound level of engine generator set while operating at full rated load and ventilation to a maximum of ____ at property line from engine generator in free-field environment.

(3) Overall Size:

(a) Drawings show generator footprint, which is maximum allowed for available space.

(b) Air intake limitations as shown on drawings. System operating within space limitations indicated above.

(4) Construction:

(a) Welded, 12 ga (2.657 mm) galvanized steel to ASTM A446/A446M.

(b) Walls: 3" (80 mm) thick satin coat steel formed panels with wall studs 16" (400 mm) on center designed to withstand wind loads as required by UBC.

(c) Roof: 3" (80 mm) thick with 3" (80 mm) deep cross members every 24 inches (600 mm) minimum, seal welded construction, and crowned to prevent ponding of water.

(d) Interior insulation: 3" (80 mm) thick rigid fiberglass. Insulation lined with 22 ga perforated steel screwed in place. Intake and discharge to be lined with poly prior to lining with 22 ga perforated steel.

(e) Interior liner: 22 ga perforated galvanized steel.

(f) Base: Nominal 3" x 2" (80 mm x 50 mm) perimeter mounting angle with 7/8" (22 mm) diameter anchor holes and suited for seismic hold down.

(g) Access doors: Minimum two 18 ga galvanized steel doors, each 36" x 80" (915 mm x 2032 mm), complete with panic hardware with exterior thumb latch, ball bearing hinges, weather stripping, stainless-steel threshold, and drip edge.

(h) Lifting lugs

(5) Ventilation:

(a) Intake: complete with motorized-type damper, hood with silencer, flex connections, and 1/2" x 1/2" (13 mm x 13 mm), 16 ga (1.519 mm) galvanized bird screen.

(b) Discharge: complete with gravity-type damper with discharge duct, hood with silencer, flex connector, and 1/2" x 1/2" (13 mm x 13 mm), 16 ga (1.519 mm)galvanized bird screen.

(6) Electrical:

(a) Include panelboard wired to the following:

1) 6 battery-powered fluorescent fixtures, each with (2) 32W T-8 lamps, battery and wire guard; battery units shall have a minimum run-time of 90 minutes; Provide Columbia KL4-2 SLR, equipped with an electronic .9PF ballast and a parallel Bodine B33 ballast or approved equal.
2) (2) 3-way switches
3) 2 GFCI duplex receptacles
4) 2 block heaters wired to a junction box local to front of generator set
5) Battery charger
6) Battery heater
7) Space heater
8) 120 V circuit for day tank reverse pump
9) 120 V circuit for day tank controls

(b) Wiring shall be #12 AWG minimum in surface-mounted EMT conduit with compression fittings.

(c) Coordinate all loads type, voltage, and rating with engine-generator supplier prior to ordering panel. See panel schedules for connection of loads.

(d) Provide with 36" (920 mm) space in front of panelboard.

(e) Provide electrical connections from bottom of enclosure. Water seal around enclosure floor penetrations.

(7) Paint:

(a) Clean surfaces to SSPC-SP1, seams sealed, primed with industrial phenolic primer to 1.5 mils (0.0381 mm) D.F.T. Topcoat exterior with Clovacoat epoxy enamel to 2.0 mils (0.0508 mm) D.F.T.

(b) Coordinate color with Architect.

M. Outdoor Weather Protective Drop-Over Enclosure:

(1) Rated NEMA 3R

(2) Attenuation:

(a) Provide engine-generator set with sound-attenuated enclosure. Enclosure will reduce sound level of engine-generator set while operating at full rated load and ventilation running to maximum of _____ at 3 ft (1 m) or _____ at 21 ft (7 m) from engine-generator set in free-field environment.

(3) Overall Size:

(a) Drawings show generator footprint, which is maximum allowed for available space.

(b) Air intake requirements are to be taken into consideration and shall not prevent enclosure from operating within space limitations indicated above.

(4) Construction:

(a) Construction to be welded, 14 ga (1.9 mm) galvanized steel to ASTM A446/A446M.

(b) Package listed to UL 2200

(c) Lockable doors

(d) Include panelboard wired to the following:

1) 6 battery-powered fluorescent fixtures, each with (2) 32W T-8 lamps, battery and wire guard; battery units shall have a minimum run-time of 90 minutes; Provide Columbia KL4-2 SLR, equipped with an electronic .9PF ballast and a parallel Bodine B33 ballast or approved equal.
2) (2) 3-way switches
3) 2 GFCI duplex receptacles
4) 2 block heaters wired to a junction box local to front of generator set
5) Battery charger
6) Battery heater
7) Space heater
8) 120 V circuit for day tank reverse pump
9) 120 V circuit for day tank controls

(e) Interior lights

(f) Remote mounted emergency stop button

(g) Lifting lugs

Refer to Paragraph 2.3.N for fuel system.

(5) Ventilation:

(a) Intake: Complete with _____ damper, hood with silencer, flex connections, and 1/2" x 1/2" (13 mm x 13 mm), 16 ga (1.519 mm) galvanized bird screen to protect against ice and snow.

(b) Discharge: Complete with gravity-type damper with discharge duct, hood with silencer, flex connector, and 1" x 1/2" (13 mm x 13 mm), 16 ga (1.519 mm) galvanized bird screen.

(6) Paint:

(a) Clean surfaces to SSPC-SP1, seal seams, prime with industrial phenolic primer to 1.5 mils (0.0381 mm) D.F.T. Topcoat exterior with Clovacoat epoxy enamel to 2.0 mils (0.0508 mm) D.F.T.

(7) Power Coat Paint. Selections to include white, beige, ASA61 gray, and manufacturer factory standard. Architect to select.

N. Fuel System

2.04 SEISMIC CAPABILITY

A. Engine-generator set and components shall meet requirements of Seismic Zone of project's location without additional external bracing to building structure. Frequency modifying devices are not allowed.

2.05 LOAD PRIORITIES

A. The following load priorities shall be provided:

(1) Priority #1 – UPS

(2) Priority #2 – Elevator 1

(3) Priority #3 – Elevator 2

(4) Priority #4 – ST-101, ST-201

(5) Priority #5 – SHP-301, SHP-302

(6) Priority #6 – Spare

(7) Priority #7 – Spare

(8) Priority #8 – Spare

2.06 PRIORITY LOAD ADDING AND LOAD SHEDDING

A. Load adding and load shedding:

(1) Priority load adding and load shedding are to be provided by automatic opening and closing distribution circuit breakers in standby switchgear.

(2) Upon signal from ATS to start engine, feeder circuit breakers for Priority #1 loads shall remain closed, but feeder circuit breakers for Priority #2 loads, Priority #3 loads, Priority #4 loads, and Priority #5 loads are to be opened.

(3) Provide opening of feeder circuit breakers within no more than 6 seconds and before automatic transfer switch will be connected to engine-generator.

(4) Load adding to be done on load priority basis. Next priority loads to be added based on ascending sequential priority.

(5) Load adding of priority loads to be achieved by closing feeder circuit breakers for corresponding priorities.

(6) Load shedding shall be done on a last-on, first-off basis.

(7) Load shedding of priority loads to be achieved by opening standby switchgear feeder circuit breakers for corresponding priorities, upon signal from Building Control System (BCS) to standby switchgear.

(8) Load shedding is not performed for priority #1 loads.

2.07 INTERFACE WITH BUILDING MANAGEMENT SYSTEM (BMS)

A. Interface shall be as follows:

(1) Control panel shall incorporate communication module with digital communication port connection to building control system (BMS) via Ethernet communication.

(2) Communications shall be for the following:

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDI 1	Low lube oil pressure prealarm	
LDI 2	Low water temperature	
LDI 3	High engine temperature prealarm	
LDI 4	Battery charger AC failure	
LDI 5	Spare	
LDI 6	Control switch not in automatic position	
LDI 7	High battery voltage	
LDI 8	Low coolant level	

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDI 9	Low cranking voltage	
LDI 10	Low voltage in battery	
LDI 11	EPS supplying loads	
LDI 12	Generator circuit breaker ground fault	
LDI 13	Low lube oil pressure	
LDI 14	High engine temperature	
LDI 15	Overcrank	
LDI 16	Overspeed	
LDI 17	Remote emergency manual stop switch	
LDI 18	Overcurrent (circuit breaker trip and lockout)	
LDI 19	Reverse power relay trip	
LDI 20	_____	
LDI 21	Engine running	
LDI 22	Generator running	
LDI 23	Generator circuit breaker open	
LDI 24	Generator circuit breaker closed	
LDI 25	Generator circuit breaker failed to close	
LDI 26	Spare	
LDI 27	Control voltage failure	
LDI 28	Auto start	
LDI 29	Battery charger failure	
LDI 30	Spare	
LDI 31	Spare	
LDI 32	Spare	
LDI 33	Sub-base fuel storage leak	
LDI 34	Spare	
LDI 35	Spare	
LDI 36	Spare	
LDI 37	Spare	
LDI 38	Spare	
LDI 39	Spare	
LDI 40	Spare	
LDI 41	Spare	
LDI 42	Load shed activated Priority #2	
LDI 43	Load shed activated Priority #3	
LDI 44	Load shed activated Priority #4	
LDI 45	Load shed activated Priority #5	

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDI 46	Load shed activated Priority #6 (spare)	
LDI 47	Load shed activated Priority #7 (spare)	
LDI 48	Load shed activated Priority #8 (spare)	
LDI 49	Load demand activated Priority #2	
LDI 50	Load demand activated Priority #3	
LDI 51	Load demand activated Priority #4	
LDI 52	Load demand activated Priority #5	
LDI 53	Load demand activated Priority #6 (spare)	
LDI 54	Load demand activated Priority #7 (spare)	
LDI 55	Load demand activated Priority #8 (spare)	
LDI 56	Air damper closed	
LDI 57	System test mode (lamp test)	
LDI 58	Spare	
LDI 59	Spare	
LDI 60	Spare	
LDI 61	Spare	
LAI 1	Generator phase A-B voltage	Volts
LAI 2	Generator phase B-C voltage	Volts
LAI 3	Generator phase C-A voltage	Volts
LAI 4	Generator phase A current	Amperes
LAI 5	Generator phase B current	Amperes
LAI 6	Generator phase C current	Amperes
LAI 7	Total real power	KW
LAI 8	Total apparent power	KVA
LAI 9	Total reactive power	KVAR
LAI 10	Generator power factor	
LAI 11	Generator phase A frequency	Hertz
LAI 12	Generator phase B frequency	Hertz
LAI 13	Generator phase C frequency	Hertz
LAI 14	Battery voltage	Volts
LAI 15	Engine oil pressure	KPA
LAI 16	Engine speed	RPM
LAI 17	Engine water temperature	Degrees Centigrade
LAI 18	Engine running time	Hours
LAI 19	Spare	
LAI 20	Spare	
LAI 21	Spare	
LDO 1	Remote fault reset	
LDO 2	Remote start initiative	
LDO 3	Cool down override control	

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDO 4	Phase select	
LDO 5	Load adding and load shedding	

Notes:

LDI - LAN: Digital Input from control panel communication module to BMS via Ethernet communication.

LAI - LAN: Analog Input from control panel communication module to BMS via Ethernet communication.

LDO - LAN: Digital Output from BMS to communication module via Ethernet communication.

LAN – Local Area Network

(3) Provide all additional information as required for a complete and operable system.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install engine-generator set and associated equipment as indicated. Coordinate final location of equipment with General Contractor. Final location of equipment to be reviewed with Engineer prior to installation.

B. Install equipment in accordance with manufacturers recommendations. Provide equipment protection during and subsequent to installation.

3.02 ACCEPTANCE TESTS

A. Perform Acceptance Testing in accordance with Section 26 08 12 - Power Distribution Acceptance Tests and Section 26 08 13 - Power Distribution Acceptance Test Tables.

B.

3.03 LOAD TEST

A. Conduct load testing of engine-generator set, under direct supervision of factory-authorized representatives of manufacturers of engine-generator set and _____.

B. Installation is NFPA 110, _____.

C. Testing shall be provided in accordance with NFPA 110. Refer to NFPA 110 for complete testing requirements.

D. Engine-generator set test results are to be certified to comply with specification parameters or necessary corrective actions implemented and tests repeated until compliance is certified at no additional cost to Owner.

E. At conclusion of testing, service engine-generator set including replacing air, oil and fuel filters, changing lubrication oil, checking and refilling batteries, adjusting fan belts for proper tightness, and refilling of cooling system as required.

F. Provide fuel for load testing of engine-generator set.

END OF SECTION 26 32 13

SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 00 00 - General Electrical Requirements

B. Section 26 05 29 - Hangers and Supports for Electrical Systems

C. Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems

D. Section 26 32 13 - Engine Generators

1.02 DESCRIPTION OF SYSTEM

A. Provide automatic transfer switch, 3 phase, 60 Hz, _____ pole, with _____ neutral for voltage and current as indicated on drawings.

1.03 REFERENCE STANDARDS

A. NEMA IA 10042-1 Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment

B. UL 1008 Automatic Transfer Switches

1.04 SUBMITTALS

A. Submit shop Drawings for equipment provided under this Section.

1.05 QUALITY ASSURANCE

A. Obtain automatic transfer switches from one source and by single manufacturer.

B. Regulatory Requirements:

(1) Comply with NFPA 70 for components and installation.

(2) Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Certifications:

(1) Furnish Engineer with Manufacturer Seismic Qualification Certification: Submit certification that switchgear, accessories, and components will remain _____ to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls For Electrical Systems. Include the following:

(a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

D. _____

(1) Test system in accordance at the factory in accordance with Section 26 08 12 - Power Distribution Acceptance Tests and Demonstration of Transfer Functions.

(2) Provide _____.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchgear as required to prevent condensation.

B. Deliver in _____, individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Use factory-installed lifting provisions. Handle carefully to avoid damage to internal components, enclosure, and finish.

1.07 WARRANTY

A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable Manufacturers: Asco by Schneider Electric, Cummins, Russelectric by Siemens, or Zenith by ABB

2.02 AUTO-TRANSFER SWITCH

A. Auto-transfer switch:

(1) Mechanically held, electrically operated type

(2) Interlocked to ensure only 2 possible positions, normal and emergency.

(3) Rated for continuous duty in unventilated sheet metal enclosure
(4) Suitable for all classes of loads at maximum rated voltages
(5) Withstand rating that meets or exceeds withstand rating of transfer switch feeder breakers.
(6) Shall be _____ transition type as specified on drawings.
(a) For closed transition switches, provide option to trip upstream breakers if switch fails to transfer leaving both sources in parallel. Provide shunt trip capability for upstream _____ source breaker and interlock to the transfer switch.

B. Provide main contacts with silver alloy wiping action type protected by arcing contacts.
C. Provide switch components accessible from front of enclosure.
D. Provide 3 cycle short circuit rating to guarantee contact opening and no damage when transfer switch is served by molded case circuit breakers.
E. Provide 10 cycle short circuit rating to guarantee contact opening and no damage when transfer switch is served by power circuit breakers.
F. Provide switch with the following items:
(1) Adjustable 1 to 3 second time delay to override momentary voltage dips and outages.
(2) Time delay on transfer to emergency. Adjustable from 1 to 300 seconds (factory set at 3 seconds).
(3) Time delay on retransfer to normal. Adjustable from 2 seconds to 30 minutes.
(4) Full phase protection consisting of 2 phase relays and one close differential relay. Phase relays shall be set to 70% drop out, 90% pick up, and differential relays set for 92 to 95% pick-up and 83 to 85% drop-out.
(5) Pushbutton reset to normal.
(6) Pushbutton to bypass time delay on retransfer to normal.
(7) Pilot light to indicate normal position.
(8) Pilot light to indicate emergency position.
(9) Auxiliary contact to close when normal power fails.
(10) Auxiliary contact to open when normal power fails.
(11) Auxiliary contact on same shaft as main contacts (closed on normal).
(12) Auxiliary contact on same shaft as main contacts (closed on emergency).
(13) Pushbutton, or selector switch, or graphical display input to provide “Test,” “Auto,” OFF”, and “Engine Start.”
(14) Contacts to start engine-generator when normal power fails.
(15) Time delay engine start, adjustable from 0 to 5 seconds.
(16) Adjustable time delay on retransfer to normal source with 5 minute unloaded running time of standby plant:
(a) Minimum delay 2 minutes
(b) Maximum delay 25 minutes
(c) Built in circuitry to nullify time delay if emergency source fails and power is available at normal source.
(17) Relay to prevent transfer to emergency until voltage and frequency of generating plant have reached 90% of rated value.
(18) Provide bi-direction in-phase monitor or dual motor operator with programmed neutral to allow voltage decay in motor and transformer circuits.
G. Bypass/isolation switch:
(1) Dual source enclosed.
(2) Isolate transfer switch and de-energize for maintenance, testing or repair.
(3) Dual-source operation - bypass either to normal or emergency source directly to load at discretion of operator.
(4) Break-before-make operation of contacts.
(5) Operation - fully mechanical, designed to provide quick-make-quick-break of contacts and only allow switch to be fully closed or fully open with no mid position possible.
(6) Operation - possible regardless of the position or condition of the automatic transfer switch.

2.03 ELEVATOR CONTROL INTERFACE

A. Provide auxiliary contacts to provide emergency system status to elevator controller.
B. Contacts required are:
(1) Emergency power signal
(2) Pre-transfer warning signal
C. Pre-transfer warning signal relay to change state prior to operation of transfer switch in either direction.
D. These contacts are in addition to other required contacts.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations.

B. Provide equipment protection during and subsequent to installation.

C. Provide wiring between transfer switch and elevator controller. Final connections at elevator controller by Elevator Contractor.

D. Connect transfer switches that are part of fire pump controllers.

3.02 OPERATION

A. Parallel “start engine-generator” contacts of automatic transfer switches, such that failure of normal source at any switch shall start engine.

B. Transfer of one switch from normal to emergency shall not preclude any other switch from transferring.

C. Engine generator cool down cycle shall not start until all transfer switches have timed out back to normal source.

3.03 ACCEPTANCE TESTING

A. Perform acceptance testing in accordance with Section 26 08 12 - Power Distribution Acceptance Tests.

B. Adjust or replace equipment as needed to comply with manufacturer's specifications and resubmit corrected test reports.

END OF SECTION 26 36 23

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems

B. Section 26 05 33 - Raceway and Boxes for Electrical Systems

1.02 DESCRIPTION

A. Section includes lightning protection systems consisting of air terminals, roof conductors, bonding conductors, down conductors, fastener connections, and grounding.

1.03 REFERENCE STANDARDS

A. ANSI/NEMA GR 1 - Grounding Rod Electrodes and Ground Rod Electrode Couplings

B. NFPA 70 - National Electrical Code

C. NFPA 780 - Standard for the Installation of Lightning Protection Systems

D. UL 467 – Grounding and Bonding Equipment

E. UL 96 - Lightning Protection Components

F. UL 96A - Installation Requirements for Lightning Protection Systems

1.04 SUBMITTALS

A. Product Data:

(1) Submit manufacturer’s descriptive and technical literature and catalog cuts.

B. Shop Drawings:

(1) Submit installation shop drawings for the overall lightning protection system. Include physical layout of the equipment, mounting details, and relationship to other parts of the work.

(2) Submit detail drawings for each major component.

(3) Submit location, size, and material of grounding electrodes, and connection type.

(4) Submit roof adhesive data for air terminals mounted on single-ply roofing.

C. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply roofing material.

D. Copy of Owner’s UL Master Label Certificate.

E. Manufacturer’s Installation Instructions:

(1) Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

F. Closeout Submittals:

(1) Project record documents:

(a) Record active location of lighting protection system components.

(2) Operation and maintenance data:

(a) Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventative maintenance instructions.

1.05 QUALITY ASSURANCE

A. Qualifications:

(1) Lightning protection system materials:

(a) Consists of standard products by a manufacturer regularly engaged in production of lightning protection systems.

(b) UL Listed

(2) Lightning protection system installer: UL Listed.

B. Regulatory Requirements:

(1) Lightning protection system: Comply with NFPA 780, UL 96, and UL 96A.

C. Certifications:

(1) Furnish Owner with UL Master Label Certificate upon completion of installation providing proof that the lightning protection system is in compliance with UL 96 and UL 96A standards.

1.06 SEQUENCING

A. Coordinate installation of lightning protection with installation of other building systems and components, including supporting structures and building materials, metal bodies requiring bonding to lightning protection components, exterior and interior building finishes, and building roofing.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Thompson Lightning Protection Company
B. Harger Lightning Protection, Inc.
C. Heary Brothers Lightning Protection Company, Inc.
D. National Lightning Protection Corporation
E. Erico International Corporation
F. Approved Equal

2.02 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. NFPA 780, UL 96.
B. Materials: Air terminals, main and cross-run roof conductors, bonding and down conductors, conductor fasteners, air terminal supports, chimney bands, clips, and connections: _____:
   (1) Air terminals: _____ type with a safety tip, _____.
C. ANSI/NEMA GR 1 Grounding Electrodes: 3/4” x 10 ft (19 mm x 3.05 m) long copper-clad steel ground rod.
D. Concrete-Encased Electrodes: As shown on drawings.
E. Solid Copper Ground Plate (if called for on drawings): Where shallow or rocky top soil conditions preclude the use of driven ground rods. This ground plate is 18” x 18” x 20 gauge thick (0.032” minimum) and comes complete with two premium die cast bolt pressure type cable connections for cables through #3/0.
F. Ground Ring Electrode: As shown on drawings.
G. Ground Connectors: Conform to UL 96
   (1) Bronze of the clamp type and bronze clamp accessories.
   (2) Provide in accordance with the requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems.
H. Galvanic Compatibility of Materials:
   (1) Air terminals, conductors, fasteners, and connectors shall be galvanically compatible with surfaces they are mounted to.
   (2) Copper materials in all locations except where the use of aluminum materials is necessary for galvanic compatibility.
   (3) Aluminum materials on copper roofs are not acceptable.
   (4) Aluminum materials where mounted on aluminum roofing, siding, or other aluminum surfaces.
I. Bimetallic fittings when joining metals that are not galvanically compatible.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install lighting protection to comply with UL 96A, NFPA 70, and NFPA 780. Conform to the most stringent requirement in NFPA 780.
B. Bond exterior metals including flashing, roof drains, vent stacks, fans, water pipes, metal raceways, enclosures, frames, and other non-current carrying metal parts of electrical and mechanical equipment on roof to lightning protection system.
C. Bond lower end of exhaust ducts, vent stacks, etc., passing through roof.
D. Run bonding jumpers continuously horizontally or down from point of bond to point of connection to main conductor.
E. Make down conductors electrically continuous, with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Protect down conductors, where necessary, to prevent physical damage or displacement to the conductor. Use PVC Schedule 40 conduits. Provide conduits in accordance with requirements in Section 26 05 33 - Raceway and Boxes for Electrical Systems .
   (1) Provide down conductors for every 100 feet of building perimeter.
   (2) For structural steel construction, utilize steel columns (bond top and bottom) in lieu of down lead conductors – every other column and not to exceed an average of 60 foot spacing.
F. Conceal system conductors and interior conductors.

G. Notify Architect at least 48 H before concealing lightning protection system components.

H. Below-grade or concealed cable connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.

I. Exposed cable connections: Use approved mechanical connections.

J. Air terminals mounted on single-ply roofing: Use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions. For roofing work, refer to Division 07 - Thermal and Moisture Protection.

K. Attach each down conductor to the grounding electrode by _____.

L. Provide grounding electrodes with top 2 ft (0.6 m) below finished grade.

M. Ramps and covered passageways shall be protected by the lightning protection system.

N. For construction utilizing post tensioning systems to secure precast concrete sections, do not use the post tension rods as down conductors. Bond tension rods to the lightning protection and grounding system – follow recommendations of the post tension rod manufacturer.

3.02 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the present of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.03 FIELD QUALITY CONTROL

A. Apply for inspection by Underwriters Laboratories, Inc. (UL) to obtain UL Master Label Certificate.

B. Verify that lightning protection surge arrestor devices are installed on all incoming power and communications lines, in order to obtain UL Master label Certificate.

END OF SECTION 26 41 13

SECTION 26 43 00 - SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 00 00 - General Electrical Requirements
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 23 00 - Low-Voltage Switchgear
D. Section 26 23 13 - Paralleling Low-Voltage Switchgear
E. Section 26 24 13 - Switchboards
F. Section 26 24 16.13 - Lighting and Appliance Panelboards
G. Section 26 24 16.16 - Distribution Panelboards
H. Section 26 27 26 - Wiring Devices

1.02 DESCRIPTION

A. Provide Type 1 Surge Protective Devices (SPD) for the protection of AC electrical circuits formerly known as Transient Voltage Surge Suppression (TVSS) System. Provide high energy surge current diversion and be suitable for application in Type 1 environments.
B. Modes of Protection:
   (1) Line to Ground, Line to Neutral, and Neutral to Ground for services with a neutral
   (2) For Services without a neutral, Line to Line and Line to Ground
C. Provide common and normal modes of protection.

1.03 REFERENCE STANDARDS

A. ANSI/UL 1449 Surge Protective Devices _____ Edition
B. IEEE C62.41.1 – Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits FIPS PUB 94
C. IEEE C62.11 – Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (> 1 kV)
D. IEEE C62.41.1 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
E. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
F. IEEE C62.45 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits
G. IEEE C62.62 IEEE Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000V and less) AC Power Circuits
H. National Electrical Code – Article 285
I. NEMA LA 1 – Surge Arresters
J. National Fire Protection Association – NFPA 20, 70, 75, and 780
K. UL 96A Installation Requirements for Lightning Protection Systems

1.04 SUBMITTALS

A. Submit Shop Drawings for equipment provided under this Section.
B. Submit shop drawings and product information for approval and final documentation in quantities listed according to Conditions of the Contract. Identify customer name, customer location, and customer order number.
C. Submit ANSI/UL 1449 Listing documentation to indicate the following:
   (1) Short Circuit Current Rating (SCCR)
   (2) Voltage Protection Ratings (VPRs) for all modes
   (3) Maximum Continuous Operating Voltage rating (MCOV)
   (4) Nominal Discharge Current rating (I-n)
   (5) Type 1 device
   (6) VPR, MCOV, I-n, and Type 1 information is posted at www.UL.com under Certifications; search using UL Category Code: VZCA. SCCRs are posted in manufacturer's published documentation.
   (7) UL data and visual inspection takes precedence over manufacturer's published documentation.

D. Provide shop drawings including manufacturer installation instruction manual and line drawings detailing dimensions and weight of enclosure, internal wiring diagram illustrating all modes of protection in each type of SPD required, wiring diagram showing field connections, and manufacturer's recommended wire and breaker sizes (if required).

E. Upon request, modules using encapsulation shall be presented without encapsulation for visual inspection, proprietary technology included. MOV type and quantity shall reflect kA ratings on cutsheets, verification of diagnostic monitoring, thermal and overcurrent protection, etc.

PART 2 - PRODUCTS

2.01 MATERIAL

A. Acceptable manufacturers:

(1) Externally mounted unit by the power distribution equipment manufacturer.

(2) Erico

2.02 PERFORMANCE CHARACTERISTICS

A. SPD shall bear the UL Mark and shall be Listed to Third Edition of ANSI/UL 1449. "Manufactured in accordance with" is not equivalent to UL Listing and does not meet intent of specification.

B. Post SPD and performance parameters at www.UL.com under Category Code: VZCA. Products or parameter without posting at UL.com are not approved.

C. Minimum surge current capacity for Service Entrance units based on 8 x 20 microsecond current waveform:

(1) 200,000 A between each phase for line-to-line mode

(2) 200,000 A each phase for line-to-ground mode

(3) 200,000 A each phase for line-to-neutral mode

(4) 200,000 A for neutral-to-ground mode

D. Minimum surge current capacity for panelboard units based on 8 x 20 microsecond current waveform:

(1) 80,000 A between each phase for line-to-line mode

(2) 80,000 A each phase for line-to-ground mode

(3) 80,000 A each phase for line-to-neutral mode

(4) 80,000 A for neutral-to-ground mode

E. Sequential Surge Current Survivability:

(1) 1,000 sequential category surges without failure.

F. Current Rating:

(1) Rated for continuous current and AIC rating of equipment protected.

(2) Mark SPD Short-Circuit Current Rating on the SPD label.

2.03 OPERATING CONDITIONS

A. Temperature range: -40°F to 122°F (-40°C to +50°C)

B. Relative humidity range: 0 to 95%, non-condensing

C. Audible noise level: > 40 dBA at 5 ft (1.5 m)

D. SPD Surface Temperature: less than 131°F (55°C)

2.04 FABRICATION

A. SPD Modules:

(1) UL Labeled as Type 1 (verifiable at www.UL.com), intended for use without need for external or supplemental overcurrent controls. Protect suppression component of every mode, including N-G, by internal overcurrent and thermal overtemperature controls. SPDs relying on external or supplementary installed safety disconnects do not meet intent of specification.

(2) Suppression components: Heavy-duty MOVs, selenium cells, or combination of both.

(3) Provide surge current diversion paths for all modes of protection: L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

(4) Provide service entrance SPD audible diagnostic monitoring by way of audible alarm.

(5) Provide service entrance SPD with 1 set of NO/NC dry contacts for alarm conditions.

(6) Provide visual LED diagnostics including a minimum of 1 green LED indicator per phase, and 1 red service LED. Include an audible alarm with on/off silence function and diagnostic test function (excluding branch).

(7) If a dedicated breaker for the SPD is not provided in the switchgear, switchboard, or panelboard include an integral UL Recognized disconnect switch. Dedicated breaker to serve as a means of disconnect for distribution SPDs.

(8) Meet or exceed the following criteria:

(a) ANSI/UL 1449 Listed Voltage Protection Ratings (VPRs) for 6kV 3000A testing as follows:

VOLTAGE	L-N L-G N-G	L-L
208Y/120V	≤800V	≤1200V
480Y/277V	≤1200V	≤2000V

(9) ANSI/UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	15%	150V
480Y/277	15%	350V

(10) Provide serviceable, replaceable modules (excluding Branch).

(11) Provide warranty for a period of 10 yrs, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.

B. Service Entrance:

(1) Install 1 primary suppressor external to the service entrance in accordance with manufacturer instructions.

(2) Install SPD on line or load side.

(3) Bond SPD ground to service entrance ground.

C. Distribution Panelboards:

(1) Install 1 suppressor external to each designated distribution panelboard.

(2) Install surge suppression device in accordance with manufacturer instructions.

D. SPD Low-Impedance Interconnect Cable:

(1) Provide low-impedance cable specifically listed for SPD installations.

(2) Low impedance approximately 25% of conventional pipe and wire for improved clamping voltage.

PART 3 - EXECUTION

3.01 APPLICATION OF SPD

A. Provide UL approved disconnect switch at Service Entrance or Transfer Switch as a means of service disconnect if a breaker sized per manufacturer's recommendations is not available.

B. Provide independent means of servicing disconnect at Distribution, MCC, and Branch such that the protected panel remains energized. A 30A breaker (or larger based on manufacturer's recommendations) may serve this function.

C. Provide SPD for each panel _____ associated with the _____ branch(es) of power.

3.02 INSTALLATION

A. Install per manufacturer's recommended practices.

B. Provide short and straight conductors not exceeding 3 ft (1 m) in length. Manufacturer-approved cables may be used that allow conductor length to extend beyond 3 ft (1 m) in length without affecting capability of unit.

C. Input conductors twisted together to reduce inductance.

D. Avoid 90-degree bends in cable.

3.03 QUALITY ASSURANCE

A. Factory test system before shipment. Include quality control check, "Hi-Pot" tests at 2 times rated voltage plus 1,000 V, ground leakage tests, and calibration.

B. Manufacturer Qualifications: Engage a firm with at least 5 yrs experience in manufacturing surge protective devices.

C. Manufacturer of equipment shall have produced similar electrical equipment for a minimum period of 5 yrs. When requested by Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with requirement.

D. Provide SPD compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

3.04 FIELD QUALITY CONTROL

A. Inspections before SPD startup:

(1) Visual Inspection:

(a) Verify installation per drawings.

(b) Verify phase, neutral, and ground conductors are properly sized and configured.

(2) Mechanical Inspection:

(a) Check connections for tightness.

(b) Check terminal screws, nuts and/or connectors for tightness.

(3) Electrical Inspection:

(a) Confirm input voltage.

(b) Confirm phase, neutral and ground connections are proper.

3.05 WARRANTY

A. Provide 10 yr manufacturer warranty.

END OF SECTION 26 43 00

SECTION 26 50 00 - LIGHTING

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 00 00 - General Electrical Requirements
B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
C. Section 26 05 19.16 - Manufactured Wiring System
D. Section 26 05 26 - Grounding and Bonding for Electrical Systems
E. Section 26 05 33 - Raceway and Boxes for Electrical Systems
F. Section 26 09 23 - Lighting Control Devices
G. Section 26 09 43 - Network Lighting Controls

1.02 DESCRIPTION OF WORK

A. Provide complete and fully operational lighting system per Contract Drawings and Specifications.
B. Luminaires shall be provided complete with necessary accessories for proper installation.
C. Catalog numbers shown in luminaire schedule are basic luminaire types. Additional features, accessories and options specified, scheduled or necessary for proper installation shall be included.
D. Specifications and drawings convey the features and functions of luminaires only and do not show every item or detail necessary for the work.
E. Work includes final aiming and focusing of luminaires under direction of the Architect/Engineer_____.

1.03 REFERENCE STANDARDS

A. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems (ANSI)
B. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems (ANSI)
C. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems (ANSI)
D. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility
E. UL 676 – Underwater Luminaires and Submersible Junction Boxes
F. UL 773 - Plug-in Photocontrols for use with area lighting
G. UL 924 - Emergency Lighting and Power Equipment
H. UL 1574 – Track Lighting
I. UL 1598 – Luminaires
J. UL 1838 – Low Voltage Landscape Lighting Systems
K. UL 2108 – Low Voltage Lighting Systems
L. UL 2388 – Flexible Lighting Products
M. UL 2562 – Pendant Cable
N. UL 8750 – LED Light Sources for use in Lighting Products
O. ANSI C78.377 – Chromaticity
P. IESNA LM-79 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
Q. IESNA LM-80 - Approved Method: Testing Lumen Maintenance of LED Light Sources
R. IESNA TM21-11 - Projecting Long Term Lumen Maintenance of LED Light Sources including Addendum A
S. IEEE STD 1789-2015 - Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers

1.04 QUALITY ASSURANCE

A. Luminaire and accessory components shall be constructed of materials appropriate for their use. Luminaires intended for use in marine environments shall be constructed of materials resistant to corrosion.
B. Luminaires, drivers, other components shall meet the requirements of all applicable State and Municipal codes and energy codes.
C. Provide luminaires listed and labeled by UL or other testing lab acceptable to local jurisdiction for their indicated use and installation conditions.
D. Contractor shall coordinate installation of lighting systems with all trades.

(1) Manufacturers listed in the luminaire schedule shall be assumed capable of supplying listed luminaires. Any such exceptions shall immediately be brought to the attention of Architect, Engineer, or Lighting Designer.

(2) Multiple Name Specification:

(a) When multiple manufacturers are listed, Electrical Contractor shall choose which of the listed products are to be provided.

(b) Products of the same type shall be of same manufacturer.

(3) Single Name Specification:

(a) When only one product is suitable for the application and/or no other known acceptable products exist, only one manufacturer/product is listed in the Luminaire Schedule. For such instances, Electrical Contractor shall provide the listed product with no exceptions.

(4) Contractor shall coordinate and verify compatibility of luminaires with lighting control system

(a) Control protocol indicated for luminaires matches protocol of lighting control system specified. Contractor shall coordinate and verify compatibility of all dimming luminaires with control system to ensure that dimming is flicker free, continuous dimming through the dimming range noted on the luminaire schedule.

E. Substitution requests:

(1) Will be evaluated prior to Bid.

(2) Shall follow procedures set forth in this Section under paragraph 1.7 and in Section 01 25 00 - Substitution Procedures.

(3) Shall be made not less than 10 days prior to bid date.

(4) Shall include the following information indicating that the proposed substitution is of similar construction quality and assembly, lumen output and distribution, color temperature, color consistency, and controllability:

(a) Specified and proposed manufacturer's product data sheet, noting options and features.

(b) Provide dimensioned drawing of luminaire.

(c) Provide photometric data in form of an electronic IES file on USB or via email.

(5) Provide table-top working samples and/or mockup of specified luminaire and proposed alternate.

(6) Electrical Contractor shall be responsible for all costs incurred by substitution request sample and/or mockup production and review.

(7) Equipment delivery lead time shall not be held as a valid reason for requesting luminaire substitution unless luminaire lead time from specified manufacturer is in excess of 14 weeks. It shall be sole responsibility of Electrical Contractor to determine necessary equipment lead times, deliver submittals for review in a timely fashion, and place orders accordingly to ensure timely delivery.

(8) When requesting a substitution, Electrical Contractor shall provide unit and extended pricing for specified luminaire, unit and extended pricing for proposed alternate, and unit and extended delta savings to Owner to be realized by accepting proposed alternate. If requested, provide unit pricing for each luminaire type specified to provide a baseline comparison for substitution request.

(9) Electrical Contractor shall guarantee pricing on all luminaire types for which a substitution request has been granted. This price guarantee shall be per unit and shall be maintained through the end of construction, regardless of quantity purchased.

(10) For all luminaire types using an LED light source, provide independently tested, IESNA LM-79 compliant photometry testing data and IESNA LM-80 Lumen Maintenance data.

1.05 WARRANTY

A. Exit Signs Utilizing LED Technology: Provide manufacturer’s warranty for a period of not less than five years from the date of substantial completion including parts and labor for full replacement of defective product.

B. LED Luminaires: Provide Manufacturer’s warranty for a period of not less than five years from the date of substantial completion or the specified warranty period greater than five years for repair or replacement of defective electrical parts, including light source and driver.

C. Luminaires without integral LED sources: Provide manufacturer’s warranty for a period of not less than one year from the date of substantial completion including parts and labor for full replacement of defective product.

1.06 SUBMITTALS

A. Electronic submittal format shall be limited to the greater of 500 pages or 30 MB to ensure that all pages load correctly. Bookmarks by luminaire type are required for ease of navigation. Submittals exceeding these limits should be broken in a logical fashion into multiple volumes for separate review. Measures to reduce file size should not compromise legibility or any other factors affecting ease of review.

B. Upon award of Contract, submit complete list of lighting products to be furnished, with manufacturer and catalog designations, including current unit cost. Unit price shall be for equipment only and not include installation or miscellaneous electrical costs.

C. Upon award of Contract, submit complete list of lighting products to be furnished, with manufacturer and catalog designations, including currently quoted lead times for product delivery. Should Electrical Contractor anticipate delivery schedule of any specified product may adversely impact construction schedule, they shall bring it to the attention of Owner/Architect /Lighting Designer at this time.

D. In addition to complying with requirements of Section 26 00 00 - General Electrical Requirements, submittals shall include the following:

(1) Manufacturer's product data

(2) Installation instructions

(3) Maintenance data

(4) Parts list for each luminaire accessory

(5) Photometric Data: photometric data for luminaire, including optical performance as follows:

(a) Coefficients of utilization

(b) Luminance table

(c) Candela distribution data

(d) Zonal lumens

(e) Area and roadway luminaires shall include Isocandela Charts, IES Roadway Distribution Classification and IES BUG (Backlight – Uplight – Glare) ratings.

(6) Driver schedule indicating manufacturer, type, and catalog number for each luminaire

(7) Driver cut sheet for each driver used, referencing luminaire type(s)

(8) Product color/finish

(a) Where specific finish or color is not specified and options exist, submit color or finish samples to Architect/Engineer/Lighting Designer for selection.

E. Shop Drawings for equipment provided under this Section shall include the following:

(1) Overall submittal drawings indicating luminaire size, mounting (including ceiling type), light source, shielding, and voltage attributes, as well as manufacturer's product data, installation instructions, maintenance data, and parts list for each luminaire.

(2) Catalog cutsheets lacking sufficient detail will not be accepted.

(3) Detailed drawings of linear pendant mounted and suspended luminaires including dimensions, support spacing, suspension type, power feed type and locations, driver locations, wiring and controls configuration, luminaire joint locations and end plates. Provide canopy details that indicate coordination with the ceiling system provided.

(4) Detailed drawings for each cove and linear wall system configuration including dimensions, power feed locations, driver locations, luminaire joint locations, extension plates for end and corner sections and end plates.

(a) LED strip luminaires mounted in architectural coves, provide dimensioned drawings and sections and include accessory cut sheets as specified. Within coves, all luminaires are to be mounted end to end with no more than 12” unlit split evenly between ends

(5) Detailed drawings for LED systems including LED color, color consistency, rated life, warranty, and scale plans with luminaire layout, number, type and location for drivers, and a complete bill of materials.

(6) Detailed drawings for continuous recessed or continuous surface mounted luminaires including dimensions, power feed locations, driver locations/quantity, luminaire joint locations, extension plates for end and corner sections and end plates as applicable.

(7) Detailed drawings for custom LED handrail systems including dimensions, power feed locations, driver locations/quantity, luminaire joint locations as applicable.

(8) Submit documentation that indicates specified products have been tested, or will be tested, for compatibility with the lighting controls being procured and will perform as specified. Control devices or system shall be able to control luminaires with flicker free, continuous dimming, in range specified. Electrical Contractor, luminaire manufacturer and lighting control manufacturer shall be financially responsible for any incompatibilities.

(9) Detailed drawings for nonstandard/custom luminaires indicating dimensions, weights, method of field assembly, components, features, and accessories. Details shall be scaled to a legible size.

(10) Detailed drawings for fiber optic systems including scaled plans with cable layout number and type of fiber bundles, illuminator quantity and location, and a complete bill of materials.

(11) Drawings for site lighting shall include pole data with wind loading, complete dimensions and finish, pertinent physical characteristics and accessories including mounting details, driver type and location and any specified control options.

(12) Photometric Data: Where indicated on luminaire schedule and Contract Drawings, supply complete photometric data for luminaire, including optical performance rendered by independent testing laboratory developed according to methods of the Illuminating Engineering Society of North America as follows:

(a) Coefficients of utilization

(b) Luminance table with data presented numerically, showing maximum luminaire luminance at shielding angles. Readings should be taken both crosswise and lengthwise in case of linear luminaire or luminaire with an asymmetric distribution.

(c) Candela distribution data presented graphically and numerically, in 5° increments (5°, 10°, 15°, etc.). Data developed for up and down quadrants normal, parallel, and at 11-1/2°, 45°, 67-1/2° to source if light output is asymmetric.

(d) Zonal lumens stated numerically in 10° increments (5°, 15°, etc.) as above.

(13) No variation from the general arrangement and details indicated on drawings shall be made on shop drawings unless required by actual conditions. All variations shall be marked on drawings submitted for approval.

F. Provide luminaires with factory or field finish as directed by Architect/Engineer/Lighting Designer. Verify final finish requirements before releasing luminaires for fabrication.

G. Where specific finish or color is not specified and options exist, submit color or finish samples to Architect for selection. Luminaires not having color or finish acceptable to Architect shall be replaced at no additional cost.

1.07 SAMPLES

A. Upon return of submittals, and prior to release for manufacturing, Contractor shall furnish one working sample of each luminaire for which sample requirement is noted in Luminaire Schedule.

(1) All requested samples shall be furnished as specified on luminaire schedule including: light output, correlated color temperature, distribution, lens type and finish EXCEPT sample shall be wired with minimum 6-ft cord and plug for energization at 120V.

B. Shipping: Samples shall be complete with specified LED module(s), cord and plug, ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to Architect/Engineer/Lighting Designer or as otherwise advised.

C. Samples may not be returned, nor included in quantities listed for project.

D. Sample must be actual working unit.

E. All custom luminaires require a submission of material finish samples, component approval and a complete operating prototype luminaire. Prototype to be submitted prior to commencement of final luminaire fabrication and shall include specified LED modules. Modifications may be required as a result of prototype review. These modifications and others that do not materially affect the cost of the luminaire shall be incorporated at no additional cost to Owner.

1.08 LUMINAIRE MOCK-UPS

A. Upon return of submittals, and prior to release for manufacturing, Contractor shall provide mock-up on site (or at another agreed upon location) in actual architectural conditions for review by Architect/Engineer/Lighting Designer and Owner.

B. Provide type and quantity of luminaires as requested by Architect/Engineer/Lighting Designer.

C. Mock-up shall include working _____ and fastening devices.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Luminaires:

(1) As shown on Luminaire Schedule

B. LED Drivers:

(1) Shall be manufacturer recommended compatible driver.

(2) All LED drivers shall be dimming type standard unless otherwise noted. Refer to construction documents for control per application.

(3) Manufacturers must be compatible with lighting control system(s) provided and control luminaires to specified minimum output per Luminaire Schedule and controls intent documents.

(4) LED Drivers "At power levels between 100% to 1%, shall perform within the frequency (Hz) and Modulation (%) of IEEE STD 1789-2015 Low Risk level.

C. Emergency LED Battery Pack:

(1) Bodine, Dual-Lite, Iota or as specified in the Luminaire Schedule

D. Low Voltage Transformers:

(1) Q-Tran or as specified in the Luminaire Schedule

E. LED Modules:

(1) Philips Lumileds, Xicato, Cree, GE, Nichia, Osram Sylvania, Bridgelux, Citizen or as specified in the Luminaire Schedule

2.02 FABRICATION AND MANUFACTURER

A. Luminaires:

(1) Construction
   (a) Luminaires shall bear label indicating circuit voltage. Labels shall not be visible from normal viewing angles.
   (b) Luminaires shall be constructed with joints made by means of welded, brazed, screwed, or bolted construction methods.
   (c) Housings shall be so constructed that all electrical components are accessible and replaceable without removing luminaires from their mountings.
   (d) Surface temperatures of luminaires with integral drivers shall not exceed 90°C in 30°C ambient.
   (e) Luminaires recessed in ceilings utilized as air handling plenums shall be certified as suitable for the purpose and conform to NEC Article 300.
   (f) Miter cuts shall be accurate, joints shall be flush and without burrs.
   (g) Troffers with doors shall have spring-loaded door cam latches unless otherwise noted for special environments and applications.
   (h) Luminaires shall be free of light leaks and designed to provide sufficient ventilation of source to provide the photometric performance documented. Low voltage transformers and drivers shall be vented per manufacturer's specifications.
   (i) Provide inscription for exit and stairway signs to conform to applicable codes. Provide battery back-up as specified.
   (j) Verify types of ceiling construction with General Contractor prior to releasing luminaires for fabrication and delivery and provide luminaires adapted to ceiling construction used.
   (k) Coordinate recessed luminaire mounting appurtenances, flanges and trims with construction of ceiling in which luminaire is to be recessed. Provide correct luminaire mounting assembly.
   (l) Luminaire frames shall be manufactured of non-ferrous metal or be painted after fabrication.

(2) LED Luminaires are considered a lighting system with dependent components that must be evaluated as a complete system. Each LED luminaire includes a light emitting source, provisions for heat transfer, electrical control, optical control, mechanical support and protection, as well as aesthetic design elements. All LED luminaires shall:
   (a) Be NRTL 3rd party tested to applicable UL standards. Where remote drivers are specified, all drivers shall also have UL listing or equivalent and comply with code requirements.
   (b) Be tested to IESNA LM-79-19 testing using absolute photometry criteria.
   (c) Be reported greater or equal to 70% lumen maintenance at 50,000 hours of operation.
   (d) Be rapid cycle stress tested.
   (e) Have integral LED modules with a minimum operating temperature of -20°C.
   (f) Have modules that are capable of being easily replaced upon failure with a manufacturer provided replacement module without voiding the UL listing of the luminaire.
   (g) Have driver housings easily accessible for ease of maintenance.
   (h) Have a maximum operating temperature at LED junction to not exceed 90°C over the expected operating range of the luminaire.
   (i) Be RoHS compliant, lead and mercury free.
   (j) Have an LED operating frequency of + or – 120 Hz.
   (k) Must meet the appropriate Federal Communications Commission (FCC) requirements for FCC 47 CFR 15 (consumer use) and/or FCC 47 CFR Part 18 (industrial use)
   (l) Be Class A Sound rated.
   (m) Be supplied with power supply that complies with IEEE C62.41-1991.
   (n) Operate at 120 or 277 volts, ±10%.
   (o) Have reverse polarity protected at all hardwired connections and have high voltage protection in the event connections are reversed or shorted during the installation process.

(3) Lenses, Reflectors and Diffusers
   (a) All lenses or louvers shall be removable but held so that normal motion will not cause them to drop out.
   (b) All glass used in luminaires shall be made from thermal shock resistant borosilicate glass.
   (c) Optical lenses shall be free from spherical and chromatic aberrations.
   (d) Acrylic lenses shall be 100% virgin acrylic material.
   (e) Diffuser materials shall be UV stabilized in applications exposed to sunlight.
   (f) Troffer lenses shall be 0.125" (3.2 mm) thick, unless otherwise noted.
   (g) Alzak reflectors and louvers shall be low iridescent equivalent to Coil Anodizers. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of ten years.
   (h) Reflector cones shall not have visible source flashing in the cone.

(4) Optics and Adjustments

(a) Adjustable Angle Luminaire: Luminaires with adjustment beam angle shall contain reliable angle locking devices.

(5) Finishes
- (a) Provide luminaires with finish as shown in the luminaire schedule. Verify final finish requirements before releasing luminaires for fabrication.
- (b) Painted luminaires shall be painted after fabrication or “post painted”.
- (c) Ferrous parts and supports shall be rust proofed after fabrication.
- (d) For weatherproof or vaportight installations, painted finishes of luminaires and accessories shall be weather resistant using proper primers or galvanized and bonderized epoxy, so that entire assembly is completely corrosion resistant for service intended and rated for an outdoor life expectancy of not less than 20 years.

(6) Wiring
- (a) Luminaires shall be completely wired at the factory and as required by code.
- (b) Internal wiring shall contain no splices.
- (c) Connections shall be made with insulated “wire nut” type mechanical connectors except that driver connections shall comply with NEC Article 410.
- (d) Luminaires shall be provided with flexible conduit, pigtails, and equipment for external connections.
- (e) Recessed luminaires installed in inaccessible ceilings shall be UL listed for through wiring with the junction box accessible from the luminaire opening.
- (f) Cords shall be fitted with proper strain reliefs and watertight entries where required by application.

(7) Ceiling Coordination
- (a) Verify type of ceiling construction prior to releasing luminaires for fabrication and delivery.
- (b) Provide mounting appurtenance, flanges, sloped ceiling adaptors where required.
- (c) Provide mounting assembly, clips or other mechanical mounting lugs as required for support of luminaires.

(8) Track-Lighting Systems:
- (a) A lighting track system is defined as a manufactured assembly designed to support and energize luminaires that are capable of being readily repositioned on the track. Its length may be altered by addition or subtraction of sections of track. Lighting track may be either flexible or rigid depending on the specific application.
- (b) Provide lighting track types as specified in Luminaire Schedule, in lengths as indicated on lighting plans.
- (c) Lighting track system includes current carrying conductors which may convey either line voltages (120V or 277V) or low voltages (12V or 24V). Characteristics of lighting track that conveys line voltages are different than a lighting track system that conveys low voltages and as such are governed by different requirements. Therefore, they are considered individually in these Specifications.
  - 1) Line voltage (120V or 277V) Lighting Track systems:
    1. Provide components, including track, fittings, and luminaires from the same manufacturer as recommended by manufacturer for the intended use. All components shall be UL Listed and comply with the National Electric Code Standards for Lighting Track.
    2. Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of live and neutral conductors must always be maintained along continuous run so that track fittings connect into the track in a consistent manner.
    3. Support lighting track at intervals recommended by the track manufacturer.
    4. One or two circuit Lighting Track shall be supplied with separate neutral busbars and have the ability to have each circuit separately dimmed as required when using standard voltage and low voltage luminaires with either magnetic or electronic transformers.
    5. Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run.
    6. One and two circuit 120 volt Lighting Track shall be rated at 120/250 volt, 60 Hz, 2,400 watts maximum each circuit. Neutral busbar(s) shall be oversized and comparable to #10 AWG 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics.
    7. One and two circuit 277 volt Lighting Track shall be rated at 277 volt, 50/60 Hz, 5,540 watts maximum each circuit. Neutral busbar(s) shall be oversized and comparable to #10 AWG 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics.
    8. A separate grounding busbar shall be integral in all track lengths.
    9. 277 volt Track fittings shall be identified by a red rotor and a 277 volt label.
  - 2) Low voltage (12V or 24V) Lighting Track systems:
    1. Provide components, including track conductors, remote mounted transformers, fittings, and luminaires from the same manufacturer as recommended by the manufacturer for the intended use. Components shall be UL Listed as applicable for low voltage use.

2. Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of conductors must always be maintained along continuous run so that track fittings connect into track in a consistent manner.
3. Support lighting track at intervals recommended by track manufacturer.
4. One and two circuit low voltage Lighting Track shall be supplied with three conductors and have the ability to have each circuit separately switched with either magnetic or electronic transformers provided by the track manufacturer. Two circuit low voltage Lighting Track can only be dimmed if both circuits are fed from the same transformer and as a result, separate circuit dimming shall not be attempted or permitted.
5. All transformers shall be supplied with both primary and secondary voltage over-current protection devices that shall remain readily accessible for maintenance and testing purposes.
6. Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run. Separate, single circuit transformers are required for each independently controlled circuit with the use of electrically isolated couplers.
7. Conductors used in low voltage Lighting Track shall be, at minimum, equivalent to #10 AWG 30 amp wire or heavier and be capable of carrying a 300 watt load (at 12 volts) up to 32 ft (9.8 m) from transformer feed within range of luminaire voltage tolerance. At 24 volts, conductors shall be capable of supplying a 600 watt load up to 60 ft (18.3 m) from transformer feed within range of luminaire voltage tolerance.
8. If taut strung cable conductors are used as low voltage Lighting Track system, they shall have a Kevlar core to prevent strain on outer current carrying conductors.
9. Only insulated type taunt strung cable conductors shall be used in order to comply with local electrical codes governing installation.

(9) FIBER OPTIC LUMINAIRES
- (a) General Constructions and Materials: Illuminators and fibers shall be of one manufacturer to ensure compatibility.
- (b) Illuminators: Shall meet all conditions previously listed for LED luminaires.
- (c) Where fans are used for cooling, they shall be low noise and quiet running.
- (d) Illuminators shall have ultraviolet and infrared absorbing filters to prevent degradation of fiber.
- (e) Provide suitable thermal cut out protection.
- (f) All fibers shall be cut and installed per manufacturers specifications.

(10) Outdoor Lighting Systems:
- (a) Provide luminaires, mounting arms, brackets, poles, hand-hole covers, base components, and all other accessories for a complete assembly. Manufacturers shall be responsible for proper fitting of elements and structural integrity of unit
- (b) Provide poles as shown on luminaire schedule.
  - 1) Poles shall have hand-holes.
  - 2) Fusing for each luminaire head shall be located in hand-hole near base of pole.
  - 3) Pole base anchor bolts shall be galvanized.
- (c) Exterior Luminaires:
  - 1) Shall operate at a minimum ambient temperature of 0°F (-17°C).
  - 2) Shall be fully gasketed, with UL wet location label.
  - 3) Shall have approved wire mesh screens for ventilation openings.
  - 4) Anodized aluminum reflectors shall have minimum of 0.00079” (0.02 mm) anodizing thickness.
- (d) Pole/Luminaire combination shall have EPA rating that will withstand site wind conditions.
- (e) All castings and extrusions shall be given minimum one coat of baked-on clear lacquer, unless painted finish is specified.
- (f) Aluminum surfaces shall receive a duronodic or polyester powder paint finish.
- (g) Cast-in Luminaire housings installed directly in concrete shall be fabricated of hot dip galvanized steel or cast aluminum or composite.
- (h) Where cast aluminum housings are used, give two coats of asphaltum paint prior to installation.
- (i) Provide 1/8” thick x 2” diameter (3 mm thick x 50 mm diameter) solid neoprene grommets at each point light luminaire surfaces are mounted to concrete structure.

2.03 LED SOURCES

A. Static white LED sources shall be:
- (1) Minimum CRI of 85 unless otherwise noted on Luminaire Schedule
- (2) Less than 5% flicker

(3) Within 0.004 on the CIE 1976 diagram for color spatial uniformity
(4) Within 0.007 on the CIE 1976 diagram for color maintenance over the rated lifetime of the source
(5) Binned within a 3-step MacAdam ellipse minimum, or as indicated in Luminaire Schedule
(6) Color temperature as noted on Luminaire Schedule
(7) Have a published life rating based on the point at which LED sources reach L70 lumen maintenance and tested in accordance with IES LM80-08 Approved Method: Testing Lumen Maintenance of LED light sources and IES TM-21-11: Projecting Long Term Lumen Maintenance of LED Light Sources
(8) L70 rated life shall be a minimum of 50,000 hours.
(9) LED modules, unless otherwise noted, shall be provided by light fixtures manufacturer and integral to luminaire.
(10) Screw-base LED replacement lamps, where required and listed on the luminaire schedule, shall meet dimming, output, CCT and CRI as specified. 25,000 hours is acceptable L70 rated life for these products.

2.04 DRIVERS

A. Drivers for use in cold or freezer rooms, parking structures, loading docks, and outdoors shall be low temperature type.
(1) Driver shall have lowest temperature rating available in standard manufacture for its type.
B. Drivers shall be located in luminaire they serve, unless otherwise noted.
C. LED Drivers and Power Supplies shall:
(1) Operate system LEDs within the current limit specification of the LED manufacturer.
(2) Be supplied with over-temperature protection circuitry.
(3) Be programmable via manufacturer-provided means to allow for LED replacement modules to be “tuned” to match the output of remaining adjacent modules in the event that some time has passed and there has been lumen depreciation.
(4) Be within a NEMA enclosure.
(5) Be equipped with knockouts to accommodate standard conduit sizes
(6) Have a Power Factor to be = or > than 0.9
(7) Dimmable LED drivers must be compatible with dimming system(s) provided and control luminaires per luminaire schedule and controls documentation.
(8) ETL certified, CBM and UL Listed, high power factor, and meet or exceed NEMA and ANSI Standards.
(9) Be Class A sound rated
(10) be Equipped with resetting thermal sensitive device.
(11) Operate with input power of 60 Hz and voltage as scheduled.
(12) Meet or exceed all ANSI or NEMA standards
(13) Be Capable of operating LEDs with less than 5% flicker
(14) Be DMX compatible in Color changing LED luminaires.
(15) At power levels between 100% to 1%, shall perform within the frequency (Hz) and Modulation (%) of IEEE STD 1789-2015 _____ level.
D. Emergency LED Drivers shall:
(1) Be UL 924 listed
(2) Operate LED luminaire at 10W minimum output for _____ minutes with efficacy equal to or greater than the normal power efficacy.
(3) Have high temperature nickel-cadmium battery. _____
(4) Be installed _____ luminaires
(5) Have solid state charging
(6) Battery to be recharged within 24 h
(7) _____

2.05 LOW VOLTAGE TRANSFORMERS

A. Transformers and power supplies shall be:
(1) Sized to compensate for voltage drop over indicated distances
(2) Locally fused
B. Transformers shall have line voltage switch within reach.
C. Provide adequate ventilation to meet code and manufacturers requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Marking:

(1) Voltage identification: Luminaires designed for voltages other than 110-125 volt circuits shall be clearly marked with rated voltage.

(2) Markings must be clear and shall be located to be readily visible to service personnel but invisible from normal viewing angles when luminaires are in place.

B. Installation of Luminaires:

(1) Housing, glassware, reflectors and refractors shall be clean and free of chips, cracks and scratches.

(2) Install decorative luminaires, reflector cones, baffles, aperture plates, lenses, trims, and decorative elements of recessed luminaires after completion of ceiling tile, plastering, painting, and general cleanup is completed. Where luminaire location or construction does not permit sequential installation, all reflectors, lenses, flanges and other visible surfaces shall be carefully protected.

(3) Light leaks between ceiling trim of recessed luminaires and ceiling are not allowed.

(4) Locations

(a) Install luminaires at locations and heights as indicated.

(b) Do not scale electrical drawings for locations of luminaires.

(c) Architectural reflected ceiling plans show locations of luminaires.

(d) Where noted on the drawings, the exact location of luminaires shall be confirmed (in the field) with the Architect/Engineer prior to installation.

(e) Where luminaires are to be concealed, or surface mounted in highly visible public spaces, a small sampling of luminaires shall be installed, adjusted and aimed for Architect/Engineer's review approval, prior to installing remaining luminaire of same type.

(f) Mount all luminaires so as to maintain full range of motion.

(g) Install luminaires plumb, square, and level with ceilings and walls.

(h) Coordinate stem, rod, chain, or aircraft cable hanger lengths with job conditions. Provide extra length of adjustable supports where diffusers are mounted directly above light fixtures to facilitate air balancing efforts.

(i) Industrial type luminaires in unfinished areas, which are near obstructions such as ducts and pipes, shall be:

1) Suspended so that bottom of luminaire is no higher than bottom of obstruction

2) Located at height of lowest luminaire

3) Minimum height: 8’-0” (2.4 m)

4) Shall not be located until locations of obstructions are determined.

5) Where a minimum height of 8’-0” (2.4 m) is unachievable, wall mounted luminaires shall be utilized.

(5) Support

(a) Support surface mount luminaires from building structure.

(b) Metal decking shall not be pierced for luminaire support.

(c) Provide luminaires and/or luminaire outlet boxes with hangers to support luminaire weight.

(d) Troffers shall be held in place by support clips.

(e) Provide plaster frames for recessed luminaires in plaster ceilings.

(f) Rigid metallic pipe stems shall be utilized for the support of pendant mounted luminaires, unless otherwise noted.

(g) Stem hangers shall be equipped with aligner box covers or canopies so that stems hang vertically, irrespective of the angle of the surface they are mounted from.

(h) Wherever a luminaire or its hanger canopy is attached to a surface mounted outlet box, a finishing ring shall conceal the outlet box.

(i) Yokes, brackets and supplementary supporting members needed to mount luminaires to suitable ceiling members shall be furnished and installed by Contractor. Verify mounting hardware required prior to installation.

(j) Recessed luminaires shall be supported with 12 ga (2.657 mm) wire hangers, 2 per luminaire, at diagonally opposite corners.

(k) Troffers and luminaires over 55 lbs (25 kg), such as 4x4 ft (1200x1200 mm) shall be supported with 12 ga (2.657 mm) wire hangers, 4 per luminaire, 2 at 45 degree diagonals, and two perpendicular to structure. Wire hangers and attachment to structure shall be capable of supporting 4 times luminaires weight.

(l) In areas with seismic requirements, suspended or pendant mounted luminaires shall be able to swing 45 degrees in any direction without hitting an obstruction. In the event hitting an obstruction is unavoidable, guy wires will be used to secure the luminaire in place.

(m) Surface luminaires installed in grid ceilings shall be supported by independent support clips and 12 ga (2.657 mm) wire.

(n) Exit signs installed in grid ceilings shall be supported by electrical box hanger and additional 12 ga (2.657 mm) wire installed from box to structure.

(o) Support surface mounted luminaires greater than 2 ft (0.6 m) in length at a minimum of each additional 2 ft (0.6 m), or as recommended by manufacturer.

(p) Brace suspended luminaires installed near ducts or other constructions with solid pendants or threaded rods.

(q) Rigidly align continuous rows of luminaires.

(r) Luminaire types with remote mounted driver shall have:

1) Proper support for driver weight.

2) Mounting distance from remote driver to luminaire per manufacturer's recommendations.

(6) Mounting and Enclosures

(a) Install flush mounted luminaires to eliminate light leakage.

(b) For luminaires mounted adjacent to insulation, provide barrier to prevent insulation from coming in contact with luminaire, unless luminaire is approved for installation in contact with such insulation.

(c) Provide approved fire rated enclosures around luminaires in fire rated ceilings.

(7) Conduit and Wiring

(a) Wire for connections to modules and auxiliaries shall be suitable for temperature, current, and voltage conditions.

(b) Recessed luminaires shall have final connections made with flexible metal conduit, not in excess of 72” (1830 mm), with THHN conductors and green wire ground conductor.

(c) Conduit shall be hidden from normal view in all possible cases. In public areas where surface mounted conduit must be used, Contractor shall install conduit as unobtrusively as possible. Contractor shall obtain field approval by the Architect for all exposed conduit runs prior to rough in.

(8) In-Grade Luminaires:

(a) Where installed in tree grates, furnish burial light lens and louver to tree grate manufacturer for coordination of opening.

(b) Provide adequate drainage system per manufacturer's recommendations.

C. Installation of Outdoor Pole Bases

(1) Contractor shall provide bases for luminaires.

(2) Pole base details shall be provided by the project structural engineer.

(3) Provide handhole for electrical connection within 4’-0” of pole base.

(4) Contractor shall:

(a) Rough-in conduits

(b) Coordinate spacing, base dimensions, heights, orientation of bases, etc. as necessary.

(5) Where square or rectangular poles or luminaire heads are used, Contractor shall verify orientation with Architect/Engineer/Lighting Designer.

D. Pole Installation:

(1) Install luminaires, poles, hardware, etc., for complete system.

(2) Use web fabric slings (not chain or cable) to raise and set poles.

E. Grounding:

(1) Ground luminaires and metal poles according to Division 26 Section “Grounding and Bonding for Electrical Systems”.

(2) Poles:

(a) Install 10 ft (3 m) driven ground rod at each pole.

(3) Nonmetallic Poles:

(a) Ground metallic components of lighting unit and foundations. Connect luminaires to grounding system with #10 AWG conductor.

3.02 SUBSTANTIAL COMPLETION

A. Quality Control:

(1) At Date of Substantial Completion, replace LED modules/LED luminaires which are not operating properly.

(2) Protection wrapping on lensed or louvered luminaires shall be removed before installation of furniture, but after finish work is complete.

(3) Deliver spare equipment to Owner's representative.

B. Tests:

(1) Give advance notice of dates and times for field tests.

(2) Provide instruments to make and record test results.

(3) Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized.

(4) Verify operation of luminaires with lighting control system and daylight harvesting systems. Any dimmed fixtures shall exhibit no signs of flickering.

(5) Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.

(6) Report results of tests.

C. Adjusting and Cleaning:

(1) Clean luminaires of handling marks, dust and dirt.

(2) Cleaning and touch-up work shall be performed in accordance with luminaire manufacturer's recommendations.

(3) Damaged luminaires or components shall be replaced with new.

(4) Keep luminaires clean and protected for remainder of construction period.

(5) Verify orientation of directional luminaires prior to installation.

(a) This includes wall washers, cove lighting, floodlights, exterior area lights and adjustable accent luminaires. Contractor shall provide electrician's services to aim, adjust, and focus luminaires, as required, at direction of Architect/Engineer. These electricians shall be available at times designated by Architect/Engineer and shall be provided at no extra charge to Owner over base bid. Contractor shall provide equipment for luminaries' focus including ladders and mechanical lifting systems.

(6) Program preset dimming system lighting levels.

(7) Program ambient light sensors integral to luminaires for appropriate illumination levels as indicated in control narrative or in lighting control specifications.

(8) Program occupancy sensors integral luminaires for appropriate time delay as indicated in control narrative or in lighting control specifications.

(9) Exterior poles, bollards, bases and other exterior luminaires shall be painted to match factory color where finish has been damaged.

(10) No light leaks shall be permitted at ceiling line from any visible part or joint.

D. Training

(1) Contractor shall provide Owner with _____ complete hardcopy and (1) digital copy of Operations and Maintenance manuals.

(a) All "Approved as Noted" comments shall be corrected/picked-up in this record manual set.

(b) Each manual shall contain specific information pertaining to the equipment installed. Each manual shall contain at a minimum:

1) Detailed as built shop drawings for all lighting equipment installed.

2) Manufacturer's product cut sheets for all equipment installed keyed by type as to as built drawings.

3) Manufacturer's complete installation instructions for all equipment installed keyed by type to as built drawings.

4) Equipment maintenance requirements and schedules.

5) Equipment manufacturer contacts.

6) Equipment manufacturer warranties.

1. Luminaires
2. Drivers
3. LED modules

(2) Contractor shall provide qualified personnel onsite to provide a minimum of one day of training to Owner's representatives.

(3) This training shall cover:

(a) Luminaire use and maintenance

(b) Architectural lighting system use and maintenance

END OF SECTION 26 50 00

END OF DIVISION 26

DIVISION 27 - COMMUNICATIONS

SECTION 27 00 00 GENERAL COMMUNICATIONS REQUIREMENTS

SECTION 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

SECTION 27 05 28.29 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

SECTION 27 05 28.33 RACEWAY AND BOXES FOR COMMUNICATIONS SYSTEMS

SECTION 27 05 28.36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

SECTION 27 05 28.39 SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS

SECTION 27 05 53 COMMUNICATIONS SYSTEMS IDENTIFICATION

SECTION 27 10 00 STRUCTURED CABLING

SECTION 27 11 00 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

SECTION 27 13 00 COMMUNICATIONS BACKBONE CABLING

SECTION 27 15 00 COMMUNICATIONS HORIZONTAL CABLING

SECTION 27 41 00 AUDIOVISUAL SYSTEMS

SECTION 27 41 00.1 AUDIOVISUAL SYSTEMS EQUIPMENT SCHEDULE

SECTION 27 41 00.2 AUDIOVISUAL SYSTEMS CABLE SCHEDULE

SECTION 27 51 29 TWO-WAY COMMUNICATION SYSTEM

SECTION 27 53 19 EMERGENCY RESPONDER RADIO REINFORCEMENT SYSTEM

SECTION 27 00 00 - GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

A. This section details references, standards, guidelines, requirements and conditions common to all Division 27 work.

B. Work under this Section and related sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.02 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, terms "provide", "furnish" and "install" as used in Division 27 contract documents shall have the following meanings:

(1) "Provide" or "provided" shall mean "furnish and install".

(2) "Furnish" or "furnished" does not include installation.

(3) "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this contract are connections to equipment provided by others. Refer to Architectural, Electrical, Integrated Automation, Mechanical, Security and final shop drawings for equipment being furnished under other sections for exact locations of outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

G. Where architectural features govern location of work, refer to architectural drawings.

H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

1.03 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0526 - Grounding and Bonding for Communications Systems

(2) Section 27 0528.29 - Hangers and Supports for Communications Systems

(3) Section 27 0528.33 - Raceway and Boxes for Communications Systems

(4) Section 27 0528.36 - Cable Tray for Communications Systems

(5) Section 27 0528.39 - Surface Raceways for Communications Systems

(6) Section 27 0553 - Communications Systems Identification

(7) Section 27 1000 - Structured Cabling

(8) Section 27 1100 - Communications Equipment Room Fittings

(9) Section 27 1300 - Communications Backbone Cabling

(10) Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

(1) Section 26 0593 – Electrical Systems Firestopping

(2) Also refer to individual technical sections identified above.

C. Utility Services:

(1) Campus network services will be provided via fiber optic connection to the tunnel system located near the basement of Reynolds Hall, Server Room 108.

D. Continuity of Service:

(1) No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.

(2) When interruption of services is required, persons concerned shall be notified and shall agree upon a time.

E. Cleaning and Repair

(1) Clean and repair existing materials and equipment that remain or will be reused.

F. Concrete Work:

(1) Provide cast-in-place concrete as required by contract documents unless otherwise noted.

(2) Concrete shall comply with Division 03 - Concrete.

(3) Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of equipment.

G. Painting:

(1) Furnish equipment with factory applied prime finish unless otherwise specified.

(2) If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Engineer.

(3) Furnish one can of touch up paint for each factory finish, which will be final finished surface of product.

(4) Contractor is responsible for painting of plywood in Telecommunications Equipment Rooms. Refer to Drawings.

1.04 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

1.05 REFERENCES AND STANDARDS

A. Design, cable and component selection, and installation practices shall conform with following:

(1) ANSI/NFPA 70 - National Electrical Code

(2) Local Electrical Code

(3) Country, state and local health, safety and building codes

(4) UL 444 - Communications Cables

(5) Standards identified in individual Technical Sections.

(6) BICSI Telecommunications Distribution Methods Manual (TDMM)

(7) TIA 568.C - Commercial Building Telecommunications Cabling Standard (including applicable Addenda)

(8) TIA 569-C - Commercial Building Standard for Telecommunications Pathways and Spaces

B. Agencies or publications referenced herein refer to the following:

(1) ANSI American National Standards Institute

(2) ASME American Society of Mechanical Engineers

(3) ASTM American Society for Testing and Materials

(4) BICSI Building Industry Consulting Services International

(5) FIPS Federal Information Processing Standards

(6) FCC Federal Communications Commission

(7) ICEA Insulated Cable Engineers Association

(8) IEEE Institute of Electrical and Electronics Engineers

(9) NEC National Electrical Code

(10) NECA National Electrical Contractors Association

(11) NEMA National Electrical Manufacturers Association

(12) NESC National Electrical Safety Code

(13) NETA National Electrical Testing Association

(14) NFPA National Fire Protection Association

(15) NIST National Institute of Standards and Technology

(16) OSHA Occupational Safety and Health Administration

(17) TIA Telecommunications Industry Association

(18) UL Underwriters Laboratories, Inc.

C. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.06 DEFINITIONS

A. The following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction.

(1) Entrance facility - an entrance to building for both public and private network service cables and/or wireless services including entrance point of building and continuing to Entrance Room.

(2) Entrance Room - room where both public and private network service cables and/or wireless services are terminated. Service provider(s) point-of-demarcation (DEMARC) is typically located here.

(3) Equipment Room (Telecom): an environmentally controlled centralized space for telecommunications equipment that usually houses main or intermediate cross-connect. Backbone cabling, cabling to Building Entrance and horizontal cabling may be terminated here.

(4) Guarantee - promise or an assurance that attests to quality or durability of product or service or that task will be performed in specified manner. Used interchangeably with "Warranty" in these documents.

(5) Intra-building - within single building.

(6) Inter-building - between 2 or more buildings.

(7) IP Telephony – Use of Internet Protocol (IP) for two-way transmission of conversations. Sometimes referred to as “Voice over Internet Protocol (VoIP)”.

(8) Rack Unit - standard measurement of vertical mounting space on an equipment rack. Each Rack Unit is 1-3/4” high.

(9) Voice over Internet Protocol – Refer to IP Telephony.

B. Typical NEMA Enclosures and Usage

(1) Refer to Section 26 0000 – General Electrical Requirements.

(2) NEMA 1 - Indoors. Falling dirt

(3) NEMA 2 - Indoors. Falling dirt. Falling liquids. Light splashing

(4) NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust

(5) NEMA 3X - Same as NEMA 3 plus corrosion resistant

(6) NEMA 3S - Same as NEMA 3 plus mechanism operable when ice covered

(7) NEMA 3SX - Same as NEMA 3S plus corrosion resistant

(8) NEMA 3R - Outdoors. Rain, snow, sleet

(9) NEMA 3RX - Same as NEMA 3R plus corrosion resistant

(10) NEMA 4:

(a) Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down

(b) Outdoors - Rain, sleet, snow. Wind blown dust. Hose down

(11) NEMA 4X - Same as NEMA 4 plus corrosion resistant

(12) NEMA 5 - Indoors. Falling Dirt. Falling Liquids. Settling dust, lint and fibers

(13) NEMA 6:

(a) Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down. Temporary submersion.

(b) Outdoors - Rain, snow, sleet. Windblown dust. Hose down. Temporary submersion.

(14) NEMA 6P:

(a) Indoors - Same as NEMA 6 / Indoors plus corrosion resistant. Prolonged submersion.

(b) Outdoors - NEMA 6 /Outdoors plus corrosion resistant. Prolonged Submersion.

(15) NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).

(16) NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).

(17) NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.

(18) NEMA 13 - Same as NEMA 12 plus oil or coolant spraying or splashing.

1.07 ABBREVIATIONS AND ACRONYMS

A. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.

(1) AFF Above Finished Floor

(2) ATM Asynchronous Transfer Mode

(3) AWG American Wire Gauge

(4) BAS Building Automation Systems

(5) BTU British Thermal Unit

(6) CATV Community Antenna Television

(7) CCTV Closed-Circuit Television

(8) CDDI Copper Distributed Data Interface (Cisco Systems trade name for TP-PMD)

(9) cm centimeters

(10) °C degrees Celsius

(11) °F degrees Fahrenheit

(12) DTMF Dual Tone Multi Frequency

(13) EIA Electronic Industries Alliance

(14) EF Entrance Facility

(15) ER Entrance Room

(16) EIDF Equipment Intermediate Distribution Facility

(17) FDDI Fiber Distributed Data Interface

(18) ft feet

(19) GbE Gigabit Ethernet
(20) Hz Frequency in Hertz (k = kilo, M = Mega, G = Giga)
(21) ID Inside Diameter
(22) in inch
(23) IPT IP Telephony
(24) kg kilogram
(25) lbs pounds
(26) LAN Local Area Network
(27) MATV Master Antenna Television
(28) MC Main Cross-connect
(29) m meters
(30) mm millimeters
(31) Mbps Megabits per second
(32) µm micrometer (10-6.56 yard (6 meter)
(33) OD Outside Diameter
(34) PBX Private Branch Exchange (Telephone Switch)
(35) pF pico-Farad (10-12 Farad)
(36) PVC Polyvinyl Chloride
(37) RU Rack Unit
(38) sq ft square feet (area)
(39) TP-PMD Twisted Pair Physical Medium Dependent
(40) TR Telecommunications Room
(41) WAN Wide Area Network
(42) WLAN Wireless Local Area Network
(43) VoIP Voice over Internet Protocol

B. Refer also to technical sections for additional terminology.

1.08 LISTING

A. Refer to technical sections of this Division of work for listing requirements.

1.09 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:
(1) Refer to Division 01 - Submittal Procedures.
(2) Note that for satisfying submittal requirements for Division 27, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, expression "Shop Drawings" is generally used throughout specification.
(3) Mark catalog sheets and drawings to indicate specific items submitted.
(a) Markings shall be reproducible (e.g. arrow, boxed, encircled, checkmark).
(b) Where sheet includes multiple product options, mark proposed option(s).
(4) Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
(5) When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Mark and annotate submittals accordingly.
(6) Group submittals by Section to include complete documentation of related systems, products and accessories. Where applicable, dimensions shall be marked in units to match those specified.
(7) Submittals shall be in electronic form or on paper per Division 01.
(a) Documents in electronic form shall be ADOBE Acrobat PDF.
(b) Paper documents shall be original catalog sheets or photocopies thereof.
(c) Facsimile (fax) sheets will not be accepted.
(8) Engineer’s Review is to confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that all required items have been submitted.
(9) When equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include required components.
(10) Include wiring diagrams for electrically powered or controlled equipment.
(11) Submit equipment room layouts drawn to scale, including equipment, raceways, accessories and clearance for maintenance.

(12) Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.

(13) Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.

(14) Submittals, which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.

(15) "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 27 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork, communications and/or electrical raceway layouts.

(a) Unless specifically requested in Division 27 technical sections, submittals of coordination drawings will be returned without review.

B. Certificates and Inspections:

(1) Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:

(1) Refer to Division 01 - Operation and Maintenance Data.

(2) Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2” thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.

(3) Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system.

(4) Manuals shall include the following:

(a) Copies of shop drawings

(b) Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.

(c) CD ROM's of O&M data with exploded parts lists where available

(d) Phone numbers and addresses of local parts suppliers and service companies

(e) Internet/WEB page addresses where applicable

(f) Wiring diagrams

(g) Start up and shut down procedure

(h) Factory and field test records

(i) Additional information, diagrams or explanations as designated under respective equipment or systems specification section

(5) Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.

(6) O&M manuals and instructions to Owner shall be provided prior to request for final payment.

D. Record Documents:

(1) Refer to General Conditions of Contract, and Division 01 - Closeout Procedures. Prepare complete set of record drawings in accordance with Division 01.

(2) Use designated set of prints of contract documents as prepared by Architect to mark-up for record drawing purposes.

1.10 JOB CONDITIONS

A. Building Access:

(1) Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Cutting and Patching:

(1) Refer to General Conditions of Contract, and Division 01 - Cutting and Patching.

(2) Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.

(3) Provide materials required for patching unless otherwise noted.

(4) Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.

(5) Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

C. Housekeeping and Cleanup:

(1) Refer to Division 01 - Closeout Procedures.

(2) Periodically as work progresses and/or as directed by Architect, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.11 WORK BY OWNER

A. Owner will provide:

(1) Active electronics for interface with building voice and data cabling systems

(2) Communications connecting patch cords for horizontal cabling and fiber optics.

(3) Wireless Access PointsRack mounted UPS system

1.12 QUALITY ASSURANCE

A. Refer to the individual technical sections for general product quality requirements, manufacturer qualifications, and contractor qualifications and certification requirements.

1.13 GUARANTEE

A. Refer to Division 01 for general Guarantee (Warranty) requirements.

B. Refer to technical sections for Guarantee requirement for each system.

(1) Where no guarantee requirements are called out, guarantee for one year after acceptance by Owner equipment, materials, and workmanship to be free from defect.

C. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.

D. Wherein fulfilling requirements of any guarantee, if Contractor disturbs any work guaranteed under another contract, restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Guarantees shall include labor, material and travel time.

PART 2 PRODUCTS

2.01 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

PART 3 EXECUTION

3.01 GENERAL

A. Verify elevations and measurements prior to installation of materials.

3.02 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

3.03 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.

B. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted.

C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

D. For core drilled holes, size and location shall be reviewed and approved by Structural Engineer prior to execution.

E. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 26.

G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved by the structural engineer prior to preparing openings in structural member.

H. Openings for penetrations shall be minimum 1/2” larger on all sides than outside dimensions of raceways or cables. However, where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.

I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

J. Seal non-rated wall openings with urethane caulk.

K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Architect. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

L. Finish and trim penetrations as shown on details and as specified hereinafter.

M. Provide chrome or nickel plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor’s closets, storage rooms, etc., unless suspended ceilings are specified.

N. In areas subject to washdown procedures the, penetrations shall be sealed.

(1) Provide gasketed device cover plates with an additional continuous bead of silicone caulk between device plate and adjacent wall, ceiling or floor surface.

(2) Once wiring is installed, surround wiring with 1” barrier of silicone caulking around conductors within device box hub.

(3) Caulk shall be resistant to microbiological growth.

3.04 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocation of raceways, or accessories as required to provide access, shall be provided at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs or maintenance is located in walls, chases or above inaccessible ceilings.

D. Provide necessary coordination and information to Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions, without limitations.

E. Provide access doors where equipment, requiring access for servicing, repairs and maintenance is located in walls, chases or above inaccessible ceilings, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Access doors used in fire-rated construction shall have UL label. Access doors shall be steel, prime coated, except use stainless steel doors in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Access doors shall be of sufficient size to allow for total maintenance. Location of access doors shall be coordinated with General Contractor and location of equipment shall be roughed in accordingly.

F. Locate communications outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.

G. Verify room door swings before installing wall-mounted communications outlets and install boxes on latch side of door unless otherwise noted.

3.05 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.

C. Do not support equipment or cable pathways from metal roof decking.

3.06 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.

B. Provide minimum 1/2”thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.07 CABLE PROTECTION

A. Protect cabling and termination components from contact with, and potential application of, foreign materials.

(1) Foreign material is defined as material that is not part of cabling assembly and termination components when delivered from manufacturer.

(2) Examples include paint overspray and drywall compound.

B. Cabling and components that come into contact with foreign materials shall be replaced at no cost to project.

(1) Solvents and other cleaning agents shall not be used to remove foreign materials that have already accumulated on cabling and components.

3.08 HOUSEKEEPING PADS

A. Not applicable to this Division of work.

3.09 LEAD SHIELDING

A. Wherever installation of this Contractor's equipment destroys radiological integrity of wall, floor, or ceiling, this Contractor shall be responsible to provide suitable lead shielding to maintain that integrity. Coordinate these requirements with General Contractor.

3.10 ACCEPTANCE TESTING

A. Prior to testing, submit to owner (or Owner’s representative) and Engineer, proposed schedule for acceptance testing.

(1) This notification shall be minimum of 10working days in advance to allow for participation by Owner and/or Engineer.

B. Prior to testing, submit written description of intended test procedures and submit sample test forms to Engineer.

(1) Submitted information shall include proposed file naming format to be used in identifying cable, pair or optical fiber which is subject of test record.

(2) Failure to provide above information shall be grounds for Engineer or Owner to reject any Documentation of related testing and to require repeat of affected test.

C. Conduct tests during course of construction when identifiable portion(s) of installation is complete.

(1) Alternatively, testing can be conducted after entire installation is complete if this does not delay project schedule.

D. Provide equipment and personnel necessary to conduct acceptance tests.

E. Testing shall be completed and accepted by Owner and Engineer before Owner furnished equipment and cross connects are installed.

F. Document tests.

G. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test. This shall be at no additional cost to the owner. Replacement materials shall be new.

H. This Contractor is responsible for certifying, in writing, equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

I. Maintain copies of certified test results, including those for failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.11 START-UP

A. Systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation.

(1) This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/installer knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with trades.

3.12 DOCUMENTATION

A. Upon completion of installation, Contractor shall provide System Documentation. Documentation shall include:

(1) Acceptance Test Results

(2) Record Drawings

(3) All Approved Submittals

(4) Manufacturer's Warranty Documents

B. Submit System Documentation in accordance with Division 01 "Project Record Documents".

(1) Documents shall be submitted in same electronic format in which they were received from Architect and Engineer.

(2) Document updates shall be performed in native software format matching original design team documents.

(a) Scans of hand marked documents shall not be allowed.

(3) Update documents to reflect installed conditions for equipment shown on documents.

C. Submit documentation within ten (10) working days of the completion of testing of each testing phase (e.g. subsystem, cable type, area, floor) or 3 weeks prior to scheduled occupancy of subject area, whichever is sooner. This is inclusive of Test Result and draft Record Drawings.

(1) Draft drawings may include mark-ups done by hand.

(2) Machine generated (final) copies of Record Drawings shall be submitted within 30 working days of completion of each testing phase.

(3) Documentation will include all aspects of systems covered by these specifications that are required for systems to be fully functional.

(4) For structured cabling this includes the horizontal link from the TO to the HC, backbone cabling from the HC to the MC, cross-connections, interconnections and/or patch cords that are the responsibility of the contractor.

D. Submit Acceptance Test Results in electronic form for review and distribution.

(1) Interim documentation of Test Results (if applicable) may be submitted via email or on CD-ROM.

(2) Final documentation of Test Results shall be submitted on CD-ROM.

(3) Test results shall be submitted in format(s) native to test instrument(s) used in performing testing.

(4) Where unique software (other than an MS-Word□ compatible Word Processor or MS-Excel□ spreadsheet) is required for viewing of test results, Contractor shall provide along with above documentation, one licensed copy of such software. Software shall run on MICROSOFT Windows-based personal computer.

E. Acceptance Test results shall include description of sub-system tested, equipment/cable/outlet I.D., reference and test setup, test equipment type/model and serial number(s), equipment location and direction of test (if applicable), test frequencies/wavelengths, date and operator name(s).

F. Engineer or Owner may request that 10% random re-test be conducted on cable system - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above and in technical sections.

(1) Owner may also perform independent testing to verify results.

(2) If findings contradict documentation submitted by Contractor, additional testing can be requested to extent determined necessary by Engineer or Owner, including 100% re-test. This re-test shall be at no additional cost to Owner.

G. Documentation - including hard copy and electronic forms of Test Data and Record Drawings - shall become property of Owner.

H. Refer also to Technical Sections for requirements specific to covered subsystems.

3.13 CLEANING

A. After installation is complete, Contractor shall clean all systems.

B. Vacuum debris from system components, enclosures, junction boxes and pull boxes prior to testing and again prior to completion.

C. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

END OF SECTION 27 00 00

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. This section includes product and execution requirements for Grounding and Bonding that are unique to communications systems and not included in Division 26 sections.

1.02 DESCRIPTION

A. Grounding and Bonding infrastructure for communications includes Cabling, Busbars and Connectors.

1.03 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements
(2) Section 27 0528.33 - Raceway and Boxes for Communications Systems
(3) Section 27 0528.36 - Cable Tray for Communications Systems
(4) Section 27 0528.39 - Surface Raceways for Communications Systems
(5) Section 27 0553 - Communications Systems Identification
(6) Section 27 1000 - Structured Cabling
(7) Section 27 1100 - Communications Equipment Room Fittings
(8) Section 27 1300 - Communications Backbone Cabling
(9) Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

(1) Section 26 0526 - Grounding and Bonding for Electrical Systems

1.04 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.

B. In addition, the following apply:

(1) IEEE/ANSI 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
(2) IEEE 837 - Standard for Qualifying Permanent Connections Used in Substation Grounding.
(3) UL 467 Electrical Grounding and Bonding Equipment
(4) ANSI J-STD-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
(5) ANSI J-STD-607-D - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

1.05 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements which provides information on Definitions used in this and related sections.

B. Additional definitions (per referenced standards):

(1) Telecommunications Main Grounding Busbar: Busbar placed in convenient and accessible location and bonded by means of bonding conductor for telecommunications to building service equipment (power) ground.
(2) Secondary Bonding Busbar: Interface to building telecommunications grounding system generally located in telecommunications room. Common point of connection for telecommunications system and equipment bonding to ground, and located in telecommunications room or equipment room.
(3) Primary Bonding Busbar: Conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.
(4) Telecommunications Bonding Backbone: Conductor that interconnects tele-communications main grounding busbar to telecommunications grounding busbar.
(5) Grounding Equalizer: Conductor that interconnects elements of telecommunications grounding infrastructure.
(6) Exothermic Weld: Method of permanently bonding two metals together by controlled heat reaction resulting in molecular bond.
(7) Irreversible Compression: Permanent mechanical bond between conductors or conductor and connector using mechanical or hydraulic tool.

C. Cross-Reference of Bonding and Grounding Nomenclature:

Preferred Terms used in this Specification	Other Industry Terms
Grounding Equalizer (GE)	Backbone Bonding Conductor (BBC)
Telecommunications Main Grounding Busbar (TMGB)	Primary Bonding Busbar (PBB)

Telecommunications Grounding Busbar (TGB)	Secondary Bonding Busbar (SBB)
Telecommunications Bonding Conductor (TBC)	Bonding Conductor for Telecommunications (BCT)

1.06 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements which provides information on Abbreviations and Acronyms used in this and related sections.

B. Additional abbreviations and acronyms (per referenced standards):

(1) Telecommunications Main Grounding Busbar - TMGB

(2) – Secondary Bonding Busbar - SBBTelecommunications Bonding Backbone - TBB

(3) Grounding Equalizer - GE

1.07 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

1.09 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements which identifies general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

PART 2 PRODUCTS

2.01 TELECOMMUNICATIONS BUSBARS

A. Material: Copper (aluminum not permitted)

(1) 1/4” thick

B. Pre-drilled

(1) 3/8” Diameter

(2) Hole spacing per ANSI Joint Standard J-STD-607-B

(3) Hole pattern shall accommodate two-hole lugs

C. Insulators and stand-off brackets shall electrically isolate busbar from wall or other mounting surface.

D. Busbars shall be listed by nationally recognized testing laboratory.

E. Size:

(1) Telecommunications Main Ground Busbar (TMGB) – 12”12” x 4” .

(2) Telecommunications Grounding Busbar (TGB) – 12” x 4”

2.02 CONDUCTORS

A. Material: Stranded copper (aluminum not permitted)

B. Bonding Conductors shall be insulated.

(1) Green Jacket or Black Jacket marked with Green Tape or Green adhesive labels per NEC Guidelines

C. Size:

(1) Telecommunications Bonding Conductor (TMGB to Grounding Electrode): As indicated on Project Drawings

(2) Telecommunications Bonding Backbone (TBB; TMGB to TGB): As indicated on Project Drawings

(3) Grounding Equalizer (GE): As indicated on Project Drawings

2.03 CONNECTIONS

A. Mechanical Connectors

(1) Connector Body shall:

(a) Be high-strength, high-conductivity cast copper alloy

(b) Be 2 bolt type

(2) Bolts, nuts, washers and lock-washers: Silicon Bronze

(a) Shall be supplied as part of connector body

(b) Split bolt connector types are not allowed

(3) Connector shall:

(a) Meet or exceed UL 467

(b) Be clearly marked with catalog number, conductor size and manufacturer.

B. Compression Connectors

(1) Connector Body: pure wrought copper.

(a) Conductivity shall be no less than 99% by IACS standards.

(2) Connector shall:

(a) Meet or exceed performance requirements of IEEE 837, latest revision

(b) Be factory filled with an oxide-inhibiting compound

(c) Be clearly marked with manufacturer, catalog number, conductor size and required compression tool settings

(3) Connection shall be irreversible.

C. Exothermic Weld Connections

(1) Not Allowed

PART 3 EXECUTION

3.01 SEQUENCING AND SCHEDULING

A. Permanently attach communications grounds prior to energizing communications equipment.

3.02 TOPOLOGY

A. Refer to the project drawings.

3.03 INSTALLATION

A. Provide required elements and miscellaneous hardware necessary to establish Telecommunication Grounding infrastructure as specified.

B. Install Products in accordance with manufacturer's instructions.

(1) Install Compression Connectors with compression, tool and die system, as recommended by manufacturer of connectors.

C. Grounding connections shall be tight and shall be made with UL listed grounding devices, fittings, bushings, etc.

D. On the Telecommunications Bonding Conductor, Telecommunications Bonding Backbone (TBB) and Grounding Equalizer (GE) all connections shall be Compression type.

E. Locate SBBs and TMGB per drawings.

F. Telecommunications Bonding Backbone (TBB) shall be continuous and not interrupted by Secondary Bonding Busbar

(1) SBBs shall be bonded to TBB via tap off of TBB.

(a) Exception is "last" SBB on TBB (e.g. furthest from TMGB).

(2) Grounding Equalizer(s) (GE) shall connect to TGBs to be interconnected.

G. Insulate Busbars from their support.

H. Connections shall be bare metal to bare metal contact.

(1) Clean surfaces of paint, dirt, oil, etc.

I. Connections shall be exposed and visible for inspection at all times.

(1) Do not install insulation over ground connections.

J. Terminate each grounding conductor on its own terminal lug.

(1) Multiple conductors on single lug not permitted.

3.04 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Test resistance of each TGB to ground.

(1) Maximum resistance to ground shall be less than 5 Ohms.

3.05 DOCUMENTATION

A. Accurately record actual locations of grounding electrode(s), busbars and backbone grounding conductors.

END OF SECTION 27 05 26

SECTION 27 05 28.29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. This section includes product and execution requirements for items unique to communications systems and not included in Division 26 sections.

B. Refer to Section 27 0000 – General Communications Requirements and 26 0529 - Hangers and Supports for Electrical Systems - Part 1 for requirements for Reference Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee.

1.02 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements
(2) Section 27 0528.33 - Raceway and Boxes for Communications Systems
(3) Section 27 0528.36 - Cable Tray for Communications Systems
(4) Section 27 0549 - Seismic Anchorage and Restraints
(5) Section 27 1000 - Structured Cabling
(6) Section 27 1100 - Communications Equipment Room Fittings
(7) Section 27 1300 - Communications Backbone Cabling
(8) Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

(1) Section 26 0529 - Hangers and Supports for Electrical Systems

1.03 REFERENCES AND STANDARDS

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

PART 2 PRODUCTS

2.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0529 - Hangers and Supports for Electrical Systems - Part 3 for:

(1) Hanger Rods
(2) Beam Clamps
(3) Wall Anchors
(4) Metal Framing

2.02 J-TYPE CABLE SUPPORT HOOKS

A. Cable support hooks shall be a wide-base type for use in a non-continuous pathway.

B. Hook material shall be Galvanized metal or Nylon for smooth cable pull and corrosion resistance.

(1) Hook may be coated to reduce cable friction.
(2) Hook material shall be rigid. Flexible material not allowed.

C. Hooks shall:

(1) Comply with UL, cUL, NEC and TIA requirements for structured cabling systems.
(2) Be designed to limit cable bending per cable manufacturers' recommendations.
(3) Be capable of being installed in a single- or multiple-hook ("tree") configuration.
(4) Incorporate a latch or other mechanism to retain cable.

PART 3 EXECUTION

3.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0529 - Hangers and Supports for Electrical Systems - Part 3 for all products identified in Part 1.

3.02 J-TYPE CABLE SUPPORT HOOKS

A. Where installed free-air above suspended ceiling or below raised floor, support cables using J-hook type cable supports installed in accordance with manufacturer's installation requirements.

B. Support hooks from structure. Do not support from ceiling grid, conduit or other trades work.

C. Space J-hook cable supports every 4 ft or in accordance with cable manufacturer's specifications, whichever distance is shorter.

D. J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.

END OF SECTION 27 05 28.29

SECTION 27 05 28.33 - RACEWAY AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. This section includes product and execution requirements for items unique to communications and not included in Division 26 sections.

1.02 DESCRIPTION

A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 1 for requirements for Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee for:

(1) Outlet Boxes
(2) Pull and Junction Boxes
(3) Raceways and Wireways (including sleeves, expansion fittings, penetrations and seals)
(4) Poke-through Fittings
(5) Floor Boxes
(6) Cable Supports

1.03 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements
(2) Section 27 0526 - Grounding and Bonding for Communications Systems
(3) Section 27 0528.29 - Hangers and Supports for Communications Systems
(4) Section 27 0528.36 - Cable Tray for Communications Systems
(5) Section 27 0528.39 - Surface Raceways for Communications Systems
(6) Section 27 0553 - Communications Systems Identification
(7) Section 27 1000 - Structured Cabling
(8) Section 27 1100 - Communications Equipment Room Fittings
(9) Section 27 1300 - Communications Backbone Cabling
(10) Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

(1) Section 26 0533 - Raceway and Boxes for Electrical Systems

1.04 REFERENCES AND STANDARDS

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

PART 2 PRODUCTS

2.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 2 for Outlet Boxes for Communications, Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 1.

PART 3 EXECUTION

3.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 3 for Outlet Boxes for Communications, Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 1.

(1) COMMUNICATIONS RACEWAYS

B. Optical Fiber Communications Cable Raceway (Innerduct):

(1) Minimum innerduct size: 1”, unless otherwise noted on drawings.
(2) Extend innerduct to termination and/or storage enclosure.
(3) Provide couplings designed for innerduct size and type where innerduct enters a termination and/or storage enclosure.
(4) Splice innerduct segments using couplings designed for that purpose, where not installed in a continuous length.
(5) Provide 200 lb nylon pull cord in empty innerduct. Leave at least 12” of slack at each end of pull wire. Cap innerduct at both ends.

(6) Label innerduct with tags indicating cable type and cables contained therein.

(a) Label in each maintenance hole, pull box and communications equipment room, where exiting a conduit and at 20 ft intervals in cable tray or where otherwise exposed.

END OF SECTION 27 05 28.33

SECTION 27 05 28.36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements
(2) Section 27 0526 - Grounding and Bonding for Communications Systems
(3) Section 27 0528.29 - Hangers and Supports for Communications Systems.
(4) Section 27 0528.33 - Raceway and Boxes for Communications Systems
(5) Section 27 1000 - Structured Cabling
(6) Section 27 1100 - Communications Equipment Room Fittings
(7) Section 27 1300 - Communications Backbone Cabling
(8) Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

(1) Section 26 0526 - Grounding and Bonding for Electrical Systems
(2) Section 26 0529 - Hangers and Supports for Electrical Systems
(3) Section 26 0533 - Raceway and Boxes for Electrical Systems
(4) Section 26 0536 - Cable Trays for Electrical Systems
(5) Section 26 0593 - Electrical System Firestopping

1.02 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

A. Provide complete cable tray system including straight tray sections, fittings, splice plates, and cable tray supports to support cable systems in locations as indicated on drawings.

B. Cable tray system is intended to carry communications cable only. Fire alarm system and overhead page cables are not allowed.

1.04 REFERENCE STANDARDS

A. ASTM A 123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and forged Steel Shapes, Plates, Bars, and Strip.

B. ASTM A 446 - Specification for Zinc-Coated (Galvanized) by Hot-Dip Process, Structural (Physical) Quality.

C. ASTM A 525 - Specification for Steel Sheet, Zinc-Coated Galvanized by Hot Dip Process.

D. ASTM A 607 - Specification for Steel Sheet and Strip, Hot-rolled and Cold-Rolled, High Strength, Low Alloy Columbium or Vanadium.

E. ASTM B 633 - Specification for Electro-deposited Coatings of Zinc on Iron and Steel.

F. NEMA VE 1 - Metal Cable Tray Systems.

G. NEMA VE 2 - Cable Tray Installation Guidelines

H. BICSI - Telecommunications Distribution Methods Manual (TDMM)

1.05 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section.

B. Submit as-built drawings showing floor plan locations, elevation changes, and conduit drops.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Acceptable Manufacturers

(1) Cooper B-Line (FLEXTRAY™)
(2) Chalfant Cable Trays
(3) Mono-Systems (Mono-Mesh™)
(4) MP Husky
(5) Legrand (CABLOFIL®)
(6) WBT

2.02 MATERIALS AND FABRICATION

A. Materials of Construction:

(1) Materials shall be adequately protected against corrosion or made of corrosion resistant material.

B. Wire Mesh Trays

(1) Tray shall be continuous, rigid, welded steel wire mesh cable management system.

(2) Maximum mesh dimension shall be 2 x 4 inches (50 x 100 mm).

(a) Wire diameter shall be at least 0.2 inch (5 mm).

(3) Material shall be carbon steel wire, ASTM A510, Grade 1008. Wire welded, bent, and surface treated after manufacture

(4) Finish shall be Electro-Plated Zinc Galvanizing per ASTM B 633, Type III, SC 1 or Electro-plated yellow zinc dichromate in accordance with ASTM B 633, Type III, SC 2.

(5) Dimensions:

(a) Inside width: As indicated on Project Drawings

(b) Loading depth (NEMA VE 1): 4" minimum

(6) Tray system shall not present sharp edges, burrs or projections injurious to wiring.

(7) Hardware, including splice connectors and support components, shall be furnished by tray manufacturer.

(8) Tray shall be UL classified for use as an equipment grounding conductor.

(9) Tray shall be designed to support volume capacity of cables and provide safe mechanical support for spans up to 8 feet (243.84 cm) on center. Tested load deflection data is available either in accordance with NEMA VE 1 or IEC 61537 standards

(10) Splice plates shall be bolted type made specifically for tray type provided.

(a) Splice plate construction shall be designed to permit splice location at any point within support span without diminishing cable tray rated loading capacity.

2.03 SUPPORT SYSTEM

A. Supports shall comply with product requirements defined in specification section 26 0529 - Hangers and Supports for Electrical Systems.

B. Flexible cordage/wire shall not be used.

2.04 ACCESSORIES

A. Special accessories shall be furnished as required to protect, support, and install cable tray system.

(1) Accessories include section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts and barriers.

PART 3 EXECUTION

3.01 GENERAL

A. Provide complete cable tray system, including straight tray sections, fittings, splice plates, and cable tray supports to support cable systems in locations, as indicated on drawings.

B. Comply with manufacturer’s recommended installation practices in addition to applicable standards and codes.

C. Completed installation shall present smooth surfaces and rounded edges with no burrs, projections or sharp edges that may prove injurious to installed wiring.

3.02 WIRE MESH

A. Cut wires in accordance with manufacturer’s instructions.

B. Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.

C. Cut each wire with one clean cut to eliminate grinding or touch-up.

3.03 INSTALLATION

A. Install metallic cable tray in accordance with NEMA VE 1 and VE 2.

B. Provide manufacturer’s standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, connectors, and grounding straps as required.

C. Provide blind end plates for trays that dead end.

D. Provide full-width dropouts (4" minimum bend radius) where cables exit from tray bottom.

E. Join cable tray system sections at ends using manufacturer prefabricated splice plates.

(1) No more than one cable tray splice shall be placed between support spans.

F. Tray system shall be accessible, with sufficient space provided about cable trays to permit side and top access for installation and maintenance of cables.

(1) Coordinate installation of cable tray to maintain clearance between cable tray and other trades work.

(2) Clearance shall be minimum 18" on at least one side, 12" on top and 6" below cable tray.

(3) Tray shall not restrict removal of ceiling panels or lighting assemblies.

(4) Notify Engineer for clarification and direction before proceeding with installation if access conditions cannot be met.

G. Do not install cable tray below re-heat coils, VAV boxes, traps, or other building components that require access from below.

H. Refer to specification section 27 1000 - Structured Cabling for separation requirements from potential EMI sources.

I. Provide prefabricated expansion splice plates at intervals as defined in NEMA VE 2 and where cable tray systems cross building expansion joints.

J. Provide minimum of 1 expansion splice plate in straight runs which exceed 12 ft for tray installations in exterior areas.

K. Field fabricate fittings in accordance with manufacturer's instructions.

(1) Minimum inside radius of fittings shall approximate 12-inch radius available using ladder-type cable tray.

L. Where cable tray would penetrate fire rated wall, stop tray at wall and fasten tray end to wall.

(1) Provide quantity of (1) 4" sleeve , threaded on both end for each 4" of cable tray width..

(2) Sleeves shall extend 4" beyond both sides of fire rated wall as required to meet UL fire rated assembly requirements. Final assembly shall carry UL listing to maintain fire and smoke rating of wall penetrated.

(3) Provide UL listed grounding connectors and conductors to extend cable tray grounding path through wall penetration.

M. Where cable tray distribution system encounters inaccessible ceiling area, provide sufficient 4" EMT sleeves/conduit through area to maintain same available cross sectional area as cable tray.

(1) Each sleeve/conduit shall maintain maximum of 40% cable fill ratio.

N. Provide cable tray liner that matches manufacturer's product line in all areas as indicated by the Architectural drawings.

O. Secure barriers into cable tray system using prefabricated barrier strip clips. Join barriers at ends using manufacturer prefabricated barrier strip splices.

P. Provide bolts and nuts in all holes of cable tray fittings per manufacturer's installation instructions.

Q. Cable tray systems shall be electrically continuous.

R. Nicks and scratches and ends of cut sections with galvanized coatings shall be coated, with approved coating that matches cable tray finish, after tray installation.

3.04 SUPPORT

A. Support cable tray system utilizing trapeze hangers from building or other structural steel members, angle brackets from vertical structural steel members, upright angle brackets on pipe racks, or directly upon horizontal structural steel members of the building or pipe racks.

(1) Center run hangers are not allowed.

(2) Cable tray may be wall mounted only in cases where trapeze mounting from above is not possible due to obstructions. Contractor shall review such situations with Engineer for approval prior to installation.

B. Supports shall be constructed from formed shape channel members 1.625" x 1.625", pre-galvanized 14 Ga. steel complete with nuts, bolts, washers, lock washers and tray clamps as required for complete and finished installation.

(1) Where formed mounting assemblies are part of manufacturer's integrated cable tray system, these may be used in compliance with manufacturers recommended practices.

C. Threaded rod used for tray support shall be 3/8" minimum diameter.

D. Size, anchor, and space supports to sustain weight of cable tray system, cable, and tubes that are to be installed into cable tray, and 200 lbs excess on any individual section, with safety factor of 1.5 minimum when supported as simple span and tested per NEMA requirements. Load and safety factors are applicable to all tray components.

E. Calculate supports based on 60 lbs/ft load of cables and tubes. Support spans shall not exceed manufacturer's recommendations.

F. Total vertical tray deflection shall not exceed 1-1/2" between supports when tray is loaded to capacity.

G. Include dynamic loads in calculations for outside area installations.

H. Maximum allowable deviation of tray, from level horizontal plane measured across width of tray, is one half of one inch (1/2") with tray loaded to capacity.

(1) Approval of installation method does not relieve contractor from meeting above deviation requirement. If additional support is needed, as determined by project engineer, contractor shall provide additional support at no additional cost

3.05 GROUNDING

A. Cable tray systems shall be electrically continuous.

(1) Bonding Jumpers shall be used between discontinuous tray sections as called for in manufacturer's installation guidelines to maintain grounding continuity of cable tray system.

(2) Grounding connections to tray shall be made using a UL listed mechanical connection.

B. Connect each cable tray system subassembly to building ground system using grounding clamps and grounding conductors. Provide 3.0 ohm maximum resistance to building ground connection.

C. Cable tray shall not be connected to instrumentation grounding system.

D. Bond conduits to cable tray as defined by NEC references in NEMA VE-1 and VE-2.

END OF SECTION 27 05 28.36

SECTION 27 05 28.39 - SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section includes product and execution requirements for items unique to communications and not included in Division 26 Sections.

B. Refer to Section 26 0533.13 - Surface Raceway System - Part 1 for References, Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee.

1.02 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements.

(2) Section 27 1000 - Structured Cabling.

(3) Section 27 1300 - Communications Backbone Cabling.

(4) Section 27 1500 - Communications Horizontal Cabling.

B. Related sections in other Divisions of Work:

(1) Section 26 0533.13 - Surface Raceway System.

PART 2 PRODUCTS

2.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0533.13 - Surface Raceway System - Part 2.

PART 3 EXECUTION

3.01 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0533.13 - Surface Raceway System - Part 3.

END OF SECTION 27 05 28.39

SECTION 27 05 53 - COMMUNICATIONS SYSTEMS IDENTIFICATION

PART 1 GENERAL

1.01 SCOPE

A. This section details product and execution requirements for labeling of communications cabling, termination components, pathways and spaces for Communications Systems.

1.02 DESCRIPTION

A. All components shall be clearly labeled to identify them as unique throughout the project.

B. Labeling requirements include identification of Rooms, Equipment Racks, Telecommunications Outlets, Horizontal and Backbone Cabling, Termination Hardware, Patch Panels and Grounding.

1.03 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements
(2) Section 27 0526 - Grounding and Bonding for Communications Systems
(3) Section 27 1000 - Structured Cabling
(4) Section 27 1100 - Communications Equipment Room Fittings
(5) Section 27 1300 - Communications Backbone Cabling
(6) Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

(1) Refer to individual technical sections identified above (if applicable).

1.04 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.

B. Other applicable references and standards include:

(1) TIA-606-C - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

1.05 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.06 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.07 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product and/or installation information to be submitted by contractor.

B. Prior to installation, provide samples of label types planned for the project.

(1) Samples shall include examples of lettering to be used and shall follow standards detailed below.

1.09 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements which identifies general quality assurance requirements for the project.

PART 2 PRODUCTS

2.01 GENERAL

A. Labels and markings shall be physically and chemically resistant to damage that would make label unreadable.

B. Cable labels shall be self-laminating, White/Transparent Vinyl (or other substrates facilitating easy application and flex as cables are bent) and incorporate an integrated clear lamination which covers printed part of label when label is wrapped around cable.

(1) If cable jacket is white, provide cable label with printing area that is a color other than white to easily distinguish label from cable jacket.

(2) Labels shall be of adequate size to accommodate circumference of cable(s) being marked and properly self-laminate over full extent of printed area of label.

(3) Labels on larger cables (e.g. Copper Backbone) may be wrapped with clear non-removable tape.

C. Labels shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing. Tags shall be non-removable.

(1) Exceptions:

(a) Telecommunications Outlet labels that are placed in recessed label holders.

(b) Telecommunications Ground tags secured with cable ties.

(c) Innerduct Tags secured with cable ties.

PART 3 EXECUTION

3.01 GENERAL

A. Labeling shall be by mechanical means.

(1) Hand lettered designations are not allowed.

B. Tags shall be non-removable.

(1) Exceptions:

(a) Telecommunications Outlet labels that are placed in recessed label holders.

(b) Telecommunications Ground tags secured with cable ties.

(c) Innerduct Tags secured with cable ties.

C. Characters shall be Black Ink and printed on background of contrasting color.

D. Labels shall match hardware layout and design.

E. Labels shall be as large as practicable while fitting properly.

F. No lettering shall be smaller than 10-point.

G. Label cables with tag which is wrapped around cable sheath.

(1) Clean cable sheath thoroughly before applying label.

(2) Labels shall not be obscured by termination hardware.

3.02 ROOM IDENTIFICATION

A. Telecommunications Rooms shall be identified per the Architectural Drawings according to plan room number and will be labeled with building signage located outside the room.

B. Room IDs will be:

(1) Equipment Room 112

(2) Telecommunications Rooms 210, 305, 405

(3) Telecommunications AV Rooms Main 136, 216, 311, 411

3.03 EQUIPMENT RACK IDENTIFICATION

A. Label each Equipment Rack with a single numeral beginning with the number one at the rack closest to the wall.

(1) TR-##, where:

(a) "TR" will be the room ID where the rack is located.

(b) "#" is the sequential number for the rack starting at "1".

B. Position Labels at top of rack.

C. Characters shall be 1-inch minimum.

3.04 TELECOMMUNICATIONS OUTLET

A. Label each Telecommunications Outlet (TO) connector with unique identifying code.

B. Telecommunications Outlet connector numbering shall result in logical numbering sequence in work area.

(1) Labeling plans that results in random TO numbering in work area are not acceptable.

C. Place Faceplate labels on outside of cover.

D. Position Labels in recessed label holders on faceplate and covered with clear plastic covers.

(1) Where Communications Outlet Faceplates not incorporating recessed holders are allowed, faceplate labels shall be protected with clear laminate.

E. Telecommunications Outlet labeling code shall be as follows:

(1) TR-RPP-##, where:

(a) “TR” is identifier for the room ID where the cable terminates in horizontal cross-connect.

(b) “R” is identifier for Equipment Rack where cable terminates

1) Numerical character starting at “1”.

(c) "PP" is Patch Panel on which cable is terminated at HC.

1) Number starting at “01”.

2) Panel numbering shall be from Top (of Rack) to Bottom.

(d) "##" is sequential POSITION of Jack on Panel

1) 1 - 48 is typical

2) Position sequence shall be Left-Right and Top-Bottom.

(2) Example: 101-103-25represents 25th Jack Position in 3rd Panel on Equipment Rack “1” in Telecom Room "".”101”

(a) Faceplate labels can use common TR identifiers on each label strip. For example, two data jacks served from TR 101 sharing common label strip may be represented by:

101

103-25 103-26

3.01 HORIZONTAL CABLING

A. Label each horizontal cable at Telecommunications Outlet and at horizontal cross-connect with unique identifying code.

B. Cable shall be labeled at both ends within 4" of cable choke (end of jacket).

C. Horizontal labeling code shall be same as identified for Telecommunications Outlet above:

3.02 MODULAR PATCH PANEL

A. Label each patch panel and port at horizontal cross-connect with unique identifying code.

B. Patch panel labeling code shall be same as identified for Telecommunications Outlet above:

(1) Label Panel I.D.beginning at the top with #01

(a) Panel numbering shall be from Top to Bottom

(2) Label Individual Port I.D.

(a) Port I.D. shall be from Left to Right, Top to Bottom.

(b) Manufacturers port labeling is acceptable.

C. Room number is not required on modular patch panels.

D. Equipment Rack number is not required on modular patch panels.

3.03 BACKBONE FIBER OPTIC CABLING

A. Label each backbone cable at both ends at termination point with unique identifying code.

B. Label shall be placed on adhesive labels adhered to cable sheath.

C. Label Intra-building cables with:

(1) From and to locations,

(2) Fiber type (core/cladding diameter)

(3) Fiber count

(a) Where multiple cable is installed between same end-points, labeling shall indicate sequential fiber numbering.

1) For example 144-fibers provided as two 72-fiber cables would be labeled "001-072" and "073-144".

(4) Date installed.

(5) Example 72-fiber cable from ER106 to TR3164 installed October 2009:

ER106-TR3164

50/125 001-072

10/2009

D. Label Inter-building cables with:

(1) From and to locations,

(2) Fiber type (core/cladding diameter)

(3) Fiber count

(a) Where multiple cable is installed between same end-points, labeling shall indicate sequential fiber numbering.

1) For example 144-fibers provided as two 72-fiber cables would be labeled "001-072" and "073-144".

(4) Date installed.

(5) Example 72-fiber cable from Building 108 ER to Building 110 ER installed October 2009:

ER108-ER110

50/125 001-072

10/2009

3.04 FIBER OPTIC PATCH PANELS

A. Label each fiber coupling in patch panel or workstation outlet with unique identifying code.

B. Patch panel labels shall be visible from front of panel without opening panel cover.

C. Place labels in manufacturer designated labeling areas.

D. Label Fiber Optic Patch Panels with unique labeling code to identify:

(1) Cable Destination Cable Number/ ID

(2) Fiber type (core/cladding diameter)

(3) Fiber (or coupler) number of each panel position.

(a) Port I.D. shall be from Top to Bottom, Left to Right,

(b) Manufacturers port labeling is acceptable.

E. Label Fiber Optic Patch Panels with unique labeling code to identify:

(1) Patch panel number in rack

(2) Fiber (or coupler) number of each panel position.

(a) Port I.D. shall be from Top to Bottom, Left to Right,

(b) Manufacturers port labeling is acceptable.

F. Room number is not required on fiber optic patch panels.

G. Equipment Rack number is not required on fiber optic patch panels.

3.05 INNERDUCT

A. Innerduct containing fiber optic cable installed under this project shall be labeled where exposed.

(1) Includes areas where innerduct is installed in trays and in equipment rooms.

B. Label innerduct with durable Yellow Polyethylene tag that reads "CAUTION FIBER OPTIC CABLE"

(1) Tag shall provide blank spaces for adding fiber count and cable destination information.

C. Label Tag to include:

(1) Identifier(s) of cable(s) contained therein.

(a) Use Backbone Cable labeling formats as described above.

D. Hand lettering is acceptable on tag

(1) Use an indelible type ink.

E. Tag shall be secured to Innerduct using self-locking ties.

3.06 TELECOMMUNICATIONS GROUNDS

A. Label Grounds as close as practicable to point of termination.

B. Labels shall be non-metallic and include the following:

WARNING

IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER.

(a) 3.11 TAG PLAN

1) A. Provide a “Tag Plan” that will meet the following criteria for each ER/TR.

(b) 1. 21” W x 15” H plan shall be labeled “As-Built” plotted floor plan showing the WAO locations throughout the area served by the ER/ TR.

(c) 2. The tag plan shall be secured to the wall in each ER and TR as designated in Appendix A.

(d) 3. A clear plexiglass sheet 22” W x 19” H shall be secured to the plywood lined wall. Fastener locations shall be on top and bottom only.

(e) 4. The tag plan shall slide behind the plexiglass from left to right.

(f) 5. This plan shall be updated to reflect any move, add or change to the area served by the ER/ TR.

(g) 6. See Appendix A of the University OF Arkansas, Communications Infrastructure Specification. TAG PLAN drawings for clarification.

END OF SECTION 27 05 53

SECTION 27 10 00 - STRUCTURED CABLING

PART 1 GENERAL

1.01 SCOPE

A. This section details product and execution requirements for Structured Cabling for Communications Systems.

1.02 DESCRIPTION

A. Systems shall include cabling, termination hardware and active components, installed as indicated on drawings and specifications.

B. Cables and equipment shall be provided, tested, and terminated, including proper grounding and bonding.

1.03 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements
(2) Section 27 0526 - Grounding and Bonding for Communications Systems
(3) Section 27 0528.29 - Hangers and Supports for Communications Systems
(4) Section 27 0528.33 - Raceway and Boxes for Communications Systems
(5) Section 27 0528.36 - Cable Tray for Communications Systems
(6) Section 27 0528.39 - Surface Raceways for Communications Systems
(7) Section 27 0553 - Communications Systems Identification
(8) Section 27 1100 - Communications Equipment Room Fittings
(9) Section 27 1300 - Communications Backbone Cabling
(10) Section 27 1500 - Communications Horizontal Cabling
(a) Section 27 4100 – Audio Visual Systems

B. Related sections in other Divisions of Work:

(1) Refer to individual technical sections identified above (if applicable).

1.04 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.

B. In addition:

(1) TIA 568-C - Commercial Building Telecommunications Cabling Standard (including applicable Addenda)
(2) TIA 569-C - Commercial Building Standard for Telecommunications Pathways and Spaces.
(3) BICSI Telecommunications Distribution Methods Manual (TDMM)
(4) TIA-758-B - Customer-Owned Outside Plant Telecommunications Infrastructure Standard
(5) TIA-598-D: Optical Fiber Cable Color Coding.
(6) TIA 455-21-A: Mating Durability for Fiber Optic Interconnecting Devices
(7) TIA 526-14-C: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
(8) TIA-526-7-A: Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
(9) UL-910: Tests for Flame Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air
(10) UL-1666: Tests for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
(11) IEEE 802.3af and 802.3at Power-over-Ethernet Standards.
(12) IEEE 802.3an 10 Gigabit Standard

1.05 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, the following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction:

(1) Backbone Cabling - cable or conductors between telecommunications rooms, or floor distribution terminals, entrance facilities, and equipment rooms within or between buildings. Backbone cabling may be twisted pair copper, fiber optic or coaxial.
(2) Cable - assembly of 1 or more conductors or optical fibers within enveloping sheath, constructed so as to permit use of conductors singly or in groups.
(3) Cable ID - unique alpha-numeric identification used for tagging of backbone or horizontal cabling.

(4) Channel - end-to-end transmission path to which application-specific equipment is connected. Same as "Permanent Link", but also includes patch cords at Telecommunications Outlet and in Telecom Room.

(5) Consolidation Point (CP): A location for interconnection between horizontal cables extending from the horizontal cross-connect and horizontal cables extending to the telecommunication outlet at the workstation.

(6) Contractor: Telecommunications Contractor or sub-contractor(s) responsible for installation, termination, test and documentation of communications cabling, termination components, pathway hardware, telecommunications equipment room hardware and related components detailed in technical sections of this Division of work.

(7) Cross-Connect - group of connection points between cabling runs and/or equipment used to administer building wiring using patch cords or wire jumpers.

(8) Horizontal Cabling - Cables connecting Telecommunications Outlets to horizontal or intermediate cross-connect. Sometimes referred to as "Station Cabling".

(9) Horizontal Cross-connect (HC) – Connection of horizontal cabling to other cabling (e.g. horizontal, backbone or equipment) using patch cords or wire jumpers.

(10) Interconnection - Connection scheme using connecting hardware for the direct connection of a cable to another cable without a patch cord or jumper

(11) Main Cross-connect (MC) – Connection between backbone cables, entrance cables and equipment cables using patch cords or wire jumpers.

(12) Outlet ID - unique alpha-numeric identification used for referencing Telecommunications Outlet or connectors therein.

(13) Permanent (Cable) Link - includes Telecommunications Outlet, horizontal (station) cable and termination hardware in Telecom Room.

(14) Service Loop - Surplus cable, typically located at or near point of termination to enable future changes.

(15) Telecommunications Outlet (TO) - device assembly located in work area on which horizontal cabling terminates and which can receive modular connectors. It is interface between Station Cable and end user's equipment.

(16) Telecom Room - an enclosed space for housing telecommunications equipment, horizontal and backbone cable terminations, and cross-connect cabling, that is recognized location of horizontal cross-connect.

(17) Zone Box - An enclosure used to house one or more of the following; a) a consolidation point, b) a horizontal connection point, c) building automation system outlets.

(18) Zone Cabling - Extends permanent horizontal cabling to a shared termination (consolidation) point in the work area. Passive system extends link to workstation through at interconnect at the Consolidation Point (CP). Active system includes system electronics at the CP.

C. “10-gigabit” or “10G” performance criteria, if applicable, refers to support of 10GBASE-T application over 4-connector channel up to 109.36 yards (100 meters) and meeting requirements of TIA-568-C.2.

D. The following definitions are specific to the Project environment and shall apply to this document and its companion sections for clarification and direction.

1.06 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, the following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction:

(1) 8P8C Eight-Position, Eight-Conductor. Used in clarifying jack type; a.k.a. "RJ-45".

(2) CM Communications cable rated for General Purpose use

(3) CMP Communications cable rated for use in Plenum areas

(4) CMR Communications cable rated for use in Risers and vertical runs

(5) CP Consolidation Point

(6) ELFEXT Equal-Level Far-End Cross Talk (pair-to-pair)

(7) FEXT Far-End Cross Talk

(8) F/UTP Foiled Unshielded Twisted Pair

(a) No shielding around individual pairs and an overall foil shield under the cable jacket

(9) HC Horizontal Cross-connect

(10) HCP Horizontal Connection Point (e.g. for TIA-862)

(11) IDF Intermediate Distribution Frame

(12) MC Main Cross-connect

(13) MDF Main Distribution Frame

(14) MPTL Modular Plug Terminated Link

(15) N Newton

(16) NEXT Near End Cross Talk
(17) OFNP Optical Fiber Nonconductive Plenum
(18) OFNR Optical Fiber Nonconductive Riser
(19) OTDR Optical Time Domain Reflectometer
(20) PBX Private Branch Exchange (Telephone Switch)
(21) PoE Power-over-Ethernet
(22) PSNEXT Power Sum Near End Cross Talk
(23) S/FTP Screened Foiled Twisted Pair
(a) (Individual foil shield around each individual pair and an overall braided shield under the cable jacket.)
(24) S/UTP Screened Unshielded Twisted Pair
(a) (No shielding around individual pairs and an overall braided shield under the cable jacket.)
(25) SF/UTP Screened Foiled Unshielded Twisted Pair
(a) (No shielding around individual pairs and overall foil and braided shields under the cable jacket.)
(26) TO Telecommunications Outlet
(27) TR Telecommunications Room
(28) USOC Universal Service Order Code
(29) UTP Unshielded Twisted Pair
(a) (No shielding around pairs nor overall under cable jacket.)
(30) U/FTP Unshielded Foiled Twisted Pair
(a) (Individual foil shield around each individual pair and no overall braided shield under the cable jacket.)

1.07 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.
B. In addition, Submit:
(1) Contractor Certification documents which document their participation in Installers Program operated by Manufacturer of Cabling or Termination Components used.
(a) Upon request, Certified Installer(s) assigned to Project shall be identified to Engineer.

1.09 QUALITY ASSURANCE

A. General:
(1) Cable and Equipment Manufacturer(s) shall be company specializing in communications cable, accessories and/or equipment with minimum of 5 years documented experience in producing cable, accessories and/or equipment similar to those specified herein.
B. Contractor Qualifications:
(1) Qualified personnel utilizing state-of-the-art equipment and techniques shall complete cable and equipment installation and termination.
(2) Contractor shall have been in this business for minimum of 5 years and shall have successfully completed 4projects equal in magnitude of system specified in the following sections.
C. Contractor shall have necessary certifications to provide for Warranty as specified herein.
(1) Contractor shall be an active participant in Installers Program operated by Manufacturer of Cabling or Termination Components used.
(a) Contractor shall be participant in this program at time of Bidding and remain so throughout project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents and Section 27 0000 - General Communications Requirements for general guarantee requirements.
B. Warranty structured cable system as follows:
(1) 4-pair Category-rated Horizontal CopperPermanent Link for no-less than20 years from date of substantial completion of work.
(2) Fiber Optic Backbone for no-less than20years from date of substantial completion of work.
C. Warranty shall be direct from manufacturer(s) of cabling and connecting components to Owner.

PART 2 PRODUCTS

2.01 GENERAL

A. Refer to individual Technical Sections.

2.02 POWER OVER ETHERNET

A. All cable and connecting components that comprise the TIA horizontal cabling “Permanent Link” from Horizontal Cross-connect to Telecommunications Outlet shall be compliant with the applicable requirements for “DTE Power via the MDI” to provide at least 25.5Wat the Powered Device as defined by the IEEE 802.3atstandard.

B. Cabling shall be UL-LP listed at a minimum of 0.5A.

C. Connecting hardware shall comply with IEC 60512-99-001for engaging and separating connectors under electrical load and connectors used in twisted pair communication cabling with remote power.

2.03 SYSTEM REQUIREMENTS

A. Structured cabling products shall be designed to work together as a fully-warranted system.

B. Acceptable Category 6A systems shall be:

(1) CommScope SYSTIMAX GigaSPEED X10D

PART 3 EXECUTION

3.01 GENERAL

A. Refer to individual technical specification sections for detailed Cable Routing and Installation, Testing and Documentation requirements. The following apply to communications cabling and termination work.

B. Installation shall be per manufacturers' recommendations.

C. Label cables and termination components per Section 27 0553 - Communications Systems Identification.

3.02 CABLE INSTALLATION

A. Run cabling in raceways provided, or as designated on floor plans, and support from building structure.

(1) Where installed in free-air, support cables using J-hook type cable supports installed in accordance with manufacturer’s installation requirements. Refer to Section 27 0528.29 - Hangers and Supports for Communications Systems for installation requirements.

(a) J-hook fill capacities shall be per manufacturer’s recommendations and shall consider diameter of cable type(s) being installed.

(b) Route cable/hooks at right angles, parallel to construction.

(2) Where installed in Cable Tray, lay cables neatly in tray.

(a) Do not tie. .

(b) Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.

B. Route and support cable in Equipment Rooms and Telecom Rooms utilizing "D-type" mounting rings, J-hooks and overhead cable runway.

C. Cable shall be free of tension at both ends.

(1) In cases where cable must bear stress, provide Kellems grips to spread stress over longer length of cable.

D. Provide required installation tools to facilitate cable pulling without damage to cable jacket.

E. Keep cables clear of other trades work.

F. During pulling operation provide an adequate number of workers to allow cable observation at points of raceway entry and exit, as well as to feed cable and operate pulling machinery.

G. Pull cables in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 Standards.

H. Pull cable by hand unless installation conditions require mechanical assistance.

I. Do not exceed recommended pulling tensions and bending radii.

(1) Where mechanical assistance is used, ensure that maximum tensile load for cable is not exceeded.

(a) This may be in form of continuous monitoring of pulling tension, use of "break-away" or other approved method.

(2) Replace cables bent or kinked to radius less than recommended dimension.

(a) This shall be at no expense to Owner.

J. Install cables splice-free unless otherwise specified.

K. Avoid abrasion and other damage to cables during installation.

(1) Visually inspect cables for cuts, blisters and abrasions during installation.

L. Pulling lubricant may be used and shall:

(1) Be non-injurious to cable jacket and other materials used.

(2) Not harden or become adhesive with age.

M. Repair damage to interior spaces caused by installation of cable, raceway or other hardware. Repairs must match preexisting color and finish of walls, floors and ceilings.

N. Replace contractor-damaged ceiling tiles to match color, size, style and texture.

O. Provide pull cord 200 lb minimum) with cable installed in conduit or innerduct.

P. Neatly lace, dress and support cabling.

Q. In vertical pathway, support cables on each floor using industry recognized support methods designed specifically for that purpose.

(1) Strap vertical runs as required, to prevent sagging of cables.

R. To reduce effects of EMI, adhere to thefollowing minimum cable separation distances.

(1) 5” from power lines of 2 kVA

(2) 18” from high voltage lighting (including fluorescent and LED)

(a) When using LED lighting, stated separation distance shall be from cables to LED drivers.

(3) 39” from power lines of 5 kVA or greater

(4) 47” from transformers and motors

3.03 FIELD TESTING

A. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding requirements for scheduling and performing compliance testing.

B. Cabling shall be 100% fault free unless otherwise noted. If any Channelis found to be outside specification defined herein, identify and correct problem up to and including replacement of cable and associated termination(s). Then repeat applicable tests.

C. Test each cabling sub-system (e.g. backbone, horizontal, etc.) end-to-end.

D. Where sub-systems are to be interconnected or cross-connected by the contractor, test individual sub-system followed by a test of the connected links

(1) Performance and documentation requirements shall default to the lesser of the two connected systems if different.

(2) Example 1: Combined Backbone-Horizontal Link

(a) Test and document individual Backbone and Horizontal Cabling Sub-systems.

(b) Cross-connect sub-systems.

(c) Repeat testing on combined cabling from MC - TO through HC.

(d) Performance and documentation requirements shall be based in this example on backbone cabling (continuity, pair integrity, etc.).

(3) Example 2: Interconnected Zone Cabling Link

(a) Test and document individual HC – CP links.

(b) Install interconnect cabling CP – TO

(c) Repeat testing on combined cabling from HC – TO through CP.

(d) Performance and documentation requirements shall be based in this example on TIA Permanent Link for Horizontal Cabling.

E. Test instrument shall be configured using template for exact cable under test (e.g. by manufacturer product designation).

(1) If no template is available, enter cable parameters for the cable per manufacturer’s product data.

(a) Nominal Velocity of Propagation (NVP) used for copper cable type under test shall be traceable to manufacturers' product data.

(b) Refractive Index used for fiber optic cable type under test shall be traceable to manufacturers' product data.

(2) Test results obtained using incorrect cable parameters will be rejected.

F. Test instrument shall be calibrated as defined by instrument manufacturer at least once every 12 months or as required by test instrument manufacturer if that results in more frequent calibration runs.

(1) Test instrument calibration date shall be present in test results documentation.

G. Refer to individual Technical Sections for system-specific guidelines regarding requirements for scheduling and performing compliance testing.

3.04 DOCUMENTATION

A. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding requirements for project Documentation.

B. Refer to individual Technical Sections for system-specific guidelines regarding requirements for project Documentation.

C. Information added by Contractor to Record Drawings shall include:

(1) Backbone and horizontal cable routes

(2) Telecommunications outlet locations and identification

(3) Other detail necessary to document cable installation

3.05 OWNER TRAINING

A. Provide training for Owner's personnel on operation and maintenance of total system and each component.

B. Training to include:

(1) Overview of System Topology and General Concepts

(2) Overview of Product Used

(3) Overview of Equipment Room Layouts

(4) Overview of Labeling Formats

(5) Overview of Test Results and their meaning

(6) Overview of Documentation

C. Training shall be held atProject Site] and shall be conducted during normal working hours.

D. Training session duration shall be not less than (1) h

(1) Provide one such session.

(2) Coordinate with owner to schedule session(s). Provide adequate notification to allow owner to schedule staff.

E. Attendance shall be by owner staff .

(1) Number of Students per session shall be 6

(2) Materials shall be provided for the number of students indicated.

F. Provide example course materials and instructor background in advance of training session(s).

G. Owner may videotape session(s) for use as future refresher materials for owner technical staff.

END OF SECTION 27 10 00

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.01 SCOPE

A. This section details product and execution requirements for Communications Equipment Room Fittings for Communications Systems.

1.02 DESCRIPTION

A. Communications Equipment Room Fittings include:

(1) Racks, Frames and Enclosures

(2) Cable Runway

(3) Patch Panels

B. Refer to Project Drawings for Equipment Room layout and equipment placement.

1.03 RELATED WORK

A. Refer to Section 27 0000 - General Communications Requirements which identifies related specification sections in this and other Divisions (if applicable).

1.04 REFERENCES AND STANDARDS

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

B. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements

(2) Section 27 0526 - Grounding and Bonding for Communications Systems

(3) Section 27 0528.29 - Hangers and Supports for Communications Systems

(4) Section 27 0528.33 - Raceway and Boxes for Communications Systems

(5) Section 27 0553 - Communications Systems Identification

(6) Section 27 1000 - Structured Cabling

(7) Section 27 1300 - Communications Backbone Cabling

(8) Section 27 1500 - Communications Horizontal Cabling

C. Related sections in other Divisions of Work:

(1) Refer to individual technical sections identified above (if applicable).

1.05 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.06 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.07 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

1.09 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to cable and components covered in this section.

PART 2 PRODUCTS

2.01 CABINETS, RACKS, FRAMES AND ENCLOSURES

A. Manufacturers: CPI, Commscope

B. Equipment racks shall be:
   (1) Constructed of anodized aluminum
   (2) Color Black
   (3) Supplied with ground bar 19” wide by 1” high and 6 AWG ground lugs
   (4) Supplied with minimum of 12 releasable cable support ties (e.g. "hook and loop")
   (5) Supplied with spare screws (minimum of 50)
   (6) Configured with Channel uprights spaced to accommodate industry standard 1” mounting

C. Free Standing Equipment Rack shall comply with general requirements above and shall:
   (1) Be 84” in height
      (a) Have minimum of 45usable rack mounting units (RU)
   (2) Be self-supporting
   (3) Have Minimum base footprint of 15” x 20”
   (4) Be double-sided drilled and tapped to accept 12-24 screws
      (a) Uprights shall be drilled on back to accept cable brackets, clamps, power strip(s).
      (b) Hole pattern on rack front and back shall be per EIA/TIA specifications 5/8” – 5/8” – 1/2”

D. Cable Management
   (1) Manufacturers: CommScope,
   (2) Vertical Cable Management shall:
      (a) Provide for cable routing on front and rear of each rack
      (b) Be 8” wide (minimum) when installed between two racks. Commscope VCM-DS-84-8B
      (c) Be 8” wide when installed at end of rack row. Commscope VCM-DS-84-8B
      (d) Mount on spacers attached to rack uprights and not on upright
      (e) Be accessible from front and rear of rack
      (f) Be designed to space slots/fingers at 1 RU intervals to align with rack-mounted equipment

E. Miscellaneous
   (1) Releasable Cable Support Ties shall be:
      (a) Hook & Loop type
      (b) Individual units with latch
         1) Roll of hook & loop material is not acceptable.

2.02 CABLE RUNWAY

A. Manufacturers: CPI Chatsworth Products 10250-712 and associated required accessories.

B. Cable Runway shall:
   (1) Be constructed of 0.065” thick steel
   (2) Utilize tubular stringers to support rungs.
      (a) Stringers shall be 1-1/2” high.
      (b) Rungs shall be welded to stringers and shall be spaced 9” on center.
   (3) Be painted with black epoxy

C. Runway width(s) shall be as shown on drawings.

2.03 MODULAR PATCH PANELS

A. Manufacturers: Commscope 360-IPR-1100A-E-GS6-2U-48

B. Panels shall:
   (1) Consist of Modular-to-IDC connector system
   (2) Be rack-mountable in standard EIA 19” equipment racks
   (3) Be 2 RUs high
   (4) Accommodate 48-port modular jacks in two rows of 24-ports
   (5) Be designed to terminate 4-pair, 100-Ohm UTP] cables
   (6) Have ability to terminate 22-26 AWG plastic insulated, solid and stranded copper conductors.
   (7) Be designed to maintain cable's pair twists as closely as possible to point of mechanical termination.
   (8) Have cable support and strain relief devices to secure cables at IDC connector.
      (a) Panel and cable support hardware shall ensure that cabling minimum bend radius requirements are satisfied.

(9) Have port identification numbers on both front and rear of panel.

(10) Have color-coded pair designations on rear of panel.

C. Modular Jacks in Panel shall:

(1) Be non-keyed, 8 position, 8-conductor (8P8C)

D. Panels shall meet or exceed TIA Category 6A 10-gigabit performance criteria.

2.04 FIBER OPTIC PATCH PANELS

A. Manufacturers: Commscope 360 G2

B. Patch Panels shall:

(1) Be enclosed assemblies

(2) Incorporate hinged or retractable front cover

(3) Be rack mountable on standard TIA 19” equipment racks

(4) Provide for strain relief of incoming cables

(5) Incorporate radius control mechanisms to limit bending of fiber to manufacturer's recommended minimums of 1.2”, whichever is larger

(6) Provide protection to both "facilities" and "user" sides of couplings.

(7) Be configured to require only front access when patching

(8) Incorporate patch cable routing space internal to patch panel enclosure.

(a) Routing space shall be front-accessible.

(9) Include provisions for permanent labeling of fiber optic cables.

(a) Labeling shall be accessible from front of patch panel and shall not require disassembly of patch panel enclosure or removal of front cover.

C. Couplings shall be mounted on assembly that snaps into patch panel enclosure.

(1) This assembly shall be designed to accept variety of coupler types including, ST, SC, duplex SC and high-density mini-connectors.

(2) Coupling type shall be LC duplex

(3) Coupling Color shall be as follows:

(a) Single-mode: BLUE

D. Access to inside of panel enclosure during installation shall be from front and rear.

(1) Panels that require disassembly of cabinet to gain entry will not be accepted.

E. Incoming cables shall not be accessible from patching area of panel.

(1) Enclosure shall provide physical barrier to access of such cables.

(2) Where factory-terminated cable assemblies ("pigtails") are spliced to cable, enclosure shall incorporate hardware for securing of splice tray and required cable, buffer tube and pigtail slack.

PART 3 EXECUTION

3.01 GENERAL

A. Refer to project Drawings for communications equipment room layout and equipment placement.

B. New communications equipment rooms must be free from dust, dirt, and other foreign materials before installation of any termination hardware or termination of copper or fiber optic cables.

(1) Door to room must be closed during termination if area outside room is not dust-free.

C. Follow manufacturer’s recommended installation and termination practices.

D. Provide necessary assistance to allow Owner or Carrier personnel to establish service on new cable system.

(1) Includes general wiring overview, cable pair identification, and cross connect documentation (if applicable).

3.02 EQUIPMENT RACKS AND CABLE MANAGEMENT

A. Provide equipment racks as shown on project Drawings.

B. Assemble racks per manufacturer’s recommendations. Remove paint at the point(s) of contact of assembly hardware or use internal-external tooth lock washers to pierce paint to maintain ground continuity.

C. Bolt racks to floor.

D. Secure racks to cable runway as described below.

E. Provide Horizontal and Vertical Cable Management in equipment racks Drawings

(1) Provide horizontal cable management above and below each rack mounted patch panel.

(2) Provide vertical cable management between adjacent equipment racks and at rack row ends.

F. Provide each rack with:

(1) Minimum of fifty (50) 12/24 mounting screws,

(2) Minimum of twelve (12) releasable (e.g. "hook & loop") cable support ties.

G. Bond each rack mounted ground bar to the secondary bonding backbone.

(1) Use #6 AWG or larger copper conductor (green jacket).

3.03 CABLE RUNWAY

A. Provide cable runway and accessories necessary for complete system.

B. Size and layout of cable runway shall be as shown on project Drawings.

C. Install above equipment racks 7’-6”

D. Align with equipment racksas shown on drawings

(1) Where parallel to rack row, align center of runway with center of rack.

(2) Where at right-angle to rack, align center of runway with center of rack.

E. Brace to racks with support brackets made by runway or rack manufacturer intended for this purpose.

F. Use radius drops where cables drop from tray to rack and at elevation changes of 6” or more.

G. Maximum allowable deviation of runway from level horizontal plane measured across length of cable runway shall be 1/2”, with tray loaded to capacity.

H. Where cable runway is supported from building structure:

(1) Provide 3/8” threaded rods for support of 12” wide or smaller runway.

(2) Provide 1/2” threaded rods for support of runway greater than 12” in width.

I. Bond runway components together using manufacturer's standard accessories.

J. Fasten cables to runway at intervals not to exceed 4 feet (121.92 cm)

3.04 MODULAR PATCH PANELS

A. Provide panels per project documents

B. Mount patch panels in 19” equipment racks.

C. Position cables in sequence of:

(1) Telecommunications Outlet ID for horizontal cabling

(2) Pair number for backbone cabling

D. Terminate cables using 568B wiring standard.

E. Provide horizontal management above and below each patch panel.

F. Provide minimum of 4 screws to secure each patch panel onto rack.

3.05 FIBER OPTIC PATCH PANELS

A. Provide Fiber Optic Patch Panels and coupling assemblies at horizontal and main cross-connect locations

(1) Provide minimum of 4 screws to secure each patch panel onto rack.

B. Provide couplings in coupling assemblies and mount coupling assemblies and blank covers in patch panels.

C. Position fibers consecutively - starting with lowest number - and mapped "position for position" between patch panels.

(1) There shall be no transpositions in cabling.

D. Keyways on duplex couplings shall be oriented to establish "cross-over" in cabling system.

(1) Convention defined by TIA-568-C.0 (Annex B, Section B.3.2) shall be used.

(2) Reverse-pair positioning shall not be used.

E. Provide blank covers for unused coupling assembly spaces in panels.

F. Follow manufacturer's guidelines for connector type(s) provided.

G. 1. Clean couplings with foam swab and isopropyl alcohol prior to connection insertion. Blow dry with compressed air.Provide dust caps for couplings.

H. Where factory-terminated cable assemblies ("pigtails") are spliced to cable, prepare and splice cables and fibers per manufacturers' guidelines.

3.06 FIELD TESTING

A. General

(1) Refer to Section 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding documentation requirements.

(2) Refer to referenced technical sections for detailed requirements to testing of each cable sub-system.

3.07 DOCUMENTATION

A. General

(1) Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding documentation requirements.

END OF SECTION 27 11 00

SECTION 27 13 00 - COMMUNICATIONS BACKBONE CABLING

PART 1 GENERAL

1.01 SCOPE

A. This section details product and execution requirements for backbone cabling for Communications Systems.

1.02 DESCRIPTION

A. Backbone Cabling links telecommunications rooms or floor distribution terminals, entrance facilities, and equipment rooms within or between buildings.

B. Backbone cable types include:

(1) Fiber Optic

C. Refer to Project Drawings which detail Backbone Cable System topology and conductor/fiber counts.

1.03 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements
(2) Section 27 0526 - Grounding and Bonding for Communications Systems
(3) Section 27 0528.29 - Hangers and Supports for Communications Systems
(4) Section 27 0528.33 - Raceway and Boxes for Communications Systems
(5) Section 27 0528.36 - Cable Tray for Communications Systems
(6) Section 27 0528.39 - Surface Raceways for Communications Systems
(7) Section 27 0553 - Communications Systems Identification
(8) Section 27 1000 - Structured Cabling
(9) Section 27 1100 - Communications Equipment Room Fittings
(10) Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

(1) Refer to individual technical sections identified above (if applicable).

1.04 REFERENCES & STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify pertinent References and Standards.

1.05 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.06 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.07 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

B. In addition, submit:

(1) One 3 ft section of each cable type from cable reels sent to site for Engineer's final approval.
(a) Section shall have manufacturer's cable markings visible.

1.09 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to cable and components covered in this section.

PART 2 PRODUCTS

2.01 GENERAL

A. Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA documents.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

2.02 FIBER OPTIC CABLE

A. General

(1) Manufacturers (Cable): CommScope

(2) Manufacturers (Optical Fiber): Corning, Alcatel

(3) Fibers utilized in installed cable shall be traceable to manufacturer.

B. Optical Fiber - General

(1) Optical fibers shall:

(a) Be sufficiently free of surface imperfections and occlusions to meet optical, mechanical, and environmental requirements of this specification.

(b) Have been subjected to minimum tensile proof test by fiber manufacturer equivalent to 100 kpsi.

(2) Factory optical fiber splices are not allowed.

(3) Coatings shall be mechanically strippable without damaging optical fiber.

C. Single-mode Optical Fibers:

(1) Fiber Type: Single-mode

(2) Strand Count: as shown on Drawings

(3) Transmission Windows: 1310 nm, 1550 nm

(4) Core Diameter: 8.3 micron

(5) Cladding Diameter: 125 micron ± 1 micron

(6) Coating Diameter: 245micron± 10 micron

(7) Maximum Attenuation:

(a) 1310 nm0.5 dB/km (at 23° ± 5°C)

(b) 1550 nm0..5-dB/km (at 23° ± 5°C)

(c) When tested in accordance with FOTP 3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical cable, and Other Passive Fiber Optic Components", average change in attenuation over rated temperature range of cable shall not exceed 0.05 dB/km at 1550 nm. Maximum attenuation change shall not exceed 0.15 dB/km at 1550 nm.

(d) Water Peak Attenuation: 1383 ± 3 nm (dB/km) ≤ 0.4

(8) Point Discontinuity: < 0.1 dB at specified wavelengths

D. Indoor Backbone Fiber Optic Cable

(1) Cable shall:

(a) Be suitable for installation in free air, in building risers, in conduit, in cable tray and in innerduct.

(b) Be dielectric materials (no conductive materials).

(2) Cable shall meet the following specifications:

(a) Buffer Diameter: 900 micron (tight buffer)

(b) Jacket Color

1) Single-mode: YELLOW

(c) Cable Rating: OFCP

(d) Strength Member: Aramid Yarn

(e) Storage Temperature: 40°F to 158°F (no irreversible change in attenuation)

(f) Operating Temperature: 34°F to 158°F (no irreversible change in attenuation)

(g) Humidity Range: 0 to 100%

(h) Maximum Tensile Strength:

1) During Installation – 2700 N (no irreversible change in attenuation)

2) Long Term – 1000 N

(i) Bending Radius:

1) During Installation - 20 times cable diameter

2) No Load - 10 times cable diameter

2.03 FIBER OPTIC CONNECTORS

A. Manufacturers: Corning

B. Connectors shall:

(1) Be ST type.

(2) Accept fibers having clad diameter of 125 micron.

(3) Accept fibers having buffered diameter of 900 micron.

(4) Sustain minimum of 200 mating cycles.

C. Connector ferrule shall be ceramic or glass-in-ceramic

D. Connectors shall meet the following performance criteria:

(a) Test Procedure Max. Attenuation Change

(2) Cable Retention (TIA-455-6) 0.2 dB

(3) Durability (TIA-455-21) 0.2 dB

(4) Impact (ANSI/TIA/EIA-455-2) 0.2 dB

(5) Temperature Life (TIA/EIA-455-4) 0.2 dB

(6) Humidity (TIA/EIA-455-5) 0.2 dB

E. Optical fiber shall be:

(1) Secured within connector ferrule with adhesive, or

(2) Mechanically secured and mated to a factory-installed fiber stub that is fully bonded into the ferrule. Mechanical “splice” inside connector shall include an index matching gel.

F. Attenuation per connector shall not exceed 0.5 dB.

G. Reflectance (maximum) when mated with patch-cord made up of connectors of comparable design shall be as follows:

(1) Single-mode: 55 dB

H. Color of [LC Connector shall be as follows:

(1) Single-mode: BLUE

I. Strain-relief boot of ST Connector shall indicate fiber type as follows:

(1) Single-mode: YELLOW

PART 3 EXECUTION

3.01 CABLE INSTALLATION AND TERMINATION

A. General

(1) Provide cables as shown on Project Documents.

(2) Size cables as shown on Project Documents.

(3) Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling for general cable installation requirements.

B. Backbone UTP Voice Cable:

(1) Terminate cables on backbone voice cable blocks.

(a) Maintain cables pair twists to within 1” of termination.

(b) Remove cable jacket only to extent required to make terminations.

C. Fiber Optic Cable

(1) Route backbone fiber optic cable in innerduct.

(2) Ground metallic cable sheath (if applicable) per Code.

(a) Provide armored fiber ground kit for armored cable terminations. Install as directed by kit manufacturer.

1) Ground inter-building cable at one end

2) Ground intra-building cabling at both ends

(b) Connect armored fiber ground kit to rack mounted grounding reference.

(3) Terminate fiber strands on Fiber Optic Connectors mated to couplings mounted in Fiber Optic Patch Panels.

(a) Terminate all fibers.

(4) Follow manufacturer's guidelines for connector type(s) provided.

(a) Clean connectors with specialized dry-cleaning product from Fluke or Cletop.

(5) Fibers with coatings <900 micron shall be furcated (fanned-out) to minimum of 900 micron before termination.

(a) Provide buffer tube fan-out kits for fibers terminated in patch panel couplings.

(6) Provide cable slack in each backbone fiber optic cable.

(a) Slack shall be in addition to length of fiber required for termination requirements.

(b) Store cable slack in enclosure designed for this purpose.

(c) Slack required shall be as follows:

1) Backbone Intra-Building: Minimum of 16 feet each cable if applicable (487.68 cm) coiled and secured at one end (preferably at Telecom Room).

2) Backbone Inter-Building: Minimum of 50 feet each cable if applicable feet (1524 cm) coiled and secured at one end (preferably at Equipment Room).

3) Maintenance Holes/Manholes: Minimum of 1-1/2 times inside dimension of Maintenance Hole/Manhole.

3.02 FIELD TESTING

A. General

(1) Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding requirements for scheduling and performance of compliance testing.

(a) Contractor shall be responsible for testing each system end-to-end.

B. Backbone Fiber Optic Cable Testing

(1) Pre-Installation Testing

(a) Pre-installation testing shall be done at contractor option.

(b) Submit cable manufacturer's test report for each reel of cable provided.

1) Verify fiber attenuation, bandwidth and length values as specified on cable data sheets supplied with cable reels.

(c) Visually inspect reels and packaging for damage.

(2) Post-Installation Testing

(a) Clean fiber optic connectors before beginning testing.

1) Using fiber tester capable of fiber end face inspection is strongly encouraged to help minimize requirement for retesting due to dirty connectors.

(b) Testing shall include:

1) Optical Attenuation

2) Optical Time Domain Reflectometry (OTDR)

(c) Optical Return LossOptical Attenuation

1) Light Source: FP LASER for 1300 nm tests.

2) Measure Optical Attenuation on terminated fibers.

1. Include optical connectors and couplings installed at fiber endpoints.

3) Test multimode fibers using TIA 526-14A, Method B.

4) Test single-mode fibers using TIA 526-7-1998 (MethodB).

5) Test fibers in both transmission directions.

6) Test single-mode fibers at 1310 ± 10 nmand 1550 ± 10 nmwavelengths.

7) Fiber lengths less than or equal to 300 ft shall test to ≤ 2.0 dB loss.

8) Fiber lengths greater than 300 ft shall test to loss value less than link loss budget for installed connectors and fibers.

(d) Optical Time Domain Reflectometry (OTDR)

1) OTDR testing shall not be used as the sole method for establishing optical attenuation link loss.

2) Verify fiber integrity using an Optical Time Domain Reflectometer (OTDR).

1. Includes terminated and (if applicable) un-terminated fibers.

3) OTDR(s) shall incorporate high-resolution optics and short pulse-width options optimized for viewing of short cable sections.

1. Pulse-width shall be 10-ns or less for cable lengths greater than 109.36 yards (100 meters).

2. Pulse-width shall be 5-ns or less for cable lengths less than 109.36 yards (100 meters).

4) OTDR traces shall be performed in one direction using access jumpers at transmit and receive ends.

1. Remote end of tail cord has no requirement for reference grade termination

5) OTDR traces shall be performed in two directions using access jumpers at transmit and receive ends

1. Remote end of tail cord shall meet same reference grade requirements as launch end cord.

2. Perform bi-directional OTDR measurements according to requirements of TIA-526-7-A, clauses H.6 and H.7.

3. Minimum length of access jumper at launch end shall be minimum 330 ft long for multimode or 990 ft long for single-mode, unless recommended otherwise by test equipment manufacturer.

6) Test multimode fibers at 850 ± 30 nm wavelength.
7) Test single-mode fibers at 1310 ± 10 nm wavelengths.
8) Examine traces for continuity and anomalies to confirm fiber link integrity.
    1. Point discontinuities in excess of 0.2 dB for multimode fibers or 0.1 dB for single-mode fibers shall be cause for rejection of cable.
    2. Any reflection in trace - except at patch panels - shall be cause for rejection of cable.
    3. Submitted test results shall show only fiber under test and shall have trace boundaries set to show fiber under test and not launch cords or other extraneous data.
    4. Set event markers to accurately reflect overall attenuation of installed fiber optic cable and connectors.
9) OTDR tested links showing excessive backscatter immediately following connector shall have connector cleaned and/or re-polished and then retested.

(e) Optical Return Loss
1) Testing shall include Optical Return Loss (ORL) measurement for each installed single mode fiber optic connector. Follow OTDR manufacturer's requirements for required tester settings, including scattering coefficient.
2) Perform ORL with a Back Reflection Meter or an OTDR.
    1. OTDR shall be capable of measuring fiber connector reflectance and produce accurate (± 2 dB) reflectance measurements
3) Test result cursors shall be placed at appropriate locations before tests are submitted for review. OTDR testers including automatic cursor positioning functions shall use said functions to position cursors accurately for measurement.

3.03 DOCUMENTATION

A. General
(1) Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding documentation requirements.

B. Backbone Fiber Optic Cable
(1) Files containing Attenuation and OTDR traces of individual optical fiber "signatures" shall be so named as to identify each individual fiber by location in cable system and fiber number or color.
(2) OTDR test results shall be consistent in format and presentation, including:
(a) Scale
1) Scale or window of test result view shall show only enough trace to view fiber under test plus launch cords at both ends.
2) View shall not show backscatter beyond end of fiber.
(b) Pulse width
(c) Units (English or Metric)
(d) Cursor placement
(e) Labeling

END OF SECTION 27 13 00

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL

1.01 SCOPE

A. This section details product and execution requirements for Horizontal (Station) Cabling subsystem for Communications Systems.

1.02 DESCRIPTION

A. Horizontal cabling subsystem is portion of communication link that connects horizontal or intermediate cross-connect (typically at Telecom Room) and Telecommunications Outlet.

B. Horizontal Cable types include:

(1) 4-pair Copper Unshielded Twisted Pair (UTP)

1.03 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements
(2) Section 27 0526 - Grounding and Bonding for Communications Systems
(3) Section 27 0528.29 - Hangers and Supports for Communications Systems
(4) Section 27 0528.33 - Raceway and Boxes for Communications Systems
(5) Section 27 0528.36 - Cable Tray for Communications Systems
(6) Section 27 0528.39 - Surface Raceways for Communications Systems
(7) Section 27 0553 - Communications Systems Identification
(8) Section 27 1000 - Structured Cabling
(9) Section 27 1100 - Communications Equipment Room Fittings
(10) Section 27 1300 - Communications Backbone Cabling

B. Related sections in other Divisions of Work:

(1) Refer to individual technical sections identified above (if applicable).

1.04 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identifies pertinent References and Standards.

1.05 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related Sections.

B. In this section, "Telecommunications Outlet" is considered to consist of Frame/Faceplate into which Modular Jacks or other couplings snap, Modular Jacks, blanks fitted to unused jack positions, and labeling/identification components.

1.06 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related Sections.

1.07 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

B. In addition, submit:

(1) Samples of each Telecommunications Outlet Faceplate type to confirm color and material.
(2) One 3 ft section of each cable type from cable reels sent to site for Engineer's final approval.
(a) Section shall have manufacturer's cable markings visible.
(3) Nominal Velocity of Propagation (NVP) for 4-pair Horizontal Copper Cable.

1.09 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to all cable and components covered in this section.

PART 2 PRODUCTS

2.01 GENERAL

A. Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA documents.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

C. Horizontal (Station) Cable and Termination Components (Jack, Patch Panel) are specified to function as System.

(1) Where required for warranty purposes, manufacturers of cabling and termination components used (if more than one) shall recognize each other in their Certification Programs.

D. 4-Pair Horizontal Copper Cables and Modular Jacks are application independent (e.g. no distinction between “voice” and “data”).

2.02 4-PAIR HORIZONTAL COPPER CABLE

A. Manufacturers: Refer to System Requirements list in 27 1000

B. Cables shall be suitable for installation in environment defined

C. Cabling shall be packaged to minimize tangling and kinking of cable during installation.

D. Configuration:

(1) Number of Pairs: 4 twisted pair

(a) Pair twists of any pair shall not be same as any other pair.

(b) Pair twist lengths shall be selected by manufacturer to ensure compliance with crosstalk requirements of TIA 568.

(2) Conductors: insulated solid annealed copper pairs

(a) Category 6A: 23 AWG

(b) Pairs of 4-pair cables shall be identified by banded color code in which conductor insulation is marked with dominant color and banded with contrasting color.

1) By pair number, pair colors or dominant band are:

1. Pair 1: Tip - White/Blue; Ring - Blue (or Blue/White)
2. Pair 2: Tip - White/Orange; Ring - Orange (or Orange/White)
3. Pair 3: Tip - White/Green; Ring - Green (or Green/White)
4. Pair 4: Tip - White/Brown; Ring - Brown (or Brown/White)

(3) Shield: None

(a) Drain Wire: None

(4) Cable Rating: NEC Article 800 Type CMP, UL listed

(5) Maximum outside diameter:

(a) Category 5e: 0.22 inches (5.59 mm)

(b) Category 6: 0.25 inches (6.35 mm)

(c) Category 6A: 0.28 inches (7.11 mm)

(6) Cabling rated Category 6A shall include a non-continuous shield component under the outer cable jacket.

E. Horizontal Data Cable:

(1) Shall meet or exceed TIA Category 6A performance requirements.

(2) Shall notincorporate an overall shield.

(3) Jacket Color: Lime Green

F. Horizontal Cable for Building Automation:

(1) Shall meet or exceed performance requirements of TIA Category 5.

(2) Shall not incorporate an overall shield.

(3) Jacket Color: Blue

2.03 TELECOMMUNICATIONS OUTLET

A. Manufacturers: Refer to System Requirements list in 27 1000

B. Connectors and modular jacks)) shall snap onto faceplate.

(1) In surface-mount designs (if applicable) Jacks and connectors may mount to frame onto which coverplate is mounted.

C. Work Area Faceplate

(1) Wall-mounted faceplates intended to be used in general work areas shall:

(a) Be configured to mount on standard, single gang opening when wall mounted.

(b) Accommodate minimum of4modular jacks and connectors.

(c) Be constructed of high impact plastic (except where otherwise noted).

(d) Incorporate recessed designation strips at top and bottom of frame for identifying labels.

1) Triple row faceplates with no provisions for labeling of middle outlet row are not acceptable.

2) Designation strips shall be fitted with clear plastic covers.

3) Designation strips and covers shall be positioned over faceplate mounting screws.

(2) Faceplate Color: to match electrical device faceplates.

D. Wall-mount Telephone Faceplate

(1) Faceplates intended to be used in locations where wall mounted telephone set is required shall:

(a) Be stainless steel construction.

(b) Accommodate 1 modular jack meeting performance requirements for "Voice" jack as defined above.

1) Modular jack shall be positioned to mate with wall-mounted telephone.

(c) Mount on standard single gang opening.

(d) Include mating lugs for mounting wall-mounted telephone.

E. Faceplate - Wireless Access Point Location

(1) Faceplates supporting Wireless Access Point (AP) shall:

(a) Accept 2 modular jacks or connectors.

(b) Be Surface-mounted

(c) Be made of High Impact thermoplastic.

(d) Incorporate recessed designation strips at top and bottom of frame for identifying labels.

(2) Faceplate Color: to match electrical device faceplates.

F. Faceplate - Surface Raceway

(1) Faceplates intended to be used on surface raceway shall:

(a) Accept 4 modular jacks or connectors.

(b) Snap into raceway opening and be retained by integral latching tabs.

1) Match standard opening of raceway type(s) to be installed.

(c) Have an optional extender bracket available to increase mounting depth.

(d) Be made of High Impact thermoplastic.

(e) Incorporate recessed designation strips for identifying labels

1) Raceway faceplate color shall be TBD per Owner.

G. Faceplate - Modular Furniture

(1) Faceplates intended to be used on modular furniture shall:

(a) Accept 4 modular jacks or connectors.

(b) Snap into modular furniture opening and be retained by integral latching tabs.

(c) Match standard opening of furniture type(s) to be installed. Furniture types include:

(d) TBD per OwnerHave an optional extender bracket available to increase mounting depth as required to maintain cable bend radius within manufacturers' recommendations.

(e) Be made of High Impact thermoplastic.

(f) Incorporate recessed designation strips for identifying labels.

1) Modular furniture faceplate color shall TBD per Owner.

2.04 MODULAR JACK

A. Manufacturers: Refer to "Telecommunications Outlet" above.

B. Modular Jacks shall be:

(1) 8-position, 8-conductor (8P8C)

(2) Non-keyed

C. Jacks shall have an attached color-coded wiring instruction label as an aid to installer.

D. Interface between jack and station cable shall be insulation displacement type contact.

E. Termination components shall maintain cable's pair twists as closely as possible to point of mechanical termination.

F. Jack contacts shall have minimum of 50 micro-inches of gold plating.

G. Data Jack shall:

(1) Meet or exceed performance requirements of Category 6A

(2) Be color Lime Green

(a) Alternately, color-coded Bezel or Icon may be used to identify Jack type.

PART 3 EXECUTION

3.01 GENERAL

A. Refer to project Drawings for outlet and Consolidation Point locations.

B. Provide Modular Jacks, Coaxial Connectors (if applicable) and Fiber Optic couplings (if applicable) in faceplates as shown on Project Documents.

(1) Provide 1faceplate per Telecommunications Outlet symbol shown on Project Documents.

(2) Provide 1modular furniture mounted faceplate per modular furniture symbol shown on Project Documents.

C. Maximum 4-pair Category-rated horizontal cable length shall not exceed 295 feet (8991.6 cm) measured from horizontal cross-connect (typically at TR) to Telecommunications Outlet.

(1) Includes slack required for installation and termination.

(2) Contractor is responsible for installing station cable to avoid unnecessarily long runs.

(3) Any area that cannot be reached within above constraints shall be identified and reported to Engineer prior to installation.

D. Follow manufacturers recommended termination practices.

3.02 CABLE INSTALLATION AND TERMINATION

A. General

(1) Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling for general cable installation requirements.

(2) Provide "Service Loop" for every Horizontal Cable in ceiling above outlet.

(a) Loop length shall be 3.3 feet (100.58 cm)

(b) Total length of 4-pair Category-rated horizontal cable including loop shall not exceed 295 feet (8991.6 cm).

(c) Place loop in ceiling at last support (e.g. J-Hook) before cables enter fishable wall, conduit, surface raceway or box.

(d) Coil loop in figure 8 configuration.

(e) Loop radius (minimum) shall be 4X minimum bend radius for cable.

(3) During installation, minimum bend radius shall be eight times outside diameter of UTP cables and 20 times outside diameter of fiber cables.

(4) Limit size of cable bundles along cable pathways and in communications equipment rooms to maximum of 12-24 cables.

(5) .

3.03 TELECOMMUNICATIONS OUTLET

A. Faceplates shall be configured to provide connectivity as required by location. Refer to drawings.

B. Mount modular jacks and connectors into faceplates and secure faceplates to outlet box, raceway or modular furniture.

(1) Use faceplate extender if required to provide adequate clearance between jack and furniture or raceway panel to maintain minimum cable bend radius.

(2) Provide blank(s) in unused jack/connector positions. Match color of blank to faceplate color.

C. Position Telecommunications Outlet for wall-mounted telephone in area clear of other utilities and wall mounted hardware.

(1) Coordinate with other trades to maintain 8” clear space (minimum) on all sides from faceplate centerline.

3.04 FIELD TESTING

A. Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding testing requirements common to all Division 27 Structured Cabling sections.

(1) In addition, refer to sub-sections below for cable type under test.

B. 4-Pair Horizontal Copper Cable

(1) Test from:

(a) Horizontal Cross-connect (HC) to Jack at Telecommunications Outlet (TO).

(2) Testing shall be per TIA-568 Permanent Link test configurations.

(3) Maximum length of station cable shall not exceed 300 feet (9144 cm)

(4) Cables shall be free of shorts within pairs, and be verified for Continuity, Pair Validity and Polarity, and Wire Map (Conductor Position on Modular Jack).

(a) Identify and correct defective, split or mis-positioned pairs.

(5) In addition to above, Performance Testing shall be performed on all cables. Testing of Transmission Performance shall include the following:

(a) Length

(b) Insertion Loss / Attenuation

(c) Pair-to-pair NEXT

(d) PSNEXT

(e) Pair-to-pair ELFEXT (Equal Level Far End Cross-talk)

(f) PSELFEXT

(g) Return Loss

(h) Propagation Delay

(i) Delay Skew

(j) Alien Crosstalk (AXTalk) – 10G Cable Systems only

1) AXTalk measurement method shall be as required by the manufacturer(s) of cabling/connecting components installed to certify the system for warranty.

(6) Test cables to maximum frequency defined by standards covering specified performance category.

(7) Perform Transmission Performance Testing using test instrument designed for testing to specified frequencies.

(a) Test records shall verify "PASS" on each cable and display specified parameters - comparing test values with standards based "templates" integral to unit.

(8) .]

3.05 DOCUMENTATION

A. Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for documentation guidelines.

B. Information added by Contractor to Record Drawings relating to Horizontal Cabling shall include cable routes, outlet locations and numbering and other detail necessary to document cable installation.

END OF SECTION 27 15 00

SECTION 27 41 00 – AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

(1) General provisions – Functional description of audiovisual systems.

(2) Product descriptions and requirements.

(3) Execution, standards, and commissioning requirements.

B. Related Requirements

(1) Section 26 05 00: Common Work Results for Electrical Systems

(2) Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.02 REFERENCES

A. Definitions

(1) When the following abbreviations and definitions are used in relation to the work for this Section they shall have the following meanings:

(a) AEI NW: Affiliated Engineers NW, Inc.

(b) AHJ: Authority Having Jurisdiction

(c) AV Consultant, Consultant, Engineer: AEI

(d) AVSC: Audiovisual Systems Contractor

(e) Boxes: Outlet, Junction or Pull Boxes

(f) Code: All applicable codes currently enforced at project location

(g) Compression: Compressed using leverage powered (hydraulic or equivalent) crimping tool.

(h) Connection: All materials and labor required for equipment to be fully operational

(i) Exterior Location: Outside of or penetrating the outer surfaces of the building's weather protective membrane.

(j) Fully Operational: Tested, approved, and operating to the satisfaction of the AHJ, contract documents, and the Consultant.

(k) Furnish: Deliver to the job site

(l) Install: To enter permanently into the project and make fully operational.

(m) Mfr.: Manufacturer

(n) NEC: National Electrical Code, National Fire Protection Association, Publication #70

(o) Noted: Shown or specified in the contract documents

(p) Provide: Furnish and install

(q) Required: As required by code, AHJ, contract documents, or manufacturer for the installation to be fully operational

(r) Shown: As indicated on the drawings or details

B. Reference Standards

(1) The referenced codes establish a minimum level of requirements. Where provision of the various codes conflict with each other, the more stringent provision shall govern. If any conflict occurs between referenced codes and this specification, the codes are to govern. Compliance with code requirements shall not be construed as relieving the AVSC from complying with any requirements of the drawings or specifications which may exceed the requirements of the governing codes and rules and not contrary to same.

(2) Perform all work and provide materials and equipment in accordance with the latest referenced codes and standards of the following organizations:

(a) ANSI - American National Standards Institute

(b) ASTM - American Society for Testing and Materials

(c) BICSI - Building Industry Consulting Services International

(d) EIA - Electronics Industries Association

(e) FCC - Federal Communications Commission

(f) IBC – International Building Code

(g) ICEA - Insulated Cable Engineers Association

(h) IEEE - Institute of Electrical and Electronics Engineers

(i) ISO - International Organization for Standardization

(j) NEMA - National Electrical Manufacturer's Association

(k) NFPA - National Fire Protection Association
(l) NFPA 70 – National Electrical Code
(m) NEC - National Electrical Code
(n) TIA - Telecommunications Industry Association

(3) Install the AV systems based on the following:
(a) ANSI/AVIXA Standard 2M-2010, AV Systems Design and Coordination
(b) ANSI/AVIXA Standard 3M-2011, Projected Image Contrast Ratio
(c) ANSI/AVIXA Standard 10.2013, AV Systems Performance Verification
(d) ANSI/AVIXA Standard A102.01.2017, Audio Coverage Uniformity in Listener Areas
(e) AVIXA Standard F501.01.2015, Cable Labeling for Audiovisual Systems
(f) ANSI/AVIXA Standard V202.01.2016, Display Image Size for 2D Content in Audiovisual Systems
(g) "Dashboard for Controls Design Guide", April 2005, AVIXA International

1.03 SYSTEM DESCRIPTION

A. The systems integrator will provide complete and working systems, based on the operational requirements set forth in the specification.

B. Work Includes:
(1) Provision of complete sound reinforcement, video presentation, audio and video teleconferencing, and control systems.
(2) Connection to and integration with other equipment provided by others including room lighting and shades.
(3) Generate all shop drawings and information for the complete installation and wiring of the system.
(4) Provide (or sub-contract for) the on-site installation and wiring and provide on-going supervision and coordination during the implementation phase.
(5) Initial adjustment of the systems as herein prescribed and provision of all test equipment for the system checkout and acceptance tests.
(6) Training in the operation and maintenance of the systems for personnel designated by the Owner.

C. Contract Drawings:
(1) The work of this Section and related sections is shown on the TAV-xx series of drawings and equipment schedules.
(2) The drawings do not show all requirements of the specifications. The drawings and specifications are complementary and what is called for (or shown) in either is required to be provided as if called for in both. If in conflict, the specifications shall take precedence. Notify the Consultant immediately of any conflicts.
(3) Equipment racks, connection panels, and all other associated devices are shown diagrammatically only and indicate the general character and approximate location. Furnish, install, and place in satisfactory condition all AV equipment, cabling and all other materials required for the systems shown or noted in the contract documents, so that it is a complete system which is fully operational and fully tested.

D. Operation:
(1) General
(a) Provide for amplification of program audio sources and local sound reinforcement of presentations and classes.
(b) Provide display of video sources such as computers and video teleconferencing.
(c) Allow easy setup and operation of the audiovisual and sound reinforcement systems by a wide variety of users.
(d) System override from the fire alarm control panel in case of a fire or emergency. Activating the fire alarm system will automatically mute any audio sources in the system.
(2) Room Descriptions
(a) Engagement Hub
(b) McMillon Center
(c) Active Learning Classroom
(d) 50, 72, 90, and 135 Seat Classroom
(e) Team Room
(f) Open Collab
(g) Digital Signage
(3) Audiovisual Control System
(a) The audiovisual systems will be configured from remote control panels located at the control room and a location near the stage. The control system will allow an operator to control the following:
1. System ON/OFF
2. Select system pre-sets such as Normal operation (which will require and operator to take over all controls) and Auto operation (which will engage the automix function of the DSP.

3. Volume control of individual sources and master volume
4. Video source selection and control
5. Video display/projector control

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination

(1) Conform to Division 1 for coordination of work with other Sections.

(2) The AVSC shall continually interface and coordinate the work with the work of other Contractors and/or other trades and shall examine all drawings and specifications of other trades including the mechanical, architectural, and structural for construction details and coordination.

(3) Obtain submittals, shop drawings, and other information for all equipment to be furnished by the Owner or under other divisions of the specifications.

(4) Prior to roughing-in, verify the exact location of all devices with Architect.

(5) Provide coordination to the Owner in relation to special installation details associated with all AV hardware. This will include but is not limited to mounting details of loudspeakers, I/O panels, equipment, projectors, equipment racks, and any other project related coordination between the AV integration and building construction.

(6) Special attention is called to the following items for coordination.

(a) Conduit, cable tray, boxes, and other raceway components.

(b) Location of casework, cabinets, counters, doors, and equipment racks so that all equipment is clear of and in proper relation to these items.

(c) Mounting, recessing, and concealing cameras, video projectors, video displays, loudspeakers and loudspeaker clusters, and other associated equipment in specially constructed casework and niches.

(7) The AVSC will not be paid for work associated with the relocation of equipment, conduits, cabling, or any other materials requiring removal or reinstallation resulting from a lack of coordination prior to installation.

B. Pre-Installation Meetings

(1) Arrange in accordance with Division 1.

(2) Attendance: AVSC, installer, Owner, Architect, AV Consultant, and those requested to attend.

(3) Meeting time: Minimum four (4) weeks prior to beginning work of this Section and work of related Sections affecting work of this Section.

(4) Location: Project site.

C. Sequencing and Scheduling

(1) Conform to Division 1 for sequencing and scheduling to meet Progress Schedule Critical Path and long lead items.

(2) The AVSC shall schedule its work to prevent conflicts with other activities in the building and shall execute without claim for extra payment moderate moves or changes as are necessary to accommodate other equipment or preserve symmetry and pleasing appearance.

1.05 SUBMITTALS

A. A complete set of submittal documents will include shop drawings, product data, and network device inventory, as described below, and submitted simultaneously for review and comment.

B. Submit under provisions of Division 1.

C. The AVSC agrees that submittals and shop drawings processed by the AV Consultant are not change orders. The purpose of submittals and shop drawings by the AVSC is to demonstrate to the AV Consultant that the AVSC understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use.

D. The AVSC alone accepts all responsibility for assuring that all materials furnished under this Division of the specifications meet in full all requirements of the contract documents. The AV Consultant's review is for general conformance with the design concept and contract documents. Markings or comments shall not be construed as relieving the AVSC from compliance with the project plans and specifications, nor departures there from. The AVSC remains responsible for details and accuracy for confirming and correlating all quantities and dimensions, for selecting fabrication processes and for techniques of assembly.

E. Submittals and shop drawings that are incomplete or that contain insufficient information will be returned without review, for re-submittal.

F. Shop Drawings:

(1) Floor plans, showing the layout of devices, cabling, and wiring within raceway systems. Include the number of cables, type of cables, and size of raceway for each run.

(2) Wiring diagrams showing point to point connections between components. Include wire numbers and color-coding for each connection point, with numbers corresponding to those of the wire-run list.

(3) Rack panel layout for each equipment cabinet.

(4) Scaled and dimensioned drawings of all custom assemblies and fabricated items, including but not limited to the following. Include details of all components, materials, finishes, and colors.

(a) Control panel mounting
(b) Projector and display mounting frames and hardware
(c) Input and output panels, including mounting of panels in casework.
(d) Speaker clusters

(5) Preliminary cable numbering lists.

G. Product data:
(1) Equipment list based on specified equipment list and other additional equipment or materials needed for complete systems. Include:
(a) Manufacturer
(b) Model number
(c) Descriptions
(d) Quantity
(e) Specification reference
(2) Product data by system or room, with brochures and/or catalog cuts for all items of equipment and hardware. Provide as PDF documents downloadable from the project website, on USB memory stick, or on CD/DVD ROM.
(3) Provide a single product data sheet for any devices used in multiple rooms.
(4) For each item, indicate listing by UL or other approved testing agency. For audio power amplifiers, indicated the NEC Class of output wiring.
(5) Printouts from web pages are not acceptable.
(6) Itemize variations from the specification in a separate enclosure. Refer to section, paragraph, and item of the specifications and clearly state the variation.

H. Networked Device Inventory
(1) Inventory of all network-attached devices in the project. Include:
(a) Device, manufacturer, and model number
(b) Physical location
(c) Default gateway IP address
(d) Addressing scheme
(e) IP address
(f) Subnet mask
(g) Host name
(h) DNS server(s)
(i) Ports required
(j) Transport protocol
(k) Multicast/Unicast
(2) Provide Networked Device Inventory in Microsoft Excel 2010 format.

1.06 CLOSEOUT SUBMITTALS

A. Conform to provisions of Division 1.

B. Maintenance and Operating Data and Instructions to Owner’s Personnel: Conform to Division 1. AVSC shall prepare Operations and Maintenance Manuals for each system or facility provided under these specifications. The information included must be the exact equipment installed, not the complete "line" of the manufacturer. Where sheets show the equipment installed and other equipment, the installed equipment shall be neatly and clearly identified on such sheets.

C. The manuals shall contain all the information needed to operate and maintain all systems and equipment provided in the project. It shall be presented and arranged in a logical manner for efficient use by the Owner's operating personnel. The information provided shall include but not be limited to the following:
(1) Equipment manufacturers, makes, model numbers, serial numbers, sizes, etc. Include addresses and telephone numbers for each manufacturer. List loose items separately.
(2) A copy of the delivery receipt for Loose Items.
(3) Description of system configuration and operation including component identification and equipment interconnect diagram.
(4) Manufacturers’ recommended operation instructions for each item of equipment.
(5) Overall system operating instructions, custom written for this specific project.
(6) Warranty Information, including but not limited to:
(a) An overall Statement of Warranty from the AVSC for the complete systems.
(b) A copy of the Manufacturers' warranties for each item of equipment so covered.
(c) Instructions for obtaining warranty service from the AVSC, and from each Manufacturer.

(d) Service manuals for each item of equipment as published by the manufacturers, and other manufacturers' servicing data.

(e) Complete parts list including reordering information, recommended spares and anticipated useful life (if appropriate). Parts lists shall give full ordering information assigned by the original parts manufacturer. Relabeled and/or renumbered parts information as reassigned by equipment supplier not acceptable.

(f) "As-built" Shop Drawings, including point to point wiring diagrams.

(g) "As-built" Cable Numbering Lists.

(7) Service manuals for each item of equipment as published by the manufacturers, and other manufacturers' servicing data.

(8) Complete parts list including reordering information, recommended spares and anticipated useful life (if appropriated). Parts list shall give full ordering information assigned by the original parts manufacturer. Relabeled and/or renumbered parts information as reassigned by equipment supplier not acceptable.

(9) "As-built" Shop Drawings, including point to point wiring diagrams.

(10) "As-built" Cable Numbering Lists.

(11) Copies of all test results. Include the names of the individuals performing and witnessing the tests, and the manufacturer and model of each item of test equipment which was used. Include block diagrams of the test setup for tests which involve more than one item of test equipment.

(12) Wiring diagrams for each system shall be complete drawings for the specific system installed under the contract. "Typical" line diagrams will not be acceptable unless marked to indicate the exact field installation.

(13) Networked Device Inventory

(a) Inventory of all network-attached devices in the project, including:

1. Device Properties
2. Manufacturer
3. Model number
4. Description
5. Software version(s)
6. Firmware version(s)
7. MAC address

(b) Inter-Device Communication

1. Transport protocol
2. Multicast/unicast
3. Codec
4. Incoming and outgoing peak bps
5. Average incoming and outgoing bps

(c) Routing and Addressing

1. Physical location
2. Default gateway IP address
3. Addressing scheme
4. IP address
5. Subnet mask
6. Host name
7. DNS server(s)
8. Ports required

(14) Provide Networked Device Inventory in Microsoft Excel format.

D. The information contained in the manuals shall be grouped in an orderly arrangement by specification index. The manuals shall have a typewritten index and divider sheets between categories with identifying tabs. The completed manuals shall be bound in heavy-duty slant-ring binders (3 "D" rings), or with hardboard covers and screw-post bindings. O & M manuals shall not exceed 5" thickness. Provide two or more volumes if required. The covers shall be labeled with the name of the job, Owner, Architect, Engineer, Contractor and year of completion. The spine shall be labeled with the name of the job, Owner and year of completion. Labeling may be laser-printed inserts in clear plastic overlays or imprinting by silk-screening or hot stamping. Include the following information:

(1) Project Title

(2) Project Number

(3) Owner/Operator (Owner's Name)

(4) Architect (Architect's Name)

(5) Engineer (AEI)

(6) Contractor

(7) Completion Date

E. Submit a preliminary copy 15 days prior to substantial completion of the project for checking and review.

F. Project Record Documents: Conform to provisions of Division 1.

(1) Continually record the actual "as-built" installation on a set of prints kept readily available at the project during construction. These prints shall be used for this purpose alone. At the completion of the work, Contractor shall furnish the Architect a set of reproducible record drawings (Xerox type) and the set of mark-ups. Final payment to the Contractor will not be authorized until these prints have been submitted to and accepted by the Architect.

(2) Record drawings shall include, at a minimum, updates of all sheets of the Shop Drawings.

1.07 QUALITY ASSURANCE

A. Qualifications

(1) Manufacturer's Qualifications: Firm (material producer) with not less than five years of production experience whose published literature clearly indicates general compliance of products with requirements of this section.

(2) Equipment Suppliers: Audio, video, and control components shall be supplied and installed by an authorized factory distributor of specified products. Submit statement of distributorship/dealership prior to acceptance of bid.

(3) AVSC Qualifications:

(a) Work in this section shall be performed by an AVSC with the following qualifications:

1. Complies with the requirements of Division 1.
2. Is licensed to perform work of this type in the project jurisdiction
3. Has at least five (5) years of verifiable direct experience with the devices, equipment, and systems of the type and scope specified herein.
4. Fully staffed and equipped maintenance and repair facility.

(b) The AVSC or their employees shall hold the following certifications:

1. AVIXA CTS-D (Certified Technology Specialist-Design)
2. AVIXA CTS-I (Certified Technology Specialist-Installation)
3. Video switching and routing system
4. AV control system programming
5. Audio DSP Programming
6. Synergetic Audio Concepts Sound Reinforcement for Technicians

(c) Provide copies of all certifications with bid

(d) The AVSC shall be a factory-authorized dealer for the major components specified including items such as microphones, audio processing equipment, power amplifiers, loudspeakers, video interfaces, video switchers and processors, video displays, and integrated audiovisual control system.

(e) The AVSC shall appoint a designated supervisor with the appropriate certifications. The supervisor shall be present and in responsible charge of all work in the fabrication shop and on the project site during all phases of the installation and testing of the system(s). To ensure continuity, this supervisor shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.

(f) The AVSC shall use skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work in this Section. These personnel shall have at least three years direct experience in similar work, evidence of which shall be verified in writing with appropriate references at the time of bid.

(g) Other contractors bidding this work who cannot meet the above qualifications must employ the services of a qualified AVSC who meets the above qualifications. This AVSC shall supervise the installation and perform all wiring connections.

B. System Performance Requirements

(1) Audio System

(a) Systems shall provide clear, natural sound uniformly distributed throughout the listening areas. The entire electro-acoustic system shall be carefully balanced and equalized to provide a high order of intelligibility and gain without feed back or reverberant coloration. Adequate power capability shall be provided to insure the necessary dynamic range and prevent distortion at peak levels.

(b) Acoustic Frequency Response: 50 Hz to 15 kHz, 3dB/octave roll-off above 2000 Hz ±2dB. Measured at continuous one-third octave bands at seated ear height.

(c) Sound System Coverage: as measured in accordance with ANSI/AVIXA A102.01:2017, Audio Coverage Uniformity in Listener Areas.

(d) Intelligibility: Greater than 0.75 STI at any seat in the audience area.

(e) Noise: System noise shall not exceed an equivalent input noise of -120dBu based on a 20 kHz noise bandwidth. Predominant noise component in the system output under any operating condition will be that of the input stages. Adjustment of any system controls shall produce no audible clicks, pops, thumps, or other spurious noises.

(f) Acoustic Signal-to-Noise Ratio (including crosstalk and hum at all input/output levels): 60dB.

(g) Dynamic Range:

1. General: All systems shall include a 10dB peaking factor to any location at seated ear height and at less than 5% total acoustic harmonic distortion. When the system is driven to maximum output, clipping shall occur first in the power amplifiers.
2. Conference Rooms: The system shall deliver a minimum sound pressure level of 75 dB
3. Multifunction Rooms: The system shall deliver a minimum sound pressure level of 85 dB

(h) Total Harmonic Distortion: 0.05% maximum from 20Hz to 20kHz.

(i) Polarity: A positive pressure at any system microphone shall produce a positive pressure from the speakers.

(2) Analog Video System

(a) Systems shall provide, clear, bright, and natural images viewable throughout the respective designed viewing area. Each video display system shall be balanced for color and brightness and free from extraneous interference or artifacts.

(b) Frequency Response:

1. Composite: Flat from 30Hz to 6MHz, +/-2% (ref.=1MHz)
2. YC: Flat from 30Hz to 10MHz, +/-2% (ref.=1MHz)
3. Component: Flat from 30Hz to 100MHz, +/-2% (ref.=1MHz)
4. RGBHV: Flat from 30Hz to 300MHz, +/-2% (ref.=1MHz)

(c) Signal-to-Noise Ratio (including crosstalk and hum at all input/output levels): 60dB, p-p signal to RMS noise

(d) Differential Gain: <2%

(e) Differential Phase: <2 degrees at 3.58MHz

(f) Tilt: <2%

(g) System Gain: Unity, +/-1%

(h) System Levels: <2% between sources

(i) Timing: <20nS, Y/C, Y/Cr/Cb, RGB

(j) Luminance: In conformance with NTSC RS-170A standards

(k) Chroma level: In conformance with NTSC RS-170A standards

(l) Observable noise or hum: None

(3) Digital Video System

(a) Audio & Video Switching

1. Provide 12.8 Gbps of backplane throughput to support 1080p 36-bit (Deep) Color video resolutions without compression.
2. Support at least 6.75Gbps of data transfer on each input and output to support 1080p 36-bit (Deep) Color video resolutions without compression.
3. Support 8 channel audio.
4. Support audio breakaway from video.
5. Insert less than 5us of latency from AV input to AV output.
6. Support the HDMI specification of less than 1 in $1x10^{-9}$ bit errors at 1080p 36-bit (Deep) Color.
7. Down-mix multi-channel audio into 2-channel audio to route audio content to both multi-channel and 2-channel sinks.
8. Dither between standard and deep color video signals on each input and output.
9. Support the following AV signal inputs:
    a. HDMI 1.3a (High Definition MultiMedia Interface)
    b. DVI 1.1 (Digital Visual Interface)
    c. Display Port Multimode 1.1
    d. Analog RGB
    e. YPbPr
    f. S-Video
    g. CVBS
    h. SPDIF
10. Analog Stereo Audio

11. Transcode and scale the AV signals to a single signal type for distribution.
12. Support the following digital video formats and data rates (Gbps)
    a. 1080p Deep Color: 6.75
    b. 1600x1200: 4.86
    c. 1920x1200: 4.62
    d. 1080p: 4.44
    e. 1360x768: 2.54
    f. 720p/1080i: 2.22
    g. 1024x768: 1.91
13. Audio & Video Signal Distribution
    a. Route AV signals from any input to any output.
14. Use shielded twisted pair structured cabling to carry the AV signals.
15. Use shielded twisted pair structured cabling specified to 1.2GHz of bandwidth or greater.
16. Transmit the following control signals for AV sources and sinks over the same cable plant:
    a. RS-232
    b. Infrared
    c. Ethernet
    d. USB Human Interface Device-class devices
    e. Contact closure
17. EDID Management
    a. Allow configuration of the EDID presented to sources on each AV input.
    b. Configure each input independently.
    c. Present an EDID to each input that includes only the video timings and audio formats common all sinks connected to the outputs.
    d. Allow the user to enter each input's EDID video timings individually.
    e. Allow the user to enable and disable support for the following items in each input's EDID.
    f. Deep color
    g. 3D support
18. HDCP Management
    a. Support HDCP 1.1 or greater.
    b. Detect the number of KSVs supported by each source.
    c. Cache the KSVs from each connected sink.
19. Signal Detection
    a. Report the following incoming signal information to an AV control system:
    b. Signal detect
    c. Horizontal and vertical resolution
    d. Signal refresh rate
    e. Presence of HDCP
20. Report the following information to an AV control system:
    a. HDCP authentication status for each source and sink
    b. EDID Preferred video timing for each sink

C. Control System

(1) System shall utilize a remote-controlled switching and processing system for control of audiovisual system components.

(2) The system shall provide controls for selecting system on/off, audio and video input selection, audio volume, signal routing and processing, codec connection and volume, projection screen up/down, projector lift control, camera control, and lighting control.

(3) User Interfaces:

(a) The control panel interface layout will conform to the AVIXA International "Dashboard for Controls Design Guide", published April 2005.

(b) Control system user interface conforms to control functions described in Paragraph 1.4 D.5 of this specification, and with the Owner's standard classroom AV control panel interfaces to the greatest extent possible and all pages and buttons operate as intended.

(4) Connections to other systems:

(a) All IP-controlled equipment properly configured with IP addresses, host names, time servers, gatekeeper addresses, network configurations, and subnets as applicable. All system connections are operational and devices communicating correctly.

(b) All control system programming installed and communicating properly with the equipment as intended.

(c) Confirm control system interfaces exist and are functional for devices outside the scope of this section such as activation of lighting control presets, drapes, shades, screens, security, life safety, and HVAC systems.

(5) Power Cycling: Confirm the control system will restart and resume full operation following cycling of AC power to the control system.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Delivery and acceptance requirements

B. Storage and handling requirements

C. Packaging waste management

1.09 SITE CONDITIONS

A. Ambient Conditions: Verify field measurements before beginning fabrication or installation.

1.10 WARRANTY

A. Refer to warranty provisions specified in Division 1.

B. Manufacturer: Include all provisions of the standard manufacturer's backed warranty for each piece of equipment and remain in effect for a period as stated by the manufacturer. AVSC shall be an authorized service representative for all equipment supplied as part of this project unless appropriate approval from owner has been granted prior to equipment procurement or installation. The warranty shall also cover the accuracy of technical documentation, and signal quality as specified and documented during the testing process of this project.

C. AVSC: Guarantee all work installed under this specification. Make good, repair or replace, at the Contractor's own expense, any defective work, materials or parts which may show themselves within one year after final acceptance, if in the opinion of the Architect or Engineer said defect is due to imperfection in material, design, or workmanship.

D. During the warranty period, respond to any warranty calls within four hours of having received and logged any requests for service.

E. Special Warranty: Provide the cost of an additional one-year warranty beyond what is described in this specification.

PART 2 - PRODUCTS

2.01 GENERAL

A. Quality of Materials and Equipment

(1) All materials and equipment supplied by the Contractor shall be new and shall meet or exceed the latest published specification of the manufacturer in all respects.

(2) At the time of submittal, the Contractor shall supply the latest model for each piece of equipment.

(3) All equipment shall be UL listed, or equivalent.

B. Manufacturer:

(1) All accessories, including rack mounting hardware, power supplies, etc., shall be obtained from the original equipment manufacturer. Unless otherwise noted or specified, third party accessories shall not be used.

(2) Do not provide an assortment. For each category, provide products of the same manufacturer; for each item, provide the same model for all pieces.

C. Substitutions:

(1) Substitutions of equal equipment beyond the alternatives listed will be permitted only when approved prior to bidding, in accordance with the procedures given in Section 01 25 13 – Product Substitution Procedures.

(2) Submit requests for substitutions for products prior to bid. All requests must be received by the Owner in writing no later than **[10]** days prior to bid date.

(3) Itemize any variation from the specifications. For each item, refer to the pertaining Section and Paragraph, and indicate the reason for, and/or the advantage of, the substitution.

(4) Substitutions will not be accepted if they impact overall system design and functionality.

(5) Requests for substitution which do not comply with these requirements will not be considered.

D. Product Options:

(1) Where these specifications include model or series numbers, the provided equipment (including substitutions) shall meet or exceed the manufacturer's published specifications for the specified model or series the same as if the manufacturer's published specifications were enumerated within these project specifications.

(2) This requirement is in addition to the other requirements given in the project specifications.

(3) This requirement is not intended to apply to characteristics (such as color or appearance) which do not affect the performance, function, or reliability.

E. Owner-Furnished or Owner-Supplied Equipment

(1) The AVSC, as needed, shall be responsible for removing and/or obtaining OFE equipment from the Owner's location and transporting it to his shop. At the AVSC's facility, he shall ascertain that the OFE equipment is performing at or above factory specifications.

(2) If the equipment is not operating "as-new" or is missing accessories necessary to properly integrate the equipment into the system as intended, the AVSC shall provide a proposal, including a time line, for returning the equipment to "as-new" condition and providing the needed accessories.

F. Wireless Equipment: Prior to ordering equipment, the AVSC shall coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.

G. Spare Parts: Provide one full set of spare video projector lamps.

2.02 EQUIPMENT SCHEDULE

A. Refer to the attached Equipment Schedule, 274100.1.

2.03 EQUIPMENT RACKS

A. Provide hardware as required to provide finished install of specified racks, doors, rack rails, side panels, top and bottom sections, fans, etc.

(1) Where racks are shown together, gang together using factory-provided hardware.

B. Provide hardware as required for standard 19" rack mounting of equipment.

(1) Equipment that does not include manufacturer-provided rack hardware shall utilize a factory-made rack-mount kit such as manufactured by Middle Atlantic Products.

2.04 POWER DISTRIBUTION

A. Provide plug strips or plug mold as required to connect AC power to all associated equipment in racks, equipment consoles and custom mounting enclosures. Provide a minimum of one plug strip or plug mold per rack.

B. Provide master power control and sequencing equipment, to be controlled by the AV Control System.

C. Where applicable use rack manufacturer part or plug strip kit.

2.05 CABLE

A. Refer to the attached schedule, 274100.2: Cables and Connectors

B. Provide wire and cables which are UL-listed and marked for their Class of wiring, per NEC.

C. Trade numbers shown are for general-purpose cables for use in raceway and where otherwise allowed by NEC and other codes. Prior to installation, the AVSC shall verify, for each installation situation, with the local authority having jurisdiction that non-plenum and non-riser rated cables are acceptable. If plenum or riser-rated cables are required, provide cables so rated with equivalent electrical characteristics to those specified below.

PART 3 - EXECUTION

3.01 GENERAL

A. Conform to manufacturer's instructions and provisions of Contract Documents. Where in conflict, assume requirements that are more stringent and verify with Architect before beginning work.

3.02 EXAMINATION

A. Verification of Conditions: Verify conditions as satisfactory to receive work of this Section before beginning.

B. Pre-Installation Testing

C. Evaluation and Assessment

3.03 PREPARATION

A. Protection of In-Place Conditions

B. Surface Preparation

C. Demolition/Removal

3.04 INSTALLATION

A. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.

B. Equipment Mounting

(1) Equipment (except portable equipment) shall be firmly held in place. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three. Equipment shall be braced for seismic conditions according to applicable codes and regulations.

(2) Rack-mounted equipment:

(a) Install vent panels between amplifiers.

(b) Install blank panels to fill any unused rack spaces.

(c) Mount mixers, controls, and patch panels at working height.

(d) Within racks, install cables and wiring neatly, forming straight lines and smooth corners. Bundle separately, or install in separate plastic ducts, the microphone, line-level audio, speaker, control, video, and power wiring.

(3) Loudspeakers:

(a) Do not support speaker enclosures with lay-in tiles or GWB. Provide adequate support (using attachments to structural elements and/or metal mounting bars) for back-boxes so that no perceptible sag will occur once speaker and grille are mounted. Assume a loudspeaker weight of 10 pounds, at a minimum.

(b) Caulk enclosures to ceiling surface (e.g. lay-in tile or GWB) to form an airtight seal.

(c) Verify polarity of each speaker voice coil prior to installation and connect to maintain uniform polarity.

(d) Tap 70-volt transformers as shown, or to provide an amplifier load between 60% and 90% of rated capacity with all speaker-line attenuators (if any) set for minimum attenuation.

(e) Install speaker and baffles to provide tight seal with ceiling and enclosure. Do not caulk baffle to ceiling.

(f) Install so speaker grille is centered in tile or building element, with sides of grille or line between mounting fasteners parallel to ceiling grid or building lines.

C. Raceway

(1) Install wire and cable only within raceway systems. Do not install wire or cable in wall cavities or ceiling plenums/attic spaces without the use of raceway (conduit or cable tray), without the explicit written permission of Owner, or as otherwise noted on the drawings.

(2) Maintain conduit fills equal to or less than those given by Table 1 of Chapter 9 of the NEC, regardless of the class of wiring.

D. Cable Installation

(1) Install wire and cable only within the raceway systems provided under Division 26. Do not install wire or cable in wall cavities or ceiling plenums/attic spaces without the use of raceway (conduit or cable tray) unless otherwise noted on the drawings.

(2) Maintain conduit fills equal to or less than those given by Table 1 of Chapter 9 of the NEC, regardless of the class of wiring.

(3) Use only cable lubricants that are compatible with the jacket materials.

(4) Upon completion of pull, clean exposed cables and surfaces to be completely free of lubricant and residue.

(5) Protect installed conductors from painting, overspray, and taping or patching compounds.

(6) Cable splices are allowed only in accessible junction boxes, using insulated crimp-on connectors, soldering covered with heat shrink, or other methods approved by the Engineer.

(a) Do not splice in conduits or cable tray.

(b) Splicing with wire nuts is prohibited.

(7) Install cables and wiring neatly, forming straight lines and smooth corners, without deformation, kinks, scrapes, or cuts of the jacket or insulation.

(a) Maintain the minimum bend radius of cables as recommended by the manufacturer.

(b) Do not use cable ties in the cable tray or overhead junction boxes, except where otherwise shown or otherwise directed in writing by the Engineer.

(c) Do not cinch cable ties tightly; leave loose enough so each cable can be easily moved through the cable bundle. There should be no deformation of the outer cable jacket.

(d) Where installed without raceway, support cables with D-rings or J-hooks at minimum intervals of 24”. Do not put J-hooks at equal distances; space randomly.

(e) Where bundles are subject to flexing, enclose bundle with nylon webbing or spiral wrap; do not use cable ties.

(f) Where cables are installed vertically, provide support at regular intervals. Maximum distance between supports shall not exceed 80 percent of the manufacturers' recommended maximum vertical drop, or 50% of the recommended maximum pulling tension, whichever is less.

(g) At a minimum, support cables at each floor with clamping strain relief.

(8) Cable assemblies run in conduit and/or cable trays should provide for a minimum of five (5) feet of excess cable on each end to allow for relocation of equipment or re-termination of cable in the future.

E. Signal Separation:

(1) All AV system cables shall be grouped according to the signals being carried and installed in separate raceways. To reduce signal contamination, separate groups shall be formed for the following cable families:

(a) Audio cables carrying signals less than – 20dBm (microphone circuits)

(b) Audio cables carrying signals between – 20dBm and +20dBm (analog line-level circuits)

(c) Audio cables carrying signals above +20dBm (including Class 1 and Class 2 loudspeaker circuits)

(d) Analog video and broadband CATV cables

(e) Digital audio, video, network, or telephone cables

(f) Power and lighting cables

(g) Control cables

(2) Minimum separation from other circuits:

(a) From power and switched lighting circuits: at least **24”**.

(b) From dimmed lighting circuits: at least **48”**.

(c) Where runs are adjacent for less than **80 ft**, the required spacing may be halved (**12”**, or **24”** from dimmed lighting circuits).

(d) Where runs are adjacent for less than **6 ft**, or where circuits cross at right angles, separations of **2”** may be used.

(e) Where AV circuits cross or intersect with power or lighting circuits, cross at 90 degrees (plus or minus 2 degrees) to the greatest extent possible.

F. Rack Cable Installation

(1) All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear, or side panel openings.

(2) Cables shall not protrude from the back of racks.

(3) Where bundles enter racks, arrange neatly without crossovers. Secure cable bundles within racks and equipment consoles with Velcro cable ties.

(4) As a general practice, all power cables, control cables, and high-level cables shall be run on the left side of an equipment rack as viewed from the rear. All other cables shall be run on the right side of an equipment rack, as viewed from the rear.

(5) Inside each rack, cables ties shall be placed at appropriate intervals of no greater than six inches for vertical bundles and no greater than two inches for horizontal bundles.

(6) All vertical cable bundles shall be attached to the rack frame.

(7) Provide flexible service loops for cable assemblies so that equipment in racks or equipment consoles can be fully pulled out for service without cutting wire ties or putting undue stress on cable assemblies. This includes:

(a) Equipment in casework or racks which have less than 1 meter of clearance for rear access.

(b) Equipment with sliding mounting hardware.

G. Connections and Terminations

(1) Prior to connection, verify freedom from shorts or grounds of all conductors (including shields and drain wires) of all cables.

(2) All cables shall have proper connector housing.

(3) All AV system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means.

(4) Serve shielded cables with heat shrink tubing to insulate shield and drain wire. Unused wires at the end of a cable shall remain un-stripped and shall be laid back and held in place with wire ties.

(5) Make connections to plugs, receptacles, connectors, or solder terminals with rosin-core solder using temperature-controlled solder stations.

(6) Ensure that no un-insulated wire is exposed beyond its pin.

(7) Utilize only multi-core flux resin with 60/40 tin-lead non-corrosive construction, designed for electronic equipment use.

(8) Soldering shall utilize good engineering practices and completed solder connections shall appear shiny and smooth with no visible imperfections, cracks, or cold-solder joints.

(9) Make connections to screw connections using insulated spade lugs or Phoenix-style connector blocks. Ensure that no un-insulated wire is exposed beyond its pin.

(10) For all crimp-type connectors and pins, utilize only crimp tools rated for the crimp pin type, size and wire gage being assembled. Consult the manufacturer’s specifications and recommendations for crimping.

(11) Utilize only gold-plated crimp pins.

(12) If a signal path requires that the signal pass through more than one device, each device must have looping input capability, or a distribution amplifier must be used to feed the signal to the devices. Do not use a video "T" in place of a video distribution amp to route signals to more than one device.

(13) All audio circuits shall be balanced (high, low, shield) except where otherwise indicated. Where cable runs between equipment exceed 20 feet, balance boxes shall be used to convert unbalanced circuits to balanced circuits.

(14) Wire all three and five pin audio connectors and quarter-inch phone jacks (mono and stereo) in accordance with IEC-268.

(a) For three pin connectors, Pin 1 is ground, Pin 2 is positive, and Pin 3 is negative.

(b) For five pin connectors, Pin 1 is ground, Pin 2 is left positive, Pin 3 is left negative, Pin 4 is right positive, and Pin 5 is right negative.

(c) For quarter-inch stereo phone jacks, Tip is positive, Ring is negative, and Sleeve is ground.

(d) For quarter-inch mono phone jacks, Tip is positive, and Sleeve is ground.

(15) The strain relief of the connector shall fully engage cable jacket.

H. Wire Numbering
   (1) Develop a wire numbering system to uniquely identify each AV cable.
   (2) Number or color code individual conductors of cables to identify circuits and connections.
   (3) Record number and color codes on the "AS-BUILT" drawings.
   (4) For each system, include the following on the wire run list, for each cable:
      (a) Cable number
      (b) Signal type
      (c) Cable type
      (d) "To" destination
      (e) "From" destination
      (f) Room and equipment location for both ends of the cable
      (g) Approximate length of cable run
   (5) Provide the cable numbering list as a computerized spreadsheet, in a format compatible with Microsoft Excel (version 6.0 or higher). As part of the O&M Manuals, provide:
      (a) Printed copies in each Manual.
      (b) One set of electronic files, on CD-ROM in a format compatible with IBM-PCs.

I. Cable Labeling
   (1) Label all cabling in conformance with AVIXA Standard F501.01:2015, Cable Labeling for Audiovisual Systems.

J. Grounding and Shielding
   (1) Rack Grounding:
      (a) Install a single-point grounding system for each system. Where multiple systems are installed in a single grouping of racks, they shall be considered one system for grounding purposes.
      (b) Verify integrity of grounding systems and isolated receptacles prior to connection of equipment.
      (c) Prior to installing or connecting equipment, temporarily disconnect ground wires (installed under Division 26) from equipment cabinet(s), and measure impedance between each ground wire and its cabinet. Verify electrical isolation (minimum resistance of 1 Megohm) between rack cabinets and raceway and conductive structure. Record results for test report. Reconnect ground wires.
   (2) Connect shield and grounding conductors as follows:
      (a) Connect shields of microphone wiring to receptacle and patch panel common.
      (b) Insulate shields from connector shell, plates, boxes, and raceway.
      (c) Connect shields of wiring from patch panel to control console inputs only to control console (insulate at patch panel).
      (d) Connect shields of balanced line level circuits at patch panel only; insulate at the opposite end of the cable. For balanced circuits that do not terminate at patch panels, connect shields at input ends only; insulate at output ends. Use this standard as needed to correct ground hum issues.
   (3) Maintain shield and drain wire continuity through junction boxes and intermediate termination points. Insulate shields from raceway or other conductive building elements. Maintain shields to within 3 inches of connected devices and maintain twisting of pairs of wires to within 1/2 inch of connector or device termination.
   (4) Make any modifications to grounding and shielding which are necessary to eliminate extraneous noise and RFI, prevent parasitic oscillations, and other signal instabilities, and to meet overall systems noise specifications. Record any deviations from the above guidelines, and the reasons that each deviation was deemed necessary.
   (5) Do not remove or defeat grounding terminal of 3 conductor power cords and maintain safety grounding and bonding as required by the NEC.
   (6) The overall governing requirements are that the wiring systems shall not induce or pick up perceptible noise, and that the predominant components of the noise floor of all signal paths shall be normal "thermal" noise of the upstream devices.
   (7) Because of the great number of possible variations in grounding systems, it shall be the responsibility of the AVSC to follow good engineering practice, as outlined above, and to deviate from these practices only when necessary to minimize crosstalk and to maximize signal-to-noise ratios in the audio, video, and control systems.

K. Interface with Other Work

L. Cutting Building Construction
   (1) Obtain permission from the Architect or Owner and coordinate with other trades prior to cutting. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. Cut concrete with diamond core drills or concrete saws except where space limitations prevent the use of such tools.
   (2) All construction materials damaged or cut into during the installation of this work must be repaired or replaced with materials of like kind and quality as original materials by skilled labor experienced in that building trade.

M. Penetrations of Fire Rated Elements
   (1) Must be provided such as to retain that rating.
N. Painting
   (1) The AVSC will repaint or arrange to repaint existing building components such as walls, frames, etc. which are scratched or marred by the AVSC during installation.
   (2) The AVSC will repaint or refinish equipment, loudspeaker grilles, microphones, or other AV system components which are scratched or marred by the AVSC during installation.

3.05 SYSTEM START-UP
A. System Start-Up: Conform to provisions of Division 1..

3.06 SYSTEM TESTS AND ADJUSTMENTS
A. Inspect and adjust after installation.
B. Repair or replace defective equipment or installations.
C. Testing and adjustment of equipment shall be performed by qualified technicians with general knowledge of video and audio systems alignment and trouble shooting, and knowledge of specific equipment and systems in this project.
D. Manuals: All manufacturers' maintenance or alignment manuals shall be present during testing and adjustment procedures.

3.07 TEST EQUIPMENT
A. Test Equipment:
   (1) Test equipment shall be in good mechanical and electrical condition.
   (2) Non-professional test equipment or home-built kit equipment is not acceptable.
   (3) This list constitutes the minimum instrumentation required to perform the tests in the checklists and does in no way imply a comprehensive list for engineered AV systems testing. Additional instrumentation may be required to verify performance on an item of equipment, or to quantify environmental and other issues to expedite corrective actions by others.
      (a) Sensitive AC voltmeter, -80 dBu sensitivity, 20-30 kHz response, able to measure signal to noise ratio, THD, electrical audio levels within the system. Note that some systems require measurements up to 100 volts and may require an external pad.
      (b) Sound pressure level meter, ANSI Type II, with A and C weighting filters, fast or time-averaged.
      (c) Audio signal generator, 20-30 kHz, sine wave, pink noise.
      (d) Amplified loudspeaker 100 mm producing 60 dBA at one meter, and 70 dBA at one-meter, pink noise, sine wave, speech files.
      (e) 200 MHz oscilloscope, with TV sync.
      (f) Analog video signal generator NTSC/PAL, plus computer patterns at all required resolutions and refresh rates required for the systems under test. For systems with composite video, include PLUGE pattern.
      (g) Digital video signal generator for computer patterns for all resolutions and refresh rated required for the systems under test, HDMI/DVI.
      (h) The ability to measure STI-PA (source and analyzer).
      (i) Colorimeter/luminance meter, 10% accuracy.
      (j) Infrared thermometer.
      (k) Test media with known levels (audio, video, etc.): CDs, VHS, DVDs, etc.
      (l) AC/DC multimeter.
      (m) Light meter, lux/foot-candles.
      (n) Outlet tester (to test power outlet wiring).
      (o) Cable sets, cable assemblies, adapters as required to sample and measure in or out of circuit as required.
      (p) Patch and jumper cables
      (q) Reference standards required for testing
      (r) Software to adjust remotely controlled signal processors, with necessary computer and related hardware. Provide enough cabling to permit controlling computer to be in loudspeaker service areas while signal processors remain in equipment cabinets.
B. Test Instrument Calibration
   (1) Testing firm shall have calibration program which assures test instruments are maintained within rated accuracy.
   (2) Accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
   (3) Instruments shall be calibrated in accordance with the following frequency schedule:
      (a) Field instruments: Analog, 6 months maximum: Digital, 12 months maximum.
      (b) Laboratory instruments: 12 months.
      (c) Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.

(4) Dated calibration labels shall be visible on test equipment.

(5) Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.

(6) Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.

(7) Calibrating standard shall be of higher accuracy than instrument tested.

3.08 MEASUREMENTS AND PERFORMANCE TESTING

A. Verify that the systems are in conformance with the performance criteria in Section 27 41 00 – Audiovisual Systems, paragraph 1.9.B and 1.9.C.

B. Work Includes:

(1) Provide all test equipment necessary for system checkout and acceptance tests.

(2) Perform initial system testing and adjustment as herein prescribed.

(3) Prepare and submit Audiovisual System Testing Report. Use 27 4100.3 – Audiovisual Systems Commissioning Checklist.

(4) Participate in and assist with operational system commissioning as herein prescribed.

C. Successful completion of tests and inspections shall determine suitability for first beneficial use by the Owner.

D. Systems to be inspected and tested:

(1) Sound systems, including:

(a) System inputs and outputs

(b) Wired and wireless microphone systems

(c) Audio program sources

(d) Preamplifiers, mixers, analog signal processors, and digital signal processors

(e) Audio signal distribution network

(f) Distribution amplifiers and power amplifiers

(g) Loudspeakers

(h) Assistive listening systems

(i) Recording equipment

(2) Video presentation systems, including:

(a) Video program sources

(b) Video switchers and routers

(c) Video signal processing equipment

(d) Video distribution equipment

(e) Video displays and projection systems

(3) Digital signage systems

(a) Content management software

(b) Audiovisual signal acquisition interfaces

(c) Digital signage servers

(d) Digital signage distribution

(e) Video displays

(4) Audiovisual control systems

(a) Control system network

(b) Control system processors

(c) Control system interface panels

(d) Control system software interfaces

E. The AVSC shall:

(1) Coordinate testing schedule with Construction Manager, Owner, and Engineer.

(2) Notify Owner and Engineer two weeks before testing.

(3) Perform initial system testing and adjustments.

(4) Prepare test results with comparison to specified performance and technical requirements, industry standards, and manufacturer's values and tolerances.

(5) Assure system equipment is installed in accordance with contract documents, is operational, and within industry and manufacturer's tolerances.

(6) Participate in and assist with systems acceptance testing.

(7) Assure suitability for operation.

F. The Engineer shall:
   (1) Participate in and assist with systems acceptance testing.
   (2) Recommend acceptance or rejection of the installed systems prior to final completion.

G. The Construction Manager/Owner shall:
   (1) Ensure facilities are ready for the work described in this section.
   (2) Participate in and assist with systems acceptance testing.

H. Preliminary Systems Testing and Adjustment Report
   (1) Provide one copy of preliminary testing report in Acrobat PDF format. Test report shall include the following:
      (a) Signed statement on Contractor's letterhead that preliminary systems testing, and adjustment has been completed and the system is ready for acceptance testing by the Engineer.
      (b) Completed AV Systems Commissioning Checklist for each system or room.
      (c) Recorded measurements of all systems.
      (d) List of equipment used to perform tests. Identify the following:
         1. Type
         2. Manufacturer
         3. Model number
         4. Serial number
         5. Date of last calibration
         6. Documentation of calibration leading to NIST standards
      (e) Name(s) of personnel performing tests
      (f) Signature of project manager responsible for performance and oversight of system testing and adjustments.
   (2) Provide completed reports to Engineer no later than 10 days after completion of checklists, testing, and adjustments unless otherwise directed.

I. Audio:
   (1) Verify that the system is completely free from hum, noise, parasitic oscillation, and RFI.
   (2) Measure and record the impedance of each speaker load at the main junction box or rack cabinet and total load on each amplifier. At a minimum, make measurements at 100, 1000, and 10,000 Hertz. Make corrections as required so that the load impedance of each loudspeaker circuit is equal to or greater than rated load impedance of the amplifier.
   (3) Verify that positive pressure at any microphone produces positive pressure from each loudspeaker. Verify that signal polarity is correct and consistent for all circuits and paths. Reverse polarity if required, and record which circuit was reversed.
   (4) With signal processors in bypass mode, adjust gain controls so all components except power amplifiers reach rated nominal output simultaneously. For components which have rated maximum outputs between 18 and 25dBm and line level inputs, adjust each component for unity gain.
   (5) Set audio distribution amplifiers for unity gain unless otherwise specified by the Engineer. Record final settings of each unit.
   (6) Adjust power amplifier input attenuators so power amplifiers reach clipping at 10dB above 0VU on the mixing console output meter.
   (7) Re-adjust gains if required for proper operation of each system and component. Measure and record any such re-adjustments; also record the reason adjustment was deemed necessary.
   (8) Measure and record the electronic signal-to-noise ratio of each complete signal path with all microphone inputs at full gain, or at gain settings which correspond to the onset of ringing for a single microphone, whichever is lower gain, and other controls at normal settings. During test, terminate microphone receptacles with 200-ohm resistors.
   (9) Adjust bandwidth, filter slopes, time offset correction, and signal levels of each crossover. Measure and record final settings of each unit.
   (10) Adjust equalizers to optimize the specified frequency responses. Measure and record the electronic frequency response and the acoustic frequency response of the system before and after adjustments.
   (11) Adjust time delay units to shift the apparent acoustic origin to the main loudspeakers. Measure and record delay settings for each circuit.
   (12) Adjust automatic mixers, automatic level controllers, and other signal processors to optimize use of microphones for speech using the expected (normal) microphone positions.
   (13) Measure and record the impedance of each speaker load at the main junction box or rack cabinet and total load on each amplifier. At a minimum, make measurements at 100, 1000, and 10,000 Hertz.
   (14) Make corrections as required so that the load impedance of each loudspeaker circuit is equal to or greater than rated load impedance of the amplifier.

(15) Slowly sweep all low frequency and full range speaker systems with sine waves at 25% of rated maximum amplifier power output, or at 50% of rated continuous power capacity of loudspeakers, whichever is less, from 20 Hz to 20 kHz. Observe for audible or perceptible vibration or rattling of speaker components, mounting apparatus, or building elements. Under this Section, correct vibration or rattling of speakers or mounting apparatus to the satisfaction of the Engineer. Report vibration or rattling of other building elements to the Engineer; include frequency, characterization of observed rattling or vibration, and recommendations for correcting the rattling or vibration in the report.

(16) Measure and record the maximum sound pressure level of pink noise at onset of amplifier clipping. Make measurement using both A-weighted and un-weighted (flat) settings of the Sound Level Meter (SLM).

(17) Measure and record the acoustic frequency response of the system at the four corners of the seating area, in the middle of the seating area, and at the middle rear of the seating area.

(18) Measure and record the acoustic frequency response at each location provided in the Audio Coverage Uniformity Plan (ACUP)

(19) Measure and record the speech intelligibility of the system at each location listed above (or each location provided in the ACUP).

(20) Perform tests with the measuring microphone at the seated ear height of the audience, within designated seating areas. All interior finishes and furnishings shall be in place during measurements.

(21) Make the above measurements for all loudspeaker systems.

(22) Set gain of initial input stage to match nominal output level of program sources (Microphones, wireless receivers, program sources, etc.)

(23) Perform final equalization in the presence of the Engineer.

J. Video

(1) Verify that all signals comply with the recommended manufacturer's specifications for each item of equipment.

(2) Observe each signal for AC hum or noise. Correct as required so that no hum or noise is either visible in the displayed pictures or detectable on a scope.

(3) Set signal levels to NTSC RS-170A specifications for luminance level and chroma level, gain and phase.

(4) Test signals for differential phase, differential gain, chrominance to luminance delay, multi burst frequency response and signal to noise ratio.

(5) After equipment alignment, check all signal paths from the most up-stream point in the system to verify unity gain at the final destination. Set all equalizing video distribution amplifiers to achieve correct luminance and chrominance gain at each signal destination.

(6) Measure and record initial conditions for black level, gain level, color level values, tint and gray scale values prior to making any adjustments.

(7) Measure and record final conditions for black level, gain level, color level values, tint and gray scale values after making any adjustments.

K. Digital Video

(1) Demonstration and acceptance tests shall be done by a Crestron DMC-E Certified Engineer.

(2) Verify the AV switching equipment has been installed and configured correctly. Measure and record the following information in electronic format:

(a) Number of HDCP KSVs "Keys" supported by each source

(b) Video timing, HDCP use, and audio format of each source when operating

(c) Video timings and supported audio formats for each connected sink

(d) Video timings and supported audio formats presented in the EDID to each source. The preferred video timing shall be indicated.

(e) Cable length on all shielded twisted pair cable used for AV distribution

(f) Data rate supported by each shielded twisted pair cable used for AV distribution

L. Control Systems

(1) Verify all systems connections are operational and devices pass signal as specified.

(2) Audio and video network devices: Verify all IP-connected signal processing equipment is properly configured with IP addresses, gatekeeper addresses, network configurations, and subnets as applicable.

(3) Control system network devices: Verify all IP-connected signal processing equipment is properly configured with IP addresses, gatekeeper addresses, network configurations, and subnets as applicable.

(4) External devices:

(a) Applies to drapes, shades, screens, lights, security, life safety, and HVAC systems or devices.

(b) Confirm all external devices and systems operate as specified prior to connection to AV control system.

(c) Confirm control system interfaces exist and are functional.

(d) Confirm control system functions not obvious from control flow diagrams.

(5) Control system communications: Confirm all control system programming installed and properly communicating with intended equipment or systems.

(6) Control system user interface:

(a) Confirm user interface conforms to user or specified requirements.

(b) Confirm all pages and buttons operate as intended.

(7) Control system power cycling and recovery: Confirm control system will restart and resume full operation following cycling of AC power to the control system.

(8) Document results of all system testing.

3.09 SYSTEM ACCEPTANCE TESTING

A. When the work is complete and ready for Acceptance Testing, notify the Architect and the Consultant in writing. Include copies of final inspection certificates.

B. Include:

(1) Letters from the AVSC and all AV Subcontractors, on their respective letterheads, certifying that the AV systems are substantially complete, fully tested and adjusted, fully operational, and ready for inspection, final testing, and tuning.

(2) Preliminary audiovisual systems commissioning checklist.

(3) Digital photographs of the completed installation. Include photographs of:

(a) An elevation view of the front wall of each room equipped with projection screen(s), showing the screen, loudspeakers, and other system elements.

(b) A view of each equipment room, showing the equipment racks, backboards, terminal cabinets, and other installed materials.

(c) An elevation view of each equipment rack cabinet taken with the front door (if any) fully open, and a view of the interior of each equipment rack cabinet.

(d) A view of each type of wall-mounted device, including cameras, monitors, control panels, etc.

(e) A view of each type of ceiling-mounted device, including loudspeakers, etc.

(f) Close-up views of each type of input panel and output panel.

(g) Close-up views of each type of floor box/pocket with the covers open, and with the covers closed.

(h) Professional photographs are not required; color snapshots with minimum size of 3” x 5” is acceptable. Photographs shall be legible, well lighted, and well-focused, and composed to fill the image with the intended subject as much as possible.

(4) List of discrepancies and corrective action taken.

C. Acceptance Testing

(1) The Engineer will schedule a site visit once the AVSC’s Completion Report has been submitted and approved. Allow at least 10 calendar days between receipt of Completion Report by Engineer and the earliest desired date for the site visit by Engineer. The AVSC is encouraged to communicate informally with the Engineer prior to submission of Completion Report to coordinate the scheduling of the Engineer’s site visit.

(2) The AVSC will assist the Engineer in performing acceptance tests, equalization, and other system adjustments.

(3) The AVSC will assist the Engineer in making final tests, equalization, and other adjustments. This shall include listening and viewing tests, including subjective tests by observers and various positions, under various operating conditions.

(4) All final, as-built drawings, run sheets, manuals, and other required documents shall be on hand.

(5) Manuals: All manufacturers' maintenance, service, and alignment manuals shall be present during testing and adjustment procedures.

(6) System Acceptance Tests will be supervised by the Engineer and will consist of the following:

(a) A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.

(b) The operation of all system equipment shall be demonstrated by the AVSC.

(c) The operation of the control systems/touch panels will be reviewed for acceptance by the Owner.

(d) Listening and viewing tests, including subjective tests by observers at various positions, under various operating conditions.

(e) A random verification of measurements submitted with the audiovisual systems commissioning checklist.

(f) Final adjustments to signal processors and system gain settings.

(7) The Contractor shall provide on-site personnel who performed the installation and testing.

(8) Contractor shall make any adjustments, including but not limited to re-wiring of speaker taps, resetting of gain controls, changes in shielding or grounding, and minor changes in wiring and termination, which are deemed necessary by the Engineer. Such work shall be included in the base bid contract amount.

(9) Make any adjustments, including but not limited to re-wiring of speaker taps, resetting of gain controls, changes in shielding or grounding, and minor changes in wiring and termination, which are deemed necessary by the Engineer. Such work shall be included in the base bid contract amount.

D. Additional Site Visits

(1) Additional site visits may be deemed necessary by the or AV Consultant if any of the following conditions are found during the initial acceptance testing site visit:

(a) Items of equipment which are missing or non-operational.

(b) Items of equipment which do not meet the specifications, or the manufacturers published performance criteria.

(c) Hum, buzz, or noise which degrades the signal to noise ratio of any circuit by more than 5 decibels from the manufacturers' rated signal-to-noise ratios for the upstream components.

(d) Audio distortion which is audible or video distortion which is visible.

(e) Any other conditions which are not in accordance with the specifications, drawings, AV Systems Contractor's submittals, Completion Report, or audiovisual systems commissioning checklist.

(2) In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Engineer.

(3) The AVSC shall make every possible effort to correct the deficiencies during the site visit to avoid additional site visits.

(4) The AVSC will render reasonable assistance to avoid additional site visits, including extending the site visit, so long as it does not hamper other work of the site visit.

(5) Any charge for additional time incurred by the Consultant required to observe system tests due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to, the AVSC.

(6) If additional site visits are deemed necessary, the Owner will submit a written notification of the reasons with descriptions of the deficiencies to be corrected.

(7) If additional site visits are deemed necessary:

(a) The Consultant will submit a written notification of the reasons with descriptions of the deficiencies to be corrected.

(b) Under this Section, with no increase in the Contract amount, the AVSC shall pay for the additional site visits by the Consultant, in the form of reimbursement to the Owner or Architect for their actual cost of services by AEI NW. AEI NW will bill the additional services for the additional site visit(s) at its prevailing standard hourly rates for time (including travel time), plus actual costs for travel per diem, and related expenses.

3.10 CLEANING

A. Leave installations clean and premises free from residue and debris from work of this Section.

B. Waste Management:

(1) AVSC shall continually remove debris, cuttings, crates, cartons, etc., created by his work. Perform clean up daily to eliminate hazard to the public, other workmen, the building or the Owner's employees. Before acceptance of the installation, AVSC shall carefully clean cabinets, panels, lighting fixtures, wiring devices, cover plates, etc., to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied.

(2) Remove dirt and debris from the interior of enclosures, outlet boxes, pull and junction boxes, and equipment cabinets.

(3) Clean equipment to remove plaster, taping or patching compound, overspray, paint spills, oil, grease, dust, fingerprints, or other dirt or contaminants to restore equipment to original finish and condition.

3.11 CLOSEOUT ACTIVITIES

A. Demonstration

(1) After substantial completion of the work and after all tests and final inspection of the work by the AV Consultant, the Contractor shall demonstrate the systems and instruct the Owner's designated operating and maintenance personnel in their operation and maintenance. The Contractor shall arrange scheduled instruction periods with the Owner. The Contractor's representatives shall be superintendents or foremen knowledgeable in each system, and suppliers' representatives when so specified.

B. Training

(1) At the completion of installation, submit a written request to the Owner to schedule the training sessions, at least two weeks in advance of the requested dates.

(2) At a minimum, provide the following sessions of training for systems users, covering operations. Each session shall be for at least the specified number of hours and number of attendees per session.

(a) General Operations: at least one session for operations and management staff.

(b) Technical Operations: at least two sessions for AV technical staff, covering detailed operations and maintenance.

(3) At least one of each type of class (as selected by Owner's representative) shall be video-taped by the contractor, with copies of tapes turned over to the Owner's representative as part of the O&M manuals.

(4) All maintenance and operational aspects of the systems shall be described and demonstrated to personnel selected by the Owner. The sessions shall be conducted by a representative thoroughly familiar with the characteristics of the system. O&M manual information regarding the system shall be submitted to the Owner prior to scheduling the instruction session. The training session should cover the following areas:

(a) General operation of all systems and functions.

(b) Explanation and orientation of all technical documentation.

(c) Explanation of signal flow including all signal paths through routing switchers and patching.

(d) Basic system troubleshooting and preventive maintenance.

(e) Explanation of system warranty and process for owner to follow during system malfunctions to obtain customer support from the AVSC.

3.12 ATTACHMENTS

A. Schedules

(1) Section 27 41 00.1 – Audiovisual Systems Equipment Schedule

(2) Section 27 41 00.2 – Audiovisual Systems Cable Schedule

END OF SECTION 27 41 00

Eqpt. ID	Mfg.	Model #	Description	Notes
DISPLAY/PROJECTION				
VDP/#	LG	XX	FLAT PANEL DISPLAY	
	PANASONIC	XX	FLAT PANEL DISPLAY	
PS1	DRAPER	XX	133" DIAG PROJECTION SCREEN	
PS2	DRAPER	XX	159" DIAG PROJECTION SCREEN	
PS3	DRAPER	XX	188" DIAG PROJECTION SCREEN	
PRO/1	PANASONIC	XX	10K PROJECTOR	
PRO/2	PANASONIC	XX		
VDW	LG	XX	VIDEO WALL DISPLAYS	
MOUNTS				
	CHIEF		TILT MOUNTS	
	CHIEF		LOW PROFILE FIXED MOUNT	
	PEERLESS		ARTICULATING MOUNT	
	PEERLESS		VERTICAL DISPLAY MOUNT	
VIDEO				
SW/1	Crestron	XX	4K SEAMLESS SCALING SWITCHER	
SW/2	Crestron	XX	4K PRESENTATION MATRIX SWITCHER	
RX/1	Crestron	XX	4K HDMI RECIEVER	
VC/1	VADDIO	XX	VIDEO CONFERENCE CAMERA	
INT/1	VADDIO	XX	CAMERA INTERFACE	
AVB/1	VADDIO	XX	AV BRIDGE	
HD1	Crestron	XX	HDMI TRANSMITTER AND RECEIVER PAIR	
AUDIO				
SP	QSC	AC-C8T	CEILING SPEAKER	
AMP/1	QSC	CX-Q-2K4	NETWORKED AMPLIFIER	
DSP/1	QSC	CORE 110F	DIGITAL SIGNAL PROCESSOR	
SB/1	BIAMP	PAREE 2800	CONFERNECING SOUND BAR	
WM/1	SHURE	MICROFLEX WIRELESS	WIRELESS MICROPHONE SYSTEM	
M/1	SHURE	MXA920	CEILING ARRAY MICROPHONE	
ALX/1	LISTEN TECH	LISTEN EVERYWHERE	WIFI ASSISTED LISTENING SYSTEM	
CONTROL/MISC				
CP/1	Crestron	XX	CONTROL INTERFACE	
CP/2	Crestron	XX	CONTROL INTERFACE	
TP/1	Crestron	XX	TABLE MOUNT	
TP/2	Crestron	XX	WALL MOUNT	
TP/3	Crestron	XX	PODIUM MOUNT	
PB/1	Crestron	XX	NETWORK PUSH BUTTON CONTROLLER	
WI/1	BARCO	CLICKSHARE CX-50	WIRELESS CONFERNECING	
ER/1	MIDDLE ATLANTIC	SRSR-4-16	PODIIUM MOUNT RACK	
VP/1	MIDDLE ATLANTIC	VTF1 1U	VENTED BLANK PANEL	
PS/1	LEGRAND	R5BZ	RACK MOUNT POWER STRIP	
AVS/1	NETGEAR	M4250 SERIES	12 PORT MANAGED NETWORK SWITCH	

SIGNAL	DESCRIPTION	MFG.	NON-PLENUM	Rating	Diameter		PLENUM	Rating	Diameter		MATING CONNECTORS			
Audio				NEC	(Inch)	(mm)		NEC	(Inch)	(mm)	Balanced	Unbalanced	BNC	F-Conn
Balanced or Unbalanced	2C#22, STP	BELDEN	9451	CMR	0.135		9451P	CMP	0.127		NC3FX, NC3MX, NP3X-BAG	NP2X-BAG, NF2C-B/2		
Balanced or Unbalanced	2C#22, STP, Stereo Pair	BELDEN	9451D	CMR	0.135		9451DP	CMP	0.127		NC3FX, NC3MX, NP3X-BAG	NP2X-BAG, NF2C-B/2		
Loudspeaker	2C#18	BELDEN	5300UE	CMR	0.158		6300UE	CMP	0.154					
Loudspeaker	2C#16	BELDEN	5200UE	CMR	0.180		6200UE	CMP	0.176					
Loudspeaker	2C#14	BELDEN	5100UE	CL3R	0.218		6100UE	CL2P	0.218					
Loudspeaker	2C#12	BELDEN	5000UE	CL3R	0.260		6000UE	CL2P	0.252					
Loudspeaker	2C#10	BELDEN	5T00UP	CL3	0.356		6T00UP	CL3P	0.308					
Video														
Analog/SDI	Miniature RG/59U	BELDEN	1855A	CM	0.159		1855P	CMP	0.159				1855ABHDL	
Analog/SDI	Miniature 5C RG/59U Snake	BELDEN	7789A	CMR	0.539								1855ABHDL	
Analog/SDI	RG/59U	BELDEN	1505A	CM	0.233		1506A	CMP	0.196				1505ABHDL, 1506ABHDL	
Analog/SDI	5C RG/59U Snake	BELDEN	7796A	CM	0.790								1505ABHDL	
Analog/SDI	RG/6U	BELDEN	1694A	CM	0.274		1695A	CMP	0.235				1694ABHDL, 1695ABHDL	
Analog/SDI	5C RG/6U Snake	BELDEN	7712A	CM	0.970								1694ABHDL	
Analog/SDI	RG/11U	BELDEN	7731A	CMR	0.400		7732A	CMP	0.348				FS11BNC	
CAT 5e	24 AWG, SOLID, 4-PR BONDED UTP	BELDEN	1700A	CMR	0.166		1701A	CMP	0.195		100 011LW			
CAT 6	23 AWG, SOLID, 4-PR BONDED UTP	BELDEN	1872A	CMR	0.365		1874A	CMP	0.365		100 011LW			
Low Skew Cable	23 AWG 4 Pair UTP Low Skew Video Cable	BELDEN	7988R	CMR	0.204		7988P	CMP	0.193		301602			
Low Skew Cable	23 AWG 4 Pair UTP Low Skew Video Cable	EXTRON	22-141-03	CMR	0.280		22-142-03	CMP	0.240		100 011LW			
DBS/Satellite	RG-6 18AWG Solid BC Dual Shield	BELDEN	1829AC	CATV, CM	0.270									DB6U
HDMI	28 AWG, 4-PR/28 AWG, 1-PR/28 AWG, 5C	COVID	HD-280RD	CMR	0.260		P-HD-28	CMP	0.280	7.00				
Multimedia														
HDBaseT - AMX	23AWG Solid, 4 Pair, F/UTP, Non-bonded	BELDEN	10GX62F	CMR	0.295		10GX63F	CMP	0.295					
	23AWG Solid, 4 Pair, F/UTP	GEPCO	CT104/SDM-07	CMR	0.310		CT104/SDMP-07	CMP	0.295					
HDBaseT - Crestron	24AWG Solid, 4 pair, F/UTP	CRESTRON	DM-CBL-8G-NP	CM	0.244		DM-CBL-8G-P	CMP	0.244					
	23AWG Solid, 4 Pair, F/UTP, Non-bonded	BELDEN	10GX62F	CMR	0.295		10GX63F	CMP	0.295					
	23AWG Solid, 4 Pair, F/UTP	GEPCO	CT104/SDM-07	CMR	0.310		CT104/SDMP-07	CMP	0.295					
HDBaset - Extron	26AWG Solid, 4 Pair, S/FTP	EXTRON	22-214-03	CMR	0.250		22-215-03	CMP	0.235		STP RJ-45			
RF/Wireless														
50-OHM COAX	RG/58U	BELDEN	8240	CMX	0.193		82240	CMP	0.159					
Control														
DMX Control	24 AWG 2 Pair twisted double shielded low capacitance 120Ω	BELDEN	9842	CM	0.340		82842	CMP	0.273		NC5MX, NC5FX			
AXLink/CresNet	Ultralow Capacitance 105Ω twisted shielded pair with 18/2 power	BELDEN	1502R	CMR	0.250		1502P	CMP	0.205					
RS-232/485	22AWG SHIELDED TWISTED PAIR	BELDEN	8723	CM	0.160		88723	CMP	0.148		DB9M, DB9F			
RELAY	4C#20 UNSHIELDED	BELDEN	5402UE	CMR	0.160		6402UE	CMP	0.156					
DATA														
CAT 5e	24 AWG, SOLID, 4-PR UTP	BELDEN	1583A	CMR	0.190		1585A	CMP	0.190					
CAT 6	23 AWG, SOLID, 4-PR U/UTP	BELDEN	2412	CMR	0.225		2413	CMP	0.230					
DC Power														
Remote Power Supply	22 AWG, 2 Conductor twisted unshielded general purpose	LIBERTY	22-2C-GRY	CMR	0.120		22-2C-P-GRY	CMP	0.118					
Remote Power Supply	18 AWG, 2 Conductor twisted unshielded general purpose	LIBERTY	18-2C-GRY	CMR	0.166		18-2C-P-GRY	CMP	0.154					
Specialty														
Rack Interconnection	Mini RG59/U 23 AWG High Definition Serial Digital Coaxial Cable		23-MINI-SD	CM	0.164	4.17	23-MINI-SD	CM	0.164	4.17				
Microphone	24 AWG 2 Pair Star Quad style extra flexible Mic cable		24-2P-STAR-BLK	CM	0.240	6.10	24-2P-STAR-BLK	CM	0.240	6.10	NC3FX, NC3MX			

SECTION 27 51 29 - TWO-WAY COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. This section includes product and execution requirements for Two-way Communication System.

1.02 DESCRIPTION

A. Refer to Section 27 0000 - General Communications Requirements.

B. Complete, turnkey Two-way Communication system compliant with all applicable codes and standards referenced herein and as indicated on drawings.

C. Two-way Communication system shall include following major components:

(1) Two-way Communication Call Stations

(2) Two-way Communication Master Stations

(3) Two-way Communication Power Supplies

1.03 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements

(2) Section 27 0526 - Grounding and Bonding for Communications Systems

(3) Section 27 0528.29 - Hangers and Supports for Communications Systems

(4) Section 27 0528.33 - Raceway and Boxes for Communications Systems

(5) Section 27 1000 Structured Cabling

(6) Section 27 1500 Horizontal Cabling

B. Related sections in other Divisions of Work:

(1) REQUIREMENTS OF REGULATORY AGENCIES

(a) Refer to Section 27 0000 - General Communications Requirements.

(2) REFERENCES AND STANDARDS

(a) Refer to Section 27 0000 - General Communications Requirements.

(b) Design, cable and component selection, and installation practices shall conform with following:

1) IBC International Building Code

(3) NFPA 70 - National Electrical Code

(4) NFPA 72 - National Fire Alarm and Signaling Code

(5) NFPA 101 - Life Safety Code

1.04 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

1.05 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements.

1.06 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements.

1.07 AUTHORITY HAVING JURISDICTION REVIEW MEETING

A. Prior to shop drawing submittal preparation, Contractor shall arrange and conduct meeting with Authority Having Jurisdiction (AHJ) to review and coordinate design and installation of Two-Way Communication system.

(1) At minimum, attendees shall include:

(a) AHJ

(b) Owner’s project manager, facilities/buildings and grounds/maintenance representative, security representative, and information technology/information systems representative

(c) General Contractor project manager and site superintendent/field foreman

(d) Division 26 site superintendent/field foreman

(e) Division 27 project manager and site superintendent/field foreman

(f) Two-Way Communication system subcontractor/supplier project manager

(2) At minimum, meeting agenda topics shall include:

(a) Review of proposed system equipment and devices

(b) Identification and discussion of proposed system's functional capabilities and limitations

(c) Identification and review of device locations

(d) Step-by-step review of system deployment execution plan

(e) Review of installation, configuration, programming, and testing schedule and of how those relate to overall construction schedule, including identification of interdependencies, project milestones, and critical dates.

(3) Meeting shall be scheduled with two weeks' minimum notice.

(a) Contractor shall publish meeting agenda and distribute agenda and configuration and programming guide to invited attendees minimum of one week prior to meeting.

(4) Contractor shall take detailed notes during meeting and publish meeting minutes within one week after meeting. Minutes shall be distributed to attendees, Architect, and Engineer, and be included in Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 GENERAL

A. System shall provide two-way voice communication between call stations and master station

B. If master station is not answered, system shall provide two-way voice communication with external constantly attended station and shall automatically communicate location of station initiating call using pre-recorded message unique to each call station.

2.02 TWO-WAY COMMUNICATIONS CALL STATIONS

A. Basis of Design:

(1) Rath 2400-808NSP

B. Acceptable Alternates:

(1) Cornell

C. Features:

(1) Flush wall-mounted

(2) Stainless steel faceplate

(3) Red mushroom-style pushbutton

(4) Red "call received" indicator lamp

(5) Microphone

(6) Speaker

D. Specifications:

(1) Operating Environment: 50° - 120° F

2.03 TWO-WAY COMMUNICATIONS MASTER STATIONS

A. Basis of Design:

(1) Rath 2500-16RCF

B. Acceptable Alternates:

(1) Cornell

C. Features:

(1) Flush wall-mounted

(2) Powder-coated steel enclosure with hinged door

(3) Visual and audible indication of incoming call

(4) Handset

(5) Handsfree speakerphone

(6) Modem for automatic dial-out

D. Specifications:

(1) Operating Environment: 50° - 120° F

2.04 TWO-WAY COMMUNICATIONS POWER SUPPLIES

A. Basis of Design:

(1) Rath RP7700104

B. Acceptable Alternates:

(1) Cornell

C. Features:

(1) Integral battery backup

(2) Secondary power supply (battery backup) shall have sufficient capacity to operate system under quiescent load (system operating in nonalarm condition) for minimum of 24 hours and, at end of that period, shall be capable of operating all alarm notification appliances used for evacuation or to direct aid to location of emergency for 5 minutes.

D. Specifications:

(1) Input: 120 VAC

(2) Output 24 VDC

2.05 TWO-WAY COMMUNICATIONS CABLE

A. General

(1) Refer to manufacturer's published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer's published product installation instructions, more stringent requirement shall govern.

(2) Cable shall be plenum or riser rated as dictated by environment in which cable is installed.

(3) Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.

(4) Two-way Communications system cabling shall be UL 2196 certified and have minimum pathway survivability of Level 2 or 3, provided via either of following:

(a) Cable with CI rating for free-air installation

(b) Cable with CIC rating for installation in conduit

2.06 TWO-WAY COMMUNICATION J-TYPE CABLE SUPPORT HOOKS

A. Refer to 27 0528.29 for information and requirements

2.07 TWO-WAY COMMUNICATION RACEWAY AND BOXES

A. Refer to 27 0528.33 for additional information and requirements.

B. Conduit:

(1) Minimum 3/4" trade size.

(2) No flexible conduit of any type.

C. Boxes:

(1) Minimum 4" square 2-1/8" deep.

PART 3 EXECUTION

3.01 INSTALLATION

A. General

(1) Wiring color coding for each device type shall be consistent throughout installation.

B. System Supervision

(1) System wiring shall be supervised.

(2) Two-way telephone communications circuit installation conductors shall be monitored for open circuit and short circuit fault conditions that would cause the telephone communications circuit to become fully or partially inoperative.

(a) Two-way telephone communications circuit fault conditions shall result in trouble signal in accordance with Section 10.14 of NFPA 72.

(3) Failure of either primary or secondary power supply shall result in trouble signal in accordance with section 10.14 of NFPA 72.

C. Two-way Communications Call Stations

(1) Coordinate rough-in requirements with Division 26 Contractor prior to commencement of work on site.

(2) Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.

(3) Install in accordance with Americans with Disabilities Act and Americans with Disabilities Act Accessibility Guidelines.

D. Two-way Communications Master Stations

(1) Coordinate rough-in requirements with Division 26 Contractor prior to commencement of work on site.

(2) Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.

(3) Install in accordance with Americans with Disabilities Act and Americans with Disabilities Act Accessibility Guidelines.

E. Cable

(1) Systems Identification:

(a) Label system device cabling with unique alphanumeric identifiers that include:

1) Architectural room number
2) Associated system device type
3) Unique alphanumeric identifier

(b) Refer to Section 27 0553 for additional information and requirements.

F. Configuration and Programming

(1) Coordinate programming with Owner.

3.02 TRAINING

A. Contractor shall provide to Owner's designated representative(s) a minimum of one (1) 1-hour on-site training session related to work under this section within thirty (30) days of substantial completion.

END OF SECTION 27 51 29

SECTION 27 53 19 - EMERGENCY RESPONDER RADIO REINFORCEMENT SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. This section includes product and execution requirements for Emergency Responder Radio Reinforcement system.

1.02 DESCRIPTION

A. Design and provision of a complete, turnkey Emergency Responder Radio Reinforcement system compliant with all applicable codes and standards referenced herein and as indicated on drawings.

B. The Emergency Responder Radio Reinforcement system shall include the following major components:

(1) Donor Antenna(s)
(2) Surge Protection
(3) Bi-Directional Amplifier / Repeater
(4) Splitters
(5) Directional Couplers/Taps
(6) Coverage Antennas
(7) Uninterruptible Power Supplies

1.03 RELATED WORK

A. Related Division 27 Sections include:

(1) Section 27 0000 - General Communications Requirements
(2) Section 27 0526 - Grounding and Bonding for Communications Systems
(3) Section 27 0528.29 - Hangers and Supports for Communications Systems
(4) Section 27 0528.33 - Raceway and Boxes for Communications Systems
(5) Section 27 0528.36 – Cable Trays for Communications Systems
(6) Section 27 0553 – Communications Systems Identification
(7) Section 27 0593 – Communications Firestopping
(8) Section 27 1300 – Communications Backbone Cabling
(9) Section 27 1500 – Communications Horizontal Cabling
(10) Section 27 1600 – Communications Connecting Cords and Adapters

B. Related sections in other Divisions of Work:

(1) Section 26 4113 - Lightning Protection for Structures

1.04 REFERENCES AND STANDARDS

A. Unless otherwise noted, design, products, installation, and completed work shall conform with the current version of the following, including applicable addenda and errata:

(1) United States Table of Frequency Allocations, current version
(2) Federal Communications Commission Table of Frequency Allocations, current version
(3) FCC 47 CFR Part 90.219
(4) FCC OET Bulletin 65
(5) IFC International Fire Code
(6) UL 2524 Standard for In-building 2-Way Emergency Radio Communication Enhancement Systems
(7) NFPA 1: Fire Code
(8) NFPA 72: National Fire Alarm and Signaling Code
(9) NFPA 1221: Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems

1.05 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, following abbreviations and acronyms shall apply to this document:

(1) ACG: Automatic Gain Control
(2) AHJ: Authority Having Jurisdiction
(3) ATP: Acceptance Test Plan
(4) AWS: Advanced Wireless Service
(5) BDA: Bi-Directional Amplifier

(6) BOM: Bill-of-Material
(7) BRS: Broadband Radio Service
(8) BTS: Base Transceiver Station
(9) CDMA: Code Division Multiple Access
(10) C/N: Carrier-to-Noise Ratio
(11) CWDM: Coarse Wave Division Multiplexing
(12) DAS: Emergency Responder Radio Reinforcement System
(13) DAS: Two-way Radio Communications Enhancement System
(14) DAQ: Delivered Audio Quality
(15) DWDM: Dense Wave Division Multiplexing
(16) EBS: Educational Broadband Service
(17) ESMR: Enhanced Specialized Mobile Radio
(18) ERRC: Emergency Responder Radio Coverage
(19) FCC: Federal Communications Commission
(20) GUI: Graphical User Interface
(21) iDEN: Integrated Enhanced Digital Network
(22) LMR: Land Mobile Radio
(23) LTE: Long Term Evolution
(24) MIMO: Multiple-Input and Multiple-Output
(25) MTBF: Mean Time Between Failure
(26) NFPA: National Fire Protection Association
(27) NMS: Network Management System
(28) NTIA: National Telecommunications and Information Administration
(29) PCS: Personal Communications System
(30) PSE: Public Safety Entity
(31) PSN: Public Safety Network
(32) RF: Radio Frequency
(33) RoF: Radio-over-Fiber
(34) RoHS: Restriction of Hazardous Substances
(35) RSL: Received Signal Level
(36) RX: Receive
(37) SISO: Single-Input, Single-Output
(38) SMR: Specialized Mobile Radio
(39) SMS: Short Message Service
(40) SNIR: Signal-to-Noise Interference Ratio
(41) SNMP: Simple Network Management Protocol
(42) SOW: Statement of Work
(43) TSL: Transmit Signal Level
(44) TX: Transmit
(45) VSWR: Voltage Standing Wave Ratio
(46) WSP: Wireless Service Provider

1.06 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, the following definitions are applicable to this document:

(1) Active: DAS components that require AC/DC power for operation
(2) Carrier Approval: Expressed approval to interconnect to the WSP macro network
(3) Channel: A path for an RF transmission between two points
(4) Component: A main system element of the DAS
(5) Contractor: The prime contractor bidding the project
(6) Passive: DAS components that do not require AC/DC power for operation

1.07 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.08 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

B. In addition, Submit:

(1) Initial RF site survey and analysis report, to include:

(a) Data collection point locations

(b) RF spectrum shots

(c) RF data plot maps

(2) Floor plans documenting proposed coverage antenna locations

(3) RF propagation modeling maps

(4) SNIR maps

(5) Link budget calculations, for both downlink path and uplink path

(6) Maximum Permissible Exposure calculation documentation

(a) Prepared by independent third party

(7) Documentation that each WSP and PSN has reviewed and approved proposed equipment and Contractor's design

(8) Follow-up RF site survey and analysis report, to include:

(a) Data collection point locations

(b) RF spectrum shots

(c) RF data plot maps

(d) Documentation of changes to initial system design required due to results of follow-up RF site survey, where required, to include as applicable:

1) Floor plans documenting proposed coverage antenna locations

2) RF propagation modeling maps

3) SNIR maps

4) Link budget calculations, for both downlink path and uplink path

5) Maximum Permissible Exposure calculation documentation

6) Prepared by an independent third party

7) Documentation that each WSP and PSN has reviewed and approved proposed equipment and Contractor's design

PART 2 PRODUCTS

2.01 GENERAL

A. System shall be a BDA style turnkey system capable of integral support of RF signals for PSNs managed by FCC.

B. System shall support each PSN on each frequency currently being used by PSEs serving project area.

(1) Coordinate directly with each PSE prior to the commencement of design work to confirm frequencies active on the project's scheduled date of substantial completion.

C. System shall be expandable to support each frequency band allocated by FCC for PSN use, in a MIMO antenna environment without replacement of or addition to the system's passive infrastructure.

D. System shall be capable of receiving PSN AHJ approval.

E. System shall include filtering of all frequencies unused by PSN signals in area in which project is located.

F. System shall be capable of upgrade, without need for additional hardware or software, to support changes to other frequencies within deployed frequency bands to maintain PSN coverage as originally designed.

G. System shall be expandable to extend coverage for all Public Safety frequencies supported to future new additions without need for additional head end equipment.

H. Passive system components shall be:

(1) Broadband

(2) MIMO compatible

(3) PIM (passive intermodulation) compliant

2.02 ANTENNAS

A. Broadband Donor Antenna

(1) Antennas shall feature multi-band design accommodating applicable Public Safety frequencies in a single pole-mounted antenna.
(2) Temperature range: -40°F to 140°F.
(3) Rated for outdoor use.

B. Coverage Antennas – Omnidirectional
(1) Antennas shall feature multi-band design accommodating multiple frequency bands in a single ceiling-mounted antenna
(2) Antenna beam width:
(a) Horizontal: 360° omnidirectional
(b) Vertical: 65-80° nominal
(3) Temperature range: -40°F to140°F.
(4) Rated for indoor use.

C. Coverage Antennas - Directional
(1) Antennas shall feature multi-band design accommodating multiple frequency bands in a single wall-mounted antenna
(2) Antenna beam width:
(a) Horizontal: 110° directional
(b) Vertical: 90° nominal
(3) Temperature range: -40°F to 140°F.
(4) Rated for indoor use.

2.03 BI-DIRECTIONAL AMPLIFIERS

A. Where BDA is used to drive DAS, BDA shall be modular design and use digital filtering to mitigate interference.
B. BDA shall be standard 19" rack or wall mountable.
C. BDA shall be able to individually control power level of each frequency band amplified.

2.04 CABLING

A. Feeder and riser coaxial cables shall be plenum rated.
B. Backbone, antenna distribution, radiating, and fiber optic cables shall be plenum rated.

PART 3 EXECUTION

3.01 PSN SUPPORT COORDINATION MEETING

A. Prior to Contractor's design work commencement, Contractor shall arrange and conduct coordination meeting to review and coordinate Emergency Responder Radio Reinforcement system support of PSN frequencies.
(1) At minimum, attendees shall include:
(a) AHJ and representatives of public safety entities utilizing supported PSN frequencies
(b) Owner's project manager, facilities/buildings and grounds/maintenance representative, security representative, and information technology/information systems representative
(c) Construction Manager/General Contractor project manager and site superintendent/field foreman
(d) Division 26 site superintendent/field foreman
(e) Division 27 project manager and site superintendent/field foreman
(f) Emergency Responder Radio Reinforcement subcontractor/supplier project manager
(2) At minimum, meeting agenda topics shall include:
(a) Confirmation of PSN frequencies and channel loading currently being used by PSEs serving project area
(b) Identification of planned or potential changes in active frequencies and/or channel loading that may be implemented prior to scheduled date of substantial project completion
(c) Identification and discussion of proposed system's functional capabilities and limitations
(d) Step-by-step review of system design and deployment execution plan
(e) Review of survey, design, installation, configuration, programming, and testing schedule and of how those relate to overall construction schedule, including identification of interdependencies, project milestones, and critical dates.
(3) Meeting shall be scheduled with minimum of two weeks' notice.
(a) Contractor shall publish meeting agenda and distribute agenda and configuration and programming guide to invited attendees minimum of one week prior to meeting.
(4) Contractor shall take detailed notes during meeting and publish meeting minutes within one week after meeting. Minutes shall be distributed to attendees, Architect, and Engineer, and be included in Operation and Maintenance Manual.

3.02 PRE-DESIGN SITE SURVEY

A. After specified coordination meetings and before completion of design, Contractor shall conduct pre-design site survey.

B. Data collection points shall:

(1) Include potential donor antenna locations and elevations

(a) Every effort shall be made to be accurate in locating potential donor antenna locations and elevations on site during survey, to ensure survey measurements are conducted within 10 feet (304.8 cm) of actual locations, including elevation.

(2) Be sufficient in quantity and location to provide accurate and sufficiently granular data throughout coverage areas

(3) Be sufficient in quantity and location to properly inform Contractor's design

C. Survey measurements shall include:

(1) Baseline RF noise at and adjacent to supported frequencies

(2) Signal strength of each supported PSN's macro signals, at supported frequencies

D. Survey data shall be submitted to Architect and Engineer and be included in Operation and Maintenance Manual.

3.03 DESIGN

A. Where DAS is used in lieu of a two-way in-building wired emergency communications system, DAS design shall be approved by AHJ.

B. Contractor is solely responsible for design of Emergency Responder Radio Reinforcement System.

C. Contractor shall design Emergency Responder Radio Reinforcement System in accordance with manufacturer's instructions and recommendations, industry standard best practices, and requirements of supported PSNs. Where discrepancies arise, more stringent requirement will govern.

D. Contractor shall design Emergency Responder Radio Reinforcement System to provide performance specified herein throughout the coverage areas and to meet approval of all supported PSNs.

E. Refer to Architectural drawings for building occupant information.

3.04 PRE-INSTALLATION SITE SURVEY

A. Contractor shall conduct pre-installation site survey no more than thirty (30) days prior to commencement of installation work on site to acquire updated measurement data.

(1) Pre-installation site survey shall be conducted after walls are built and after glazing is installed.

(2) Where pre-design site survey is conducted within thirty days of commencement of installation work and fulfills all requirements for both pre-design site survey and pre-installation site survey, separate pre-installation site survey is not required.

B. Data collection points shall:

(1) Include potential donor antenna locations and elevations

(a) Every effort shall be made to be accurate in locating potential donor antenna locations and elevations on site during survey, to ensure survey measurements are conducted within 10 feet (304.8 cm) of actual locations, including elevation.

(2) Be sufficient in quantity and location to provide accurate and sufficiently granular data throughout coverage areas

(3) Be sufficient in quantity and location to properly verify Contractor's design

C. Survey measurements shall include:

(1) Baseline RF noise at and adjacent to supported frequencies

(2) Signal strength of each supported PSN's macro signals, at supported frequencies

(3) Continuous wave (CW) testing to validate propagation modeling

D. Survey data shall be submitted to Architect and Engineer and be included in Operation and Maintenance Manual.

E. Contractor shall update their design as required by updated survey data.

3.05 WORK SEQUENCE

A. Coordinate schedule of Emergency Responder Radio Reinforcement system work to ensure Certificate of Occupancy is obtained in accordance with project schedule.

3.06 EQUIPMENT SUPPORTS

A. Donor Antenna Mounts

(1) Donor antenna assemblies including antenna(s), antenna cable, antenna mount/mast, and associated accessories and hardware shall be designed and installed to withstand sustained winds of ≥ 100 miles (160.93 kilometers) per hour from any direction with all devices, equipment, and material installed and with up to 6 inches (152.4 mm) of radial ice accumulated.

(2) Make donor antenna mounts/masts and associated components, accessories, and hardware electrically continuous and properly ground to lightning protection system. Refer to Section 26 4113 for conductor sizing and termination requirements, and for additional information and requirements.

3.07 INSTALLATION

A. Design and installation shall be performed and overseen by FCC GROL licensed technician employed by installing contractor.

B. Equipment Locations

(1) Install antenna(s) in coverage areas. Refer to drawings for additional information.

(2) Install donor antenna and main system head end equipment where indicated on drawings. Refer to drawings for additional information.

(3) Install system floor-level equipment (splitters, directional couplers / taps, etc.) where indicated on drawings in telecommunications rooms. Refer to drawings for additional information.

(4) Active system components, including transmitter, receiver, signal booster components, external filters and battery system components, shall be contained in NEMA 4 or 4X enclosures.

C. Power Supplies

(1) Primary power source

(a) Emergency Responder Radio Reinforcement system active electronics shall be fed via minimum 20-amp emergency power electrical circuit(s), dedicated to Emergency Responder Radio Reinforcement system head end equipment.

(2) Secondary power source

(a) System shall include battery back-up sufficient to power system at 100 percent system operation for minimum of twenty-four (24) hours.

(3) Power supply system shall be equipped with emergency power off (EPO) switch adjacent to BDA or Signal Booster in an approved location. EPO shall disconnect both circuit breaker and secondary power supply simultaneously.

(4) Coordinate power requirements, quantities, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to commencement of work on site.

D. Cabling

(1) Where DAS is used in lieu of two-way in-building wired emergency communications system, DAS shall have pathway survivability of Level 1, Level 2, or Level 3.

(2) Riser cables shall be routed through 2-hour rated enclosure.

(3) Connection between riser and feeder cables shall be made within 2-hour rated enclosure.

(a) Passage of feeder cable in and out of 2-hour rated enclosure shall be fire-stopped to 2-hour ratings.

E. Properly ground system components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs.

(1) Refer to Section 27 0526 for additional information and requirements.

F. Provide and configure filtering to maximize composite power for PSN frequencies being supported.

G. Properly terminate unused RF ports on system devices, including amplifiers, splitters, directional coupler / taps, etc.

H. Donor Antennas

(1) Coordinate donor antenna locations and mounting method with Architect and GC prior to rough-in.

(2) Fasten donor antennas and associated mounting components. with stainless steel fasteners.

(3) Bond donor antenna cables to ground at point where cable connects to antenna and at point where cable transfers off antenna mounting structure.

(4) Provide in-line surge protection on antenna cables, at point where cable enters building.

(a) Properly ground surge protection components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs.

(b) Refer to Section 27 0526 for additional information and requirements.

(5) Weatherproof exterior antenna cable connections with manufacturer-approved assembly.

I. Coverage Antennas shall be installed in accessible ceilings.. Coordinate antenna locations with work by other trades to ensure that direct access to antenna is maintained after project completion.

J. System shall provide uniform coverage. Radio coverage shall be provided throughout building as percentage of floor area.

(1) Building shall be considered to have acceptable emergency responder radio coverage when signal strength measurements in 95 percent of all areas on each floor of building meet signal strength requirements.

(2) Minimum signal strength of -95 dBm shall be receivable within the building.

(3) Minimum signal strength of -95 dBm shall be received by agency's radio system when transmitted from within building.

(4) Critical areas, including fire command centers, fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by AHJ, shall be provided with 99 percent floor area radio coverage.

(a) General building areas shall be provided with 90 percent floor area radio coverage.

(5) Minimum inbound signal strength sufficient to provide usable voice communications, as specified by AHJ, shall be provided throughout coverage area. Inbound signal level shall be sufficient to provide minimum of DAQ 3.0 for either analog or digital signals.

(6) Minimum outbound signal strength sufficient to provide usable voice communications, as specified by AHJ, shall be provided throughout coverage area. Outbound signal level shall be sufficient to provide minimum DAQ 3.0 for either analog or digital signals.

(7) Isolation shall be maintained between donor antenna and inside antennas to minimum of 20 dB under operating conditions.

K. System shall not interfere with operation of other electronic systems.

3.08 SYSTEM MONITORING

A. Fire Alarm System

(1) System shall include automatic supervisory signals for malfunctions of emergency responder radio reinforcement system annunciated by fire alarm system in accordance with NFPA 72.

(a) Monitoring for system integrity shall comply with NFPA 72, Chapter 10.

(b) Provide visual and labeled indications for each supervised system component.

(c) System supervisory signals shall include:

1) Donor antenna malfunction

2) Active RF emitting device failure

3) Low-battery capacity indication when 70 percent of the 24-hour operating capacity has been depleted

4) System component failure

(d) Power supply supervisory signals shall include the following for each RF emitting device and system component:

1) Loss of normal AC power

2) Failure of battery charger

(e) Communications link between fire alarm system and emergency responder radio reinforcement system shall be monitored for integrity.

B. Dedicated Panel

(1) Dedicated monitoring panel shall be provided within fire command center to annunciate status of RF emitting devices and system component locations. Monitoring panel shall provide visual and labeled indications of following for each system component and RF emitting device:

(a) Normal AC power

(b) Loss of normal AC power

(c) Battery charger failure

(d) Low battery capacity (to 70 percent depletion)

(e) Donor antenna malfunction

(f) Active RF emitting device malfunction

(g) System component malfunction

(2) Communications link between dedicated monitoring panel and emergency responder radio reinforcement system must be monitored for integrity.

3.09 INSPECTION AND TESTING

A. Test plan shall include tests necessary to verify that installed system meets specified requirements and requirements of each PSE.

B. Scheduling

(1) Testing shall be scheduled minimum of two weeks prior to scheduled date of final completion.

(a) Contractor shall coordinate with each PSE to arrange for them to observe system testing.

C. Data collection points

(1) Data collection points shall include:

(a) All donor antenna locations

(b) Signal level at each stair landing and elevator lobby

(c) Signal level at locations as required by AHJ

(2) Be sufficient in quantity and location to properly verify that system's performance meets specified requirements and requirements of each PSE.

(a) At a minimum, each floor shall be divided into twenty equal areas and data shall be collected at or as near as is practical to the center of each area.

D. Survey measurements shall include:

(1) Baseline RF noise at and adjacent to supported frequencies

(2) Signal strength of each supported PSN's macro signals, at supported frequencies

(3) Continuous wave (CW) testing

(4) Signal strength of each supported PSN's system coverage signals, at all supported frequencies

E. At no additional cost to Owner, Contractor shall adjust, modify, and/or add to system as necessary to achieve performance required by AHJ.

3.10 ATTIC STOCK

A. Contractor shall provide following spare devices and equipment as Owner's attic stock:

(1) Donor Antennas: One (1) of each type provided

(2) Coverage Antennas: Five (5) of each type provided

(3) Surge Suppressors: 100% of the quantity installed of each type provided.

(4) Fuses: 20% of each type provided as part of system devices and equipment, minimum ten (10) of each type provided.

3.11 TRAINING

A. Contractor shall provide to Owner's designated representative(s) a minimum of one (1) 4-hour on-site training session related to work under this section within thirty (30) days of substantial completion.

END OF SECTION 27 53 19

END OF DIVISION 27

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

SECTION 28 0000 **GENERAL ELECTRINIC SAFETY AND SECURITY REQUIREMENTS**

SECTION 28 1000 **ELECTRONIC ACCESS CONTROL**

SECTION 28 2000 **VIDEO SURVEILLANCE**

SECTION 28 4610 **ADDRESSABLE FIRE DETECTION AND ALARM SYSTEMS**

SECTION 28 00 00 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

A. This section details references, standards, guidelines, requirements, and conditions common to all Division 28 work.

B. Work under this Section and related sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

C. Systems constituting Division 28 scope of work include the following Electronic Safety and Security devices as show in the Project documents.

(1) Electronic Access Control Devices

(2) Video Surveillance

D. Fire Detection and Alarm under Section 283116 is not included as part of these general requirements.

1.02 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, terms "provide", "furnish", and "install" as used in Division 28 Contract Documents shall have following meanings:

(1) "Provide" or "provided" shall mean "furnish and install".

(2) "Furnish" or "furnished" does not include installation.

(3) "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified but necessary for proper installation and operation.

D. Check, verify, and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations, adjustments, etc. necessary to complete work and/or to avoid interference with other trades.

E. Included in this contract are connections to equipment provided by others. Refer to Architectural, Electrical, Integrated Automation, Mechanical, Communications, and final shop drawings for equipment being furnished under other sections for exact locations of outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

G. Where Architectural features govern location of work, refer to Architectural drawings.

H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

1.03 RELATED WORK

A. Related Division 28 Sections include:

(1) Section 28 1000 - Electronic Access Control

(2) Section 28 2000 - Video Surveillance

B. Refer to individual technical sections identified above for additional related sections.

C. Related sections in other Divisions of Work:

(1) Section 26 0593 – Electrical Systems Firestopping

(2) Section 27 1000 - Structured Cabling

(3) Section 27 1100 - Communications Equipment Room Fittings

(4) Section 27 1300 - Communications Backbone Cabling

(5) Section 27 1500 - Communications Horizontal Cabling

(6) Section 27 1600 - Communication Connecting Cords, Devices and Adapters

(7) Refer to individual technical sections identified above for additional related sections.

D. Temporary Services:

(1) Not applicable to this project.

E. Continuity of Service:

(1) No service shall be interrupted or changed without permission from Owner and Architect / Engineer. Obtain written permission before work is started.

(2) When interruption of services is required, persons concerned shall be notified and shall agree upon schedule.

F. Demolition:

(1) Not applicable to this project.

G. Cleaning and Repair

(1) Clean and repair existing materials and equipment that remain or is to be reused.

H. Concrete Work:

(1) Not applicable to thjs Division of work.

I. Painting:

(1) Painting of equipment will be done under Division 9 unless specified otherwise or is to be furnished with factory applied finish coats.

(2) Furnish equipment with factory applied prime finish unless otherwise specified.

(3) If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect / Engineer.

(4) Furnish one can of touch up paint for each factory finish, which will be final finished surface of product.

1.04 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State, and local authorities and utility companies in force at time of execution of contract shall become part of this specification.

B. Perform work in accordance with laws, codes, regulations, ordinances, etc. of jurisdiction in which project site is located and in accordance with Owner's published standards.

C. Perform work in accordance with referenced standards, guidelines, and industry best practices.

D. Perform work in accordance with manufacturer's instructions, guidelines, recommendations, etc.

E. Where discrepancy exists between laws, codes, regulations, ordinances, guidelines, industry best practices, Owner's published standards, manufacturer's instructions, manufacturer's guidelines, manufacturer's recommendations, etc. and Contract Documents, most stringent requirement or direction that complies with laws, codes, regulations, and ordinances shall govern.

F. Changes to work conveyed by Contract Documents made after letting of contract to comply with applicable laws, codes, regulations, ordinances, Owner's published standards, or Contract Documents or to comply with requirements of Authority Having Jurisdiction shall be made by Contractor without any cost to Owner.

G. Contractor shall include in their bid costs to procure permits, licenses, approvals, etc. applicable to work performed, including:

(1) Costs to prepare documents for applications, submittals, etc. for review by Authority Having Jurisdiction

(2) Application, submittal, etc. charges, fees, taxes, etc.

(3) Contractor shall include in their bid costs for inspections of work performed related to permits, licenses, approvals, etc. or laws, codes, regulations, ordinances, or Owner's published standards.

1.05 REFERENCES AND STANDARDS

A. Design, cable and component selection, and installation practices shall conform with following:

(1) Local Electrical Code

(2) Federal, State of Arkansas and City of Fayetteville safety and building codes.

(3) UL 444 - Communications Cables

(4) NFPA 730 - Guide for Premises Security 2006 Edition

(5) NFPA 731 – Standard for the Installation of Electronic Premises Security Systems 20060 Edition

(6) BICSI Electronic Safety and Security Design Reference Manual, First Edition, 2006

(7) TIA/EIA 568-C - Commercial Building Telecommunications Cabling Standard (including applicable Addenda)

(8) TIA/EIA 569-C - Commercial Building Standard for Telecommunications Pathways and Spaces.

(9) BICSI Telecommunications Distribution Methods Manual (TDMM)

(10) TIA 598-C: Optical Fiber Cable Color Coding.

(11) TIA 455-21-A: Mating Durability for Fiber Optic Interconnecting Devices

(12) TIA 526-14A: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

(13) TIA 526-7: Optical Power Loss Measurements of Installed Single-mode Fiber Cable Plant

(14) TIA 606: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

(15) UL-910: Tests for Flame Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air

(16) UL-1666: Tests for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

(17) Standards identified in individual Technical Sections.

B. Agencies or publications referenced herein refer to following:

(1) ANSI American National Standards Institute

(2) ASME American Society of Mechanical Engineers
(3) ASTM American Society for Testing and Materials
(4) BICSI Building Industry Consulting Services International
(5) EIA Electronic Industries Alliance
(6) FIPS Federal Information Processing Standards
(7) FCC Federal Communications Commission
(8) ICEA Insulated Cable Engineers Association
(9) IEEE Institute of Electrical and Electronics Engineers
(10) NEC National Electrical Code
(11) NECA National Electrical Contractors Association
(12) NEMA National Electrical Manufacturers Association
(13) NESC National Electrical Safety Code
(14) NETA National Electrical Testing Association
(15) NFPA National Fire Protection Association
(16) NIST National Institute of Standards and Technology
(17) OSHA Occupational Safety and Health Administration
(18) TIA Telecommunications Industry Association
(19) UL Underwriters Laboratories, Inc.

C. Work shall be in accordance with latest edition of codes, standards, specifications, etc. unless noted otherwise.

1.06 DEFINITIONS

A. Following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction.

(1) Building Entrance Facility: An entrance to building for both public and private network service cables and/or wireless services including entrance point of building and continuing to Equipment Room. . Service provider(s) point-of-demarcation (DEMARC) is typically located here.
(2) Equipment Room (Main Telecommunications Room): An environmentally controlled centralized space where Electronic Safety and Security equipment such as head end equipment, servers, control panels, power supplies, and systems wiring and cabling terminations will reside.
(3) Guarantee: Promise or an assurance that attests to quality or durability of product or service or that task will be performed in specified manner. Used interchangeably with "Warranty" in these documents.
(4) Intra-building: Within single building.
(5) Inter-building: Between 2 or more buildings.
(6) Rack Unit: Standard measurement of vertical mounting space on an equipment rack. Each Rack Unit is 1-3/4” high.

B. Typical NEMA Enclosures and Usage

(1) Refer to Section 26 0000 – General Electrical Requirements.

1.07 ABBREVIATIONS AND ACRONYMS

A. Following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.

(1) 8P8C Eight-Position, Eight-Conductor. Used in clarifying jack type; a.k.a. "RJ-45".
(2) ACMS
(3) AFF Above Finished Floor
(4) ATM
(5) AWG American Wire Gauge
(6) BAS Building Automation Systems
(7) BTU British Thermal Unit
(8) CC Fixed CCTV Camera
(9) cm centimeters
(10) EC PTZ/Dome CCTV Camera
(11) °C degrees Celsius
(12) °F degrees Fahrenheit
(13) DTMF Dual Tone Multi Frequency
(14) EF Entrance Facility
(15) ER Entrance Room

(16) FT Fiber Transceiver
(17) ft feet
(18) GbE Gigabit Ethernet
(19) HC Horizontal Cross-connect
(20) Hz Frequency in Hertz (k = kilo, M = Mega, G = Giga)
(21) ID Inside Diameter
(22) IDF Intermediate Distribution Frame
(23) in inch
(24) IPT IP Telephony
(25) kg kilogram
(26) lbs pounds
(27) LAN Local Area Network
(28) MC Main Cross-connect
(29) m meters
(30) mm millimeters
(31) Mbps Megabits per second
(32) µm micrometer (10-6.56 yard (6 meter)
(33) OD Outside Diameter
(34) PBX Private Branch Exchange (Telephone Switch)
(35) pF pico-Farad (10-12 Farad)
(36) PoE Power-over-Ethernet
(37) PVC Polyvinyl Chloride
(38) RU Rack Unit
(39) sq ft square feet (area)
(40) VR Video Receiver
(41) VT Video Transmitter
(42) TR Telecommunications Room
(43) WAN Wide Area Network
(44) WLAN Wireless Local Area Network
(45) VoIP Voice over Internet Protocol

B. Refer also to technical sections for additional terminology.

1.08 LISTING

A. Refer to technical sections of this Division of work for listing requirements.

1.09 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:
(1) Refer to Division 01 - Submittal Procedures.
(2) Provide documentation demonstrating compliance with requirements specified in 280000 - 1.13 - Quality Assurance below.
(3) Note that for satisfying submittal requirements for Division 28, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, expression "Shop Drawings" is generally used throughout specification.
(4) Mark catalog sheets and drawings to indicate specific items submitted.
(a) Markings shall be reproducible (arrow, boxed, encircled, checkmark, etc.).
(b) Where sheet includes multiple product options, mark proposed option(s).
(5) Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
(6) When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Mark and annotate submittals accordingly.
(7) Group submittals by Section to include complete documentation of related systems, products, and accessories. Where applicable, dimensions shall be marked in units to match those specified.
(8) Submittals shall be in electronic form or on paper per Division 01.
(a) Documents in electronic form shall be ADOBE Acrobat PDF.
(b) Paper documents shall be original catalog sheets or photocopies thereof.
(c) Facsimile (fax) sheets will not be accepted.

(9) Engineer's Review is to confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that all required items have been submitted.

(10) When equipment and items specified include accessories, parts, and/or additional items under one designation, submittals shall be complete and include required components.

(11) Include wiring diagrams for electrically powered or controlled equipment.

(12) Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.

(13) Submit documentation demonstrating each Contractor-proposed server, networked storage appliance, and computer workstation hardware, BIOS, and operating system configuration meets Application Software manufacturer's recommendations for optimal performance for scope defined in project documents and meets Owner's requirements for those devices.

(14) Submit calculations based on manufacturer's recommendations documenting Contractor-proposed battery capacity for each Uninterruptible Power Supply provides specified minimum battery run time.

(15) Submit equipment room layouts drawn to scale, including equipment, raceways, accessories, and clearance for maintenance.

(16) Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.

(17) Submittals which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.

(18) "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 28 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork, communications, and/or electrical raceway layouts.

(a) Unless specifically requested in Division 28 technical sections, submittals of coordination drawings will be returned without review.

1.10 UPON REQUEST BY THE OWNER OR ENGINEER, SUBMIT TWO-FOOT SECTION OF CABLE(S) OF THE TYPE(S) TO BE SENT TO THE SITE FOR FINAL APPROVAL.

A. This two-foot section shall have the manufacturer's cable markings visible.

B. Upon request, samples from every reel sent to the site shall be provided.

C. Certificates and Inspections:

(1) Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

D. Operation and Maintenance Manuals:

(1) Refer to Division 01 - Operation and Maintenance Data.

(2) Upon completion of work but before final acceptance of system, submit to Architect / Engineer for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.

(3) Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system.

(4) Manuals shall include following:

(a) Copies of shop drawings

(b) Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.

(c) CD ROMs of O&M data with exploded parts lists where available

(d) Phone numbers and addresses of local parts suppliers and service companies

(e) Internet/Web page addresses where applicable

(f) Wiring diagrams

(g) Start up and shut down procedure

(h) Factory and field test records

(i) Additional information, diagrams, or explanations as designated under respective equipment or systems specification section

(5) Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.

(6) O&M manuals and instructions to Owner shall be provided prior to request for final payment.

E. Record Documents:

(1) Refer to General Conditions of Contract and Division 01 - Closeout Procedures. Prepare complete set of record drawings in accordance with Division 01.

(2) Use designated set of prints of Contract Documents as prepared by Architect to mark-up for record drawing purposes.

1.11 JOB CONDITIONS

A. Building Access:

(1) Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Cutting and Patching:

(1) Refer to General Conditions of Contract and Division 01 - Cutting and Patching.

(2) Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.

(3) Provide materials required for patching unless otherwise noted.

(4) Do not pierce beams or columns without permission of Architect / Engineer and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.

(5) Where alterations disturb lawns, paving, walks, etc., replace, repair, or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

C. Housekeeping and Cleanup:

(1) Refer to Division 01 - Closeout Procedures.

(2) Periodically as work progresses and/or as directed by Architect / Engineer, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.12 WORK BY OWNER

A. Owner will provide:

(1) Telecommunications service data and internet

(2) Active telephone electronics, including analog/digital/VoIP private branch exchange (PBX), telephones, fax machines, and modems, for interface with building structured cabling systems

(3) Active Ethernet networking electronics, including modems, routers, firewalls, switches, wireless Ethernet access points, for interface with building structured cabling systems

(a) Does not include Contractor-provided active Ethernet networking electronics specified in Division 28 Technical Sections as part of Division 28 scope.

(4) Active office electronics, including server computers, data storage appliances, workstation computers, scanners, and printers

(a) Does not include Contractor-provided server computers, data storage appliances, workstation computers, scanners, or printers specified in Division 28 Technical Sections as part of Division 28 scope.

(5) Connections from active telephone and Ethernet networking electronics to Contractor provided structured cabling (e.g. patch cords).

(a) Does not include Contractor-provided connections for Contractor-provided equipment, devices, etc.

1.13 QUALITY ASSURANCE

A. Refer to individual technical sections for general product quality requirements, manufacturer qualifications, and contractor qualifications and certification requirements.

B. Products

(1) Only products of reputable manufacturers, as determined by Architect / Engineer, will be acceptable. Manufacturers shall have minimum of five (5) years of documented experience in designing, manufacturing, delivering, and supporting specified material.

(2) Where Contract Documents require product, material, or assembly that hasn't been specified by brand or trade name, provide product, material, or assembly meeting specified requirements, as supplied and warranted by system vendor. If system vendor does not offer product, material, or assembly, provide product, material, or assembly per system vendor's recommendation.

C. Contractor

(1) Contractor shall have minimum of five (5 years' documented experience providing and servicing specified equipment, devices, components, materials, and systems.

(2) Contractor shall have documented history of successfully completing minimum of five (5) projects of scope and magnitude equal to or greater than that specified in Contract Documents.

(3) Contractor shall have minimum of five (5) years' documented history of being continuously current on manufacturer's training and certifications applicable to specified equipment, devices, components, materials, and systems they propose for use on project.

(4) Contractor shall have minimum of five (5) years' documented history of being certified by manufacturer to offer and support manufacturer warranties applicable to specified equipment, devices, components, materials, and systems they propose for use on project.

(5) Contractor's staff assigned as project manager, site superintendent, and foreman shall each have documented history of successfully completing minimum of five (5) projects of scope and magnitude equal to or greater than that specified in Contract Documents.

(6) Contractor's staff assigned as site superintendent and foreman and Contractor's staff assigned to perform installation, termination, configuration, programming, and testing shall have minimum of five (5) years' documented experience of being continuously, individually certified by manufacturer on specified equipment, devices, components, materials, and systems proposed and approved for use on project.

(7) Contractor shall have in-house service department staffed with technicians who are individually manufacturer-certified to install and service specified equipment, devices, components, materials, and systems proposed and approved for use on project, and who are equipped with tools, equipment, materials, etc. necessary to install and service specified equipment, devices, components, materials, and systems proposed and approved for use on project.

(a) Contractor's in-house service department shall offer maximum 4-houron-site service call response time 24 hours a day, 7 days a week, 365(6) days a year.

(8) Contractor and subcontractor(s) shall only employ workers who are properly trained to execute work being performed and are skilled in their trade.

(9) Contractor and subcontractor(s) shall own and maintain equipment, tools, etc. to execute work performed in manner consistent with laws, codes, regulations, ordinances, standards, guidelines, industry best practices, manufacturer's instructions, etc.. Workers shall be properly trained in use of equipment, tools, etc. necessary for them to complete work performed.

(10) Inability to demonstrate compliance with requirements listed above shall disqualify Contractor from self-performing work conveyed by Contract Documents, and Contractor shall then, at no additional cost to Owner, subcontract with another firm qualified to perform work.

1.14 GUARANTEE

A. Refer to Division 01 for general Guarantee (Warranty) requirements.

B. Refer to technical sections for Guarantee requirement for each system.

(1) Where no guarantee requirements are called out, guarantee two years after acceptance by Owner equipment, materials, and workmanship to be free from defect.

C. Repair, replace, or alter systems or parts of systems found defective at no extra cost to Owner.

D. Wherein fulfilling requirements of any guarantee, if Contractor disturbs any work guaranteed under another contract, restore such disturbed work to condition satisfactory to Architect / Engineer and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Guarantees shall include labor, material, and travel time.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide new materials, unless specifically noted otherwise in Contract Documents.

B. Where manufacturer has replaced part number with newer part number, provide manufacturer's version that is most current offering available at time of installation.

C. Where manufacturer has published end of life or similar notice for part number, notify Architect / Engineer of notice and manufacturer's recommended substitution. Where manufacturer offers no substitution, provide Architect / Engineer three (3) options to consider for acceptable alternates.

D. Where multiple manufacturers' names or manufacturers' names and part numbers are listed, basis of design listed shall be considered benchmark for quality, features, and functionality for that material.

E. Include hardware, details, options, modules, accessories, subassemblies, etc. not shown or specified, but necessary for proper installation and operation.

F. Where one or more of same item of material is required, all such units shall be provided as same manufacturer and part number.

G. Refer to technical sections for additional information and requirements.

2.02 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

PART 3 EXECUTION

3.01 GENERAL

A. Verify elevations and measurements prior to installation of materials.

B. Examine all drawings and specifications to familiarize themselves with the type of construction to be used, and the nature and extent of work provided by other trades.

C. Beginning installation means Contractor accepts existing conditions.

D. Verify dimensions and the correct locations of hardware before proceeding with the installation of hardware, cabling and/or connections.

E. Identify and report to Owner any existing damage to walls, flooring, tiles and furnishings in the work area prior to start of work.

F. Repair all damage caused by the cable, raceway, or miscellaneous material to the interior surfaces during the communication installation.

G. Repairs must match preexisting color and finish of walls, floors and ceilings.

H. Replace any contractor damaged ceiling tiles to match color, size, style and texture and shall not be taken from Owner's attic stock.

I. Secure all rooms and offices when not in use.

J. At no time shall the Equipment Room or any Telecommunications Rooms be unattended if unsecured.

K. Assume that all installation work including cable placement, termination and testing shall be performed between the hours of 7:00 a.m. to 5:00 p.m. Monday through Friday unless stated otherwise in the bid.

L. Complete installation work using qualified personnel utilizing state-of-the-art equipment and techniques.

M. Test and document installation upon completion as defined in the technical sections.

N. Products selection, installation plans and termination layouts must be reviewed and approved by the Owner prior to construction.

3.02 THE REVIEW DOES NOT EXEMPT THE CONTRACTOR FROM MEETING ANY OF THE REQUIREMENTS STATED IN THIS DOCUMENT.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division 01 for additional information and requirements.

B. Transport, handle, and store materials in manner that avoids damage, preserves their original condition as delivered from manufacturer, is consistent with manufacturer’s guidelines and instructions, and maintains applicable manufacturer warranties.

(1) Protect material from deleterious substances, agents, contaminants, and conditions, including dust, dirt, debris, moisture, chemicals, chemical compounds, corrosion, temperatures outside material’s published tolerance range.

(2) Protect material from damage due to intentional or incidental contact, vandalism, neglect, etc.

C. Handle materials in accordance with recommended procedures, precautions, and remedies described in material safety data sheets, where applicable.

(1) Where applicable, lift only with lugs provided for purpose.

D. Store materials in clean, dry, secure, temperature-controlled location.

E. Maintain manufacturer’s original material packaging and shipping packaging until material is installed.

F. Store cable according to manufacturer's recommendations at a minimum.

G. Store cable in a location protected from vandalism and weather.

(1) If cable is stored outside, cover with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather.

H. Follow manufacturer's storage specifications - in particular, those relating to temperature.

I. Confine all tools, materials and equipment to area designated by the Owner.

J. Clean up and dispose of all debris and rubbish resulting from work on a daily basis.

(a) Clean up of the dust, debris, shipping and packaging material associated with their installation.

K. Provide storage containers as required. The Owner's disposal containers, shall not to be utilized without written authorization.

L. Contractor shall include in their bid costs to deliver, store, and handle materials.

3.04 FLOOR, WALL, CEILING, AND ROOF OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.

B. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted.

C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

D. For core drilled holes, size and location shall be reviewed and approved by Structural Engineer and Owner prior to execution.

E. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Contract Documents.

G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved by structural engineer prior to preparing openings in structural member.

H. Openings for penetrations shall be minimum 1/2” larger on all sides than outside dimensions of raceways or cables. Where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.

I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

J. Seal non-rated wall openings with urethane caulk.

K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation or sealing system by another manufacturer approved as equal by Architect / Engineer. Sealing system shall utilize Type 316 stainless steel bolts, washers, and nuts.

L. Finish and trim penetrations as shown on details and as specified hereinafter.

M. Provide chrome or nickel-plated escutcheons where raceways pass through walls, floors, or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor’s closets, storage rooms, etc., unless suspended ceilings are specified.

3.05 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocation of raceways or accessories as required to provide access shall be provided at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair, or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs, or maintenance is located in walls, chases, or above inaccessible ceilings.

D. Provide necessary coordination and information to Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes, and rough-in dimensions, without limitations.

E. Provide access doors where equipment requiring access for servicing, repairs, and maintenance is located in walls or chases or above inaccessible ceilings, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Access doors used in fire-rated construction shall have UL label. Access doors shall be steel, prime coated, except use stainless steel doors in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Access doors shall be of sufficient size to allow for total maintenance. Location of access doors shall be coordinated with General Contractor and location of equipment shall be roughed in accordingly.

F. Locate equipment, devices, etc. to fit details, panels, decorating, finish, etc. at space. Architect / Engineer reserves right to make minor position changes of outlet locations before work has been installed.

G. Verify room door swings before installing wall-mounted equipment, devices, etc. and install on latch side of door unless otherwise noted.

3.06 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc..

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide, or anchors utilizing lead are not allowed.

C. Do not support equipment or cable pathways from metal roof decking.

3.07 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms, and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.

B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes, and electrical supporting devices suspended less than 7 ft above floors, platforms, or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.08 CABLE AND CONDUCTOR PROTECTION

A. Protect cabling and termination components from contact with, and potential application of, foreign materials.

(1) Foreign material is defined as material that is not part of cable assembly and termination components when delivered from manufacturer.

(2) Examples include paint overspray and drywall compound.

B. Cable and components that come into contact with foreign materials shall be replaced at no cost to project.

(1) Solvents and other cleaning agents shall not be used to remove foreign materials that have already accumulated on cable and components.

3.09 HOUSEKEEPING PADS

A. Not applicable to this Division of work.

3.10 INSPECTION AND TESTING

A. General

(1) Submit with shop drawings documentation of proposed inspection and test procedures.

(a) Inspection and testing shall not commence without Architect / Engineer's approval of proposed procedures. Commencement of inspection and testing without Architect / Engineer's approval of proposed procedures shall be grounds for Architect / Engineer and Owner to reject documentation of related inspection and testing and require repeat of related inspection and tests at no additional cost to Owner.

(2) Prior to testing, visually inspect work to verify completion and compliance with applicable requirements.

(3) Coordinate and schedule testing to be complete minimum of fifteen (15) working days prior to scheduled occupancy, such that Architect / Engineer and Owner have minimum of ten (10) working days to review draft test results and Owner has minimum of five (5) working days to prepare phase area for occupancy.

(4) Coordinate and schedule testing phases to be complete minimum of fifteen (15) working days prior to scheduled occupancy of each construction phase, such that Architect / Engineer and Owner have minimum of ten (10) working days to review draft test results and Owner has minimum of five (5) working days to prepare phase area for occupancy.

(5) Conduct tests during course of construction when identifiable portion(s) of installation is complete.

(a) Alternatively, testing may be conducted after entire installation is complete, where doing so does not delay project schedule.

(6) Coordinate testing of work under this Division connected to or integrated with work under other sections with contractors of other trade(s) involved.

(7) Owner and/or Architect / Engineer may, at their option, be in attendance to witness testing. Submit proposed schedule for acceptance testing to Owner and Engineer minimum of ten (10) working days in advance to facilitate their participation.

(8) Provide equipment and personnel to conduct acceptance tests.

(9) Work shall be 100% fault free, unless otherwise noted. Where systems, equipment, devices, cable, etc. fail to meet required performance on criteria under test, replace or repair defective work and/or materials at no additional cost to Owner and repeat inspection and test. Replacement materials shall be new.

B. Testing Cable

(1) Test installed cable in accordance with applicable standards and cable manufacturer's and equipment manufacturer's published requirements, guidelines, and best practices.

(2) At minimum, testing of installed cable shall include:

(a) Test for opens on each conductor

(b) Test for conductor to conductor shorts, among all conductors

(c) Test for conductor to ground shorts, for each conductor (where applicable)

(d) Test for compliance with applicable cable performance standards (e.g., , Category 6, Category 6A, OS2, , etc.)

1) Refer to Section 27 1000 for additional information on and requirements for testing structured cabling.

(e) Tests recommended by manufacturer of associated equipment or devices.

C. Testing Devices

(1) Verify proper operation of each feature and function of each device.

(2) Verify that each device has been configured and programmed in accordance with requirements of Contract Documents and Owner's direction.

D. Test Documentation

(1) Document and certify test results in writing.

(2) Maintain copies of certified test results, including those for failed tests, at project site through completion of project.

E. Re-Testing

(1) Architect / Engineer or Owner may, at their option, request that random 10% re-test be conducted by this Contractor at no additional cost to Owner to verify documented findings. Re-testing conducted shall be an exact repeat of those conducted and documented previously.

(2) Owner may, at their option, also perform independent re-testing to verify documented findings.

(3) If re-test findings contradict previous test documentation submitted by Contractor, additional re-testing shall be performed by this Contractor at no additional cost to Owner. Extent of such additional re-testing, including 100% re-test, shall be determined solely by Architect / Engineer and Owner.

F. After successful completion of Contractor's testing, Contractor shall also facilitate and participate in functional performance testing that is separate and unique from Contractor's testing. Refer to functional performance testing specifications for additional information and requirements.

3.11 START-UP

A. Systems and equipment shall be started, adjusted, tested, etc. and turned over to Owner ready for operation.

(1) This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Provide services of manufacturer-trained and -certified technician who is knowledgeable in start-up, adjustment, and checkout of systems and equipment provided and is experienced with specific materials provided.

(1) Where Contractor does not employ such technician directly on their own staff, Contractor shall provide at no additional cost to Owner such services from manufacturer's personnel.

C. Where specified, provide at no additional cost to Owner, services of manufacturer's personnel for start-up, adjustment, and checkout of systems and equipment provided.

D. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting, and adjustment procedures.

E. Coordinate start-up with Owner and other trades.

3.12 DOCUMENTATION

A. Upon completion of installation, Contractor shall provide System Documentation. Documentation shall include:

(1) Acceptance Test Results

(2) Record Drawings

(3) Approved Submittals

(4) Manufacturer's Warranty Documents

B. Submit System Documentation in accordance with Division 01 "Project Record Documents".

(1) Documents shall be submitted in same electronic format in which they were received from Architect / Engineer.

(2) Document updates shall be performed in native software format matching original design team documents.

(a) Scans of hand marked documents shall not be allowed.

(3) Update documents to reflect installed conditions for equipment shown on documents.

C. Submit documentation within ten (10) working days of completion of testing of each testing phase (e.g. subsystem, cable type, area, floor, etc.) or 3 weeks prior to scheduled occupancy of subject area, whichever is sooner. This is inclusive of Test Result and draft Record Drawings.

(1) Draft drawings may include mark-ups done by hand.

(2) Machine generated (final) copies of Record Drawings shall be submitted within 30 working days of completion of each testing phase.

(3) Documentation will include all aspects of systems covered by these specifications that are required for systems to be fully functional.

(a) For structured cabling this includes horizontal link from TO to HC, backbone cabling from HC to MC, cross-connections, interconnections and/or patch cords that are responsibility of contractor.

D. Submit Acceptance Test Results in electronic form for review and distribution.

(1) Interim documentation of Test Results (if applicable) may be submitted via email or on CD-ROM.

(2) Final documentation of Test Results shall be submitted on CD-ROM.

(3) Test results shall be submitted in format(s) native to test instrument(s) used in performing testing.

(4) Where unique software (other than an MS-Wordf compatible Word Processor or MS-Excelf spreadsheet) is required for viewing of test results, Contractor shall provide along with above documentation, one licensed copy of such software. Software shall run on MICROSOFT Windows-based personal computer.

E. Acceptance Test results shall include description of sub-system tested, equipment/cable/outlet I.D., reference and test setup, test equipment type/model and serial number(s), equipment location and direction of test (if applicable), test frequencies/wavelengths, date, and operator name(s).

F. Engineer or Owner may request that 10% random re-test be conducted on cable system - at no additional cost - to verify documented findings. Tests shall be repeat of those defined above and in technical sections.

(1) Owner may also perform independent testing to verify results.

(2) If findings contradict documentation submitted by Contractor, additional testing can be requested to extent determined necessary by Engineer or Owner, including 100% re-test. This re-test shall be at no additional cost to Owner.

G. Documentation - including hard copy and electronic forms of Test Data and Record Drawings - shall become property of Owner.

H. Refer also to Technical Sections for requirements specific to covered subsystems.

3.13 CLEANING

A. Refer to Division 01 for additional information and requirements.

B. Refer to individual technical sections for additional information and requirements specific to work under that section.

C. Contractor shall, periodically, throughout execution of work under this section and/or as directed by Architect / Engineer, Owner, Construction Manager, or General Contractor, remove waste materials, trash, rubbish, debris, etc. generated by execution of work under this section from building and leave work areas broom clean.

(1) Construction waste shall be managed in accordance with provisions of Division 01 Section Construction Waste Management.

D. Prior to installation of active electronics, Electronic Safety and Security spaces must be cleaned to an ISO 14644-1 Class 8 standard.

E. After installation is complete and prior to Owner’s final acceptance, Contractor shall clean work provided under this section.

(1) Remove unused materials, tools, installation equipment, etc. from site.

(2) Faceplates, devices, components, equipment, enclosures, junction boxes, pull boxes, etc. shall be clean and free of stains, dust, dirt, debris, oil, grease, paint, and other foreign material.

(3) Interiors of equipment enclosures, junction boxes, pull boxes, etc. shall be clean and free of wire/cable scraps, pieces of wire/cable insulation, stains, dust, dirt, debris, oil, grease, paint, and other foreign material.

(4) Remove temporary labels not used for instruction or operation.

(5) Walls and floors of Electronic Safety and Security spaces and equipment rooms shall be clean and free of dust, dirt, debris, oil, grease, paint, and other foreign material.

(6) Remove and properly dispose of waste materials, trash, rubbish, debris, etc. generated by execution of work under this section.

(7) Contractor’s cleaning protocol shall not damage provided materials or invalidate manufacturer’s warranty on provided materials.

(a) Contractor’s cleaning protocol shall only include methods and use of solvents, chemicals, compounds, and agents approved by material manufacturer for use on their product.

END OF SECTION 28 00 00

SECTION 28 10 00 - ELECTRONIC ACCESS CONTROL

PART 1 GENERAL

1.01 SCOPE

A. This section includes product and execution requirements for Electronic Access Control. Unless noted otherwise, work under this section is subject to requirements of Section 28 0000.

1.02 DESCRIPTION

A. Provide a fully operational and functional Electronic Access Control system to be compliant with applicable codes and standards referenced herein and as indicated on drawings.

B. The Electronic Access Control system shall include the following major components:

(1) Intelligent System Controllers
(2) Credential Reader Interface Modules
(3) Input Control Modules
(4) Output Control Modules
(5) Electronic Access Control Panel Enclosures
(6) Electronic Access Control Panel Power Supplies
(7) Electrified Door Locking Hardware Power Supplies
(8) Credential Readers
(9) Credentials
(10) Electrified Door Locking Hardware
(11) Latch Bolt Monitors
(12) Door Position Monitors
(13) Request to Exit Devices
(14) Integrated Locksets
(15) Remote Door Release Buttons
(16) Electronic Access Control Cable
(17) Integration to the University Security Management System (SMS).

C. Electronic Access Control system shall be provided by Owner's incumbent vendor, Triple S, under subcontract to Contractor.

(1) Triple S Alarm Company
(a) Christian Talmage
(b) 2820 Cantrel Rd. little Rock AR 72202
(c) 501.664.4599
(d) Email: ctallmage@triplesinc.onmicrosoft.com

1.03 RELATED WORK

A. Related Division 28 Sections include:

(1) Section 28 1000 - General Electronic Safety and Security Requirements
(2) Section 28 1300 – Video Surveillance System

1.04 REQUIREMENTS OF REGULATORY AGENCIES

A. In addition to requirements listed in Section 28 0000:

(1) Contractor is solely responsible for securing Work Permit for Electronic Access Control prior to the commencement of work on site.
(a) Contractor shall prepare and submit Work Permit application submittal documents and forms.
(b) Contractor shall include in their bid costs, charges, fees, taxes, etc. associated with securing Work Permit.

1.05 REFERENCES AND STANDARDS

(a) The Work under this Section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.
(b) Refer to Section 28 00 00 - General Electronic Safety and Security Requirements which identifies References and Standards applicable to all Division 28 work. Other applicable standards are as follows:
1) UL 294 - Access Control System Units.
2) UL 1076 - Proprietary Burglar Alarm Units and Systems.
3) FCC Rules and Regulations Part 15, Radio Frequency Devices

1.06 DEFINITIONS

A. Refer to Section 28 0000 for additional information and requirements.

1.07 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 28 0000 for additional information and requirements.

1.08 LISTING

A. Refer to Section 28 0000 for additional information and requirements.

1.09 SUBMITTALS

A. In addition to requirements listed in Section 28 0000, Submittals shall also include the following:

(1) Shop Drawings:

(a) Submit Contractor-prepared Electronic Access Control Schedule that documents for each controlled and/or monitored portal each Electronic Access Control device, connection, function, and integration listed in Division 08 Door Schedule and Division 08 Door Hardware Group, specified herein and on drawings, and per Contractor coordination with Owner, to include:

1) Door Number
2) Room Name
3) Plan Reference
4) Door Hardware Group
5) Electronic Access Control devices and connections
6) Functionality Features:
7) Integrations

(2) Certificates and Inspections

(a) Refer to Section 28 0000 for additional information and requirements.

(3) Operation and Maintenance Manuals

(a) Refer to Section 28 0000 for additional information and requirements.

(4) Record Documents

(a) Refer to Section 28 0000 for additional information and requirements.

1.10 JOB CONDITIONS

A. Refer to Section 28 0000 for additional information and requirements.

1.11 WORK BY OWNER

A. In addition to items listed in Section 28 0000, Owner will also provide:

(1) Existing Electronic Access Control system Server(s) and server Application Software
(2) Existing Electronic Access Control system Workstation(s) and workstation Application Software

1.12 QUALITY ASSURANCE

A. Refer to Section 28 0000 for additional information and requirements.

1.13 GUARANTEE

A. Refer to Section 28 0000 for additional information and requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Refer to Section 28 0000 for additional information and requirements.

B. Unless noted otherwise, the following equipment and devices shall be the products of a single manufacturer and designed, manufactured, marketed, sold, and supported as an integrated system:

(1) Electronic Access Control System Application Software
(2) Intelligent System Controller
(3) Credential Reader Interface Modules
(4) Input Control Modules
(5) Output Control Modules
(6) Electronic Access Control Panel Enclosure
(7) Electronic Access Control Panel Power Supply
(8) Credential Readers
(9) Credentials

2.02 ELECTRONIC ACCESS CONTROL SYSTEM APPLICATION SOFTWARE

A. Basis of Design:

(1) Expansion of the existing University of Arkansas Security Management System (SMS) as required to provide adequate software and or licensing to include this new building.

B. Acceptable Alternates:

(1) AMAG Symmetry

2.03 ELECTRONIC ACCESS CONTROL SYSTEM SERVER HARDWARE

A. Server Hardware

(a) Provide adequate server hardware for the expansion of the existing SMS system to include required licensing and increased storage capacity.

2.04 ELECTRONIC ACCESS CONTROL SYSTEM WORKSTATION HARDWARE

A. Provide new workstation if required for this project

2.05 ELECTRONIC ACCESS CONTROL SYSTEM BADGING STATION HARDWARE

A. Provide system badging station hardware if required for this project.

2.06 INTELLIGENT SYSTEM CONTROLLERS

A. Components specified by Security Contractor.

B. Device quantities per Security contract documents.

2.07 CREDENTIAL READER INTERFACE MODULES

A. Components specified by Security Contractor.

B. Provide device quantities per Security contract documents.

2.08 INPUT CONTROL MODULES

A. Components specified by Security Contractor.

B. Provide device quantities per Security contract documents.

2.09 OUTPUT CONTROL MODULES

A. Components specified by Security Contractor.

B. Provide device quantities per Security contract documents.

2.10 ELECTRONIC ACCESS CONTROL PANEL ENCLOSURES

A. Components specified by Security Contractor.

B. Provide device quantities per Security contract documents.

2.11 ELECTRONIC ACCESS CONTROL PANEL POWER SUPPLIES

A. Components specified by Security Contractor.

B. Provide device quantities per contract documents.

2.12 ELECTRIFIED DOOR LOCKING HARDWARE POWER SUPPLIES

A. Where specified in Division 08 as part of Division 08 scope:

(1) Provided by Division 08. Refer to Division 08 for additional information and requirements.

B. Where not specified in Division 08 as part of Division 08 scope:

(1) Components specified by Security Contractor.

(2) Device quantities per Security contract documents.

2.13 DIGITAL ALARM COMMUNICATION TRANSMITTER

(1) Components specified by Security Contractor.

(2) Provide device quantities per Security contract documents.

2.14 CREDENTIAL READERS

A. Components specified by Security Contractor.

B. Credential Reader quantities as shown on Technology Contract Documents.

2.15 CREDENTIALS

A. s Provide credential types and quantities per Security Contract Documents and Owner requirements

2.16 ELECTRIFIED DOOR LOCKING HARDWARE

A. Provided by Division 08. Refer to Division 08 for additional information and requirements.

2.17 LATCH BOLT MONITORS

A. Provided by Division 08. Refer to Division 08 for additional information and requirements.

2.18 DOOR POSITION MONITORS

A. Provided by Division 08. Refer to Division 08 for additional information and requirements.

2.19 REQUEST TO EXIT DEVICES

A. Request to Exit Switch integral to Electrified Door Locking Hardware

(1) Provided by Division 08. Refer to Division 08 for additional information and requirements.

2.20 INTEGRATED LOCKSETS

A. Electrified door-leaf-mounted locksets that integrate Credential Reader(s), Electrified Door Locking Hardware, Latch Bolt Monitor(s), Door Position Monitor(s), and/or Request-to-Exit Device(s) in to lockset hardware.

B. Specified and provided by Division 08. Refer to Division 08 for additional information and requirements.

2.21 DURESS / PANIC BUTTONS

A. Components specified by Security contractor.

B. Provide device quantities per Security contractor contract documents

2.22 ELECTRONIC ACCESS CONTROL CABLE

A. General

(1) Refer to manufacturer's published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer's published product installation instructions, the more stringent requirement shall govern.

(2) Cable shall be plenum or riser rated as dictated by the environment in which the cable is installed. Refer to Mechanical drawings for additional information and requirements.

(3) Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.

B. Provide appropriate Access Control cable as specified by Security Contractor.

2.23 ELECTRONIC ACCESS CONTROL RACEWAYS AND BOXES

A. Refer to Section 26 0533 for additional information and requirements.

B. Device Back Boxes:

(1) Wall Mounted Devices:

(a) Dimensions: Minimum 4" square, 2-1/8" deep

(b) Plaster Ring: Single gang

(2) Door Frame Mounted Devices

(a) Dimensions: Minimum 4" x 2", 1-1/4" deep

C. Conduit:

(1) Wall Mounted Devices:

(a) Minimum 1" trade size.

(2) Door Frame Mounted Devices:

(a) Minimum 1/2" trade size.

(3) No flexible conduit of any type.

(4) No conduit bodies or conduit outlet bodies of any type.

2.24 ELECTRONIC ACCESS CONTROL SURFACE RACEWAYS

A. Refer to 26 0533 for additional information and requirements.

B. Size device back box per applicable code, in accordance with device manufacturer's recommendations, and to match form factor of device.

C. Minimum raceway capacity equivalent to 1" trade size conduit.

2.25 CREDENTIAL READER PEDESTAL WITH ENCLOSURE

A. Specified and provided by Security contractor

PART 3 EXECUTION

3.01 PRE-CONSTRUCTION COORDINATION MEETING

A. Prior to preparing and submitting shop drawings, Contractor shall arrange and conduct pre-construction coordination meeting to review and coordinate Electronic Access Control installation requirements.

(1) Attendees shall include: TBD per Owner's request.

3.02 CONFIGURATION AND PROGRAMMING COORDINATION MEETING

A. After Section 28 1000 shop drawings have been approved, Contractor shall arrange and conduct a configuration and programming coordination meeting to review and coordinate aspects of Electronic Access Control device and equipment configuration and programming.

(1) At a minimum, attendees shall include: TBD per Owner's request.

3.03 GENERAL

A. Refer to Section 28 0000 for additional information and requirements.

3.04 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 28 0000 for additional information and requirements.

3.05 LOCATIONS OF WORK

A. Refer to Section 28 0000 for additional information and requirements.

3.06 FLOOR, WALL, CEILING, AND ROOF OPENINGS

A. Refer to Section 28 0000 for additional information and requirements.

3.07 EQUIPMENT ACCESS

A. Refer to Section 28 0000 for additional information and requirements.

3.08 EQUIPMENT SUPPORTS

A. Refer to Section 28 0000 for additional information and requirements.

3.09 SUPPORT PROTECTION

A. Refer to Section 28 0000 for additional information and requirements.

3.10 CABLE AND CONDUCTOR PROTECTION

A. Refer to Section 28 0000 for additional information and requirements.

3.11 HOUSEKEEPING PADS

A. Refer to Section 28 0000 for additional information and requirements.

3.12 INSTALLATION

A. Refer to Section 28 0000 for additional information and requirements.

B. General

(1) Integrate new work under this project into Owner's existing system.

(2) Install security devices per Security Contract Documents

C. Configuration and Programming

(1) Coordinate each aspect of configuration and programming with Owner.

(2) Coordinate IP address and other Ethernet networking requirements with Owner a minimum of six weeks prior to commencement of programming work.

3.13 INSPECTION AND TESTING

A. Refer to Section 28 0000 for additional information and requirements.

B. Demonstration

(1) After successful completion of testing and prior to final acceptance, demonstrate each facet of operation of each controlled and/or monitored portal, each controlled and/or monitored device, and each point of integration with equipment and/or devices of other building systems and/or equipment on site with Owner for Owner's approval. Where deficiencies are observed, repair or replace deficient work and/or materials at no additional cost to Owner and repeat demonstration until Owner approves work and/or materials.

(2) Coordinate demonstration schedule to align with overall project schedule and accommodate attendees' schedules.

(3) Coordinate attendance and participation in demonstration by at least one representative of Owner, Division 08 Contractor, and each trade whose work is controlled and/or monitored by or integrated with Electronic Access Control.

(4) Document results of each facet of demonstration, including observed deficiencies, remediation, and re-demonstration results.

C. Verification Follow-Up Visits

(1) Contractor shall include in their bid a minimum of two (2) unique visits to the site to review operation of each controlled and/or monitored portal and system device on site with Owner.

(2) Schedule of Visits:

(a) The first of these visits will occur within six (6) months of substantial completion, or at Owner's request, whichever comes first.

(b) The second of these visits will occur within twelve (12) months of substantial completion, or at Owner's request, whichever comes first.

(c) Contractor shall tentatively coordinate scheduling for both visits upon substantial completion of work on site, but before final acceptance of the project.

(3) At a minimum, Contractor shall provide for an average of fifteen (15) minutes per controlled and/or monitored portal or system device installed under this project or a total of eight (8) hours on site for each visit, whichever is longer.

(4) After each visit, Contractor shall prepare a report detailing observation of operation at each controlled and/or monitored portal or system device, discussion about each controlled and/or monitored portal or system device with Owner, and adjustments made.

(5) Contractor's bid shall include all labor costs associated with visits, to include:

(a) Off-site pre-preparation time

(b) On-site time

(c) Travel time

(d) Off-site report preparation time

3.14 START-UP

A. Refer to Section 28 0000 for additional information and requirements.

3.15 DOCUMENTATION

A. Refer to Section 28 0000 for additional information and requirements.

3.16 CLEANING

A. Refer to Section 28 0000 for additional information and requirements.

3.17 ATTIC STOCK

A. Provide attic stock per manufacturers and Owner recommendations.

3.18 TRAINING

A. Refer to Section 28 0000 for additional information and requirements.

B. Contractor shall provide to Owner's designated representative(s) a minimum of one 1-hour on-site training session related to work under this section within time frame TBD days of substantial completion.

END OF SECTION 28 10 00

SECTION 28 20 00 - VIDEO SURVEILLANCE

PART 1 GENERAL

1.01 SCOPE

A. This section includes product and execution requirements for Video Surveillance. Unless noted otherwise, work under this section is subject to requirements of Section 28 0000.

1.02 DESCRIPTION

A. Expand the existing Video Surveillance system to be compliant with applicable codes and standards referenced herein and as indicated on drawings.

B. The Video Surveillance system shall include the following major components:

(1) Video Surveillance Cameras
(2) Media Converters
(3) Surge Suppressors
(4) Video Surveillance Cable

C. Video Surveillance shall be provided by Owner's incumbent vendor, Triple S Security Co. under subcontract to Contractor.

(1) Triple S Security Company
(a) Contact: Christian Tallmage
(b) Street Address: 2820 Cantrell Road, Little Rock AR 72202
(c) Telephone: 501.664.4599
(d) Email: Email: ctallmage@triplesinc.onmicrosoft.com

1.03 RELATED WORK

A. Related division 28 sections include:

(1) Section 28 1000 - General Electronic Safety and Security Requirements
(2) Section 28 1300 – Electronic Safety and Security

1.04 REQUIREMENTS OF REGULATORY AGENCIES

A. Refer to Section 28 0000 for additional information and requirements.

1.05 REFERENCES AND STANDARDS

A. Refer to Section 28 0000 for additional information and requirements.

1.06 DEFINITIONS

A. Refer to Section 28 0000 for additional information and requirements.

1.07 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 28 0000 for additional information and requirements.

1.08 LISTING

A. Refer to Section 28 0000 for additional information and requirements.

1.09 SUBMITTALS

A. In addition to requirements listed in Section 28 0000, Submittals shall also include the following:

(1) Shop Drawings:
(a) Refer to Section 28 0000 for additional information and requirements.
(b) Submit a Video Surveillance Camera Schedule that includes for each camera information in Video Surveillance Camera Schedule on drawings, plus the following:
1) Unique alphanumeric identifier
2) Name and Architectural number of room in which camera is located
3) Number of plan on which camera is shown
4) Telecom room in which camera's cabling terminates and connects to Ethernet network
5) Camera type
6) Camera IP address
7) Camera subnet mask
8) Required PoE power, in watts
9) Intended field of view
10) Recorded resolution, in pixels

11) Recorded frame rate, in frames per second
12) Whether camera video will be recorded continuously or on motion or other video analytics or integration trigger
    1. Where recorded on motion, list anticipated percentage of time video will be recorded over the course of an average day
    2. Where recorded on trigger, list the video analytics or integration trigger type and anticipated percentage of time video will be recorded over the course of an average day
13) Compression standard used for camera video
14) Minimum duration of video retention, in days
15) Integrations implemented involving camera
16) Video analytics implemented for camera video
17) Functionality required for camera, including:
    1. Partial view masking
    2. Audio recorded with video
    3. Audio output at camera

(c) Calculations based on Application Software manufacturer's recommendations documenting Contractor-proposed total system storage capacity provides specified minimum video retention duration.

(2) Certificates and Inspections
(a) Refer to Section 28 0000 for additional information and requirements.

(3) Operation and Maintenance Manuals
(a) Refer to Section 28 0000 for additional information and requirements.
(b) Provide a still image from each installed video surveillance camera:
1) Obtained at full resolution at the time of final acceptance
2) Scaled to and printed on a standard 8-1/2" x 11" sheet, one image per sheet
3) Marked with text indicating camera's unique alphanumeric identifier and network address

(4) Record Documents
(a) Refer to Section 28 0000 for additional information and requirements.
(b) For each video surveillance camera, indicate the following:
1) Installed location of camera
2) Direction camera is aimed
3) Camera's field of view
    1. Indicate with isosceles triangle, with apex at camera and base at vertical plane to which camera is focused. Length of triangle base shall match horizontal width of field of view to which camera is focused.

1.10 JOB CONDITIONS

A. Refer to Section 28 0000 for additional information and requirements.

1.11 WORK BY OWNER

A. In addition to items listed in Section 28 0000, Owner will also provide:
(1) Existing Video Surveillance system Server(s) and Application Software
(2) Existing Video Surveillance system Network Storage Appliance(s)
(3) Existing Video Surveillance system Workstation(s) and Application Software

1.12 QUALITY ASSURANCE

A. Refer to Section 28 0000 for additional information and requirements.

1.13 GUARANTEE

A. Refer to Section 28 0000 for additional information and requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Refer to Section 28 0000 for additional information and requirements.

B. Unless noted otherwise, the following equipment and devices shall be the products of a single manufacturer and designed, manufactured, marketed, sold, and supported as an integrated system:
(1) Video Surveillance Cameras

2.02 VIDEO SURVEILLANCE SYSTEM APPLICATION SOFTWARE

A. Basis of Design

(1) Expansion of the existing University of Arkansas Security Management System (SMS) as required to provide adequate software and or licensing to include this new building.

2.03 VIDEO SURVEILLANCE SYSTEM SERVER HARDWARE

A. Server Hardware

(1) Provide adequate server hardware for the expansion of the existing SMS system to include required licensing and increased storage capacity.

2.04 VIDEO SURVEILLANCE SYSTEM NETWORK STORAGE APPLIANCE(S)

A. Network Storage Appliance(s):

(1) Provide adequate server hardware for the expansion of the existing SMS system to include required licensing and increased storage capacity.

2.05 VIDEO SURVEILLANCE SYSTEM WORKSTATION HARDWARE

A. Workstation Hardware

(1) Provide as required for system expansion.

2.06 VIDEO SURVEILLANCE CAMERAS

A. Cameras specified by Security Contractor

B. Camera quantities as shown on Technology Contact Documents

2.07 MEDIA CONVERTERS

A. Specified by Security Contractor

2.08 VIDEO SURVEILLANCE CABLE

A. General

(1) Refer to manufacturer's published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer's published product installation instructions, the more stringent requirement shall govern.

(2) Cable shall be plenum or riser rated as dictated by the environment in which the cable is installed.

(a) Refer to Mechanical drawings for additional information and requirements.

(3) Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.

(a) Provide (1) category 6A cable at each camera location. Refer to Contract Drawings

2.09 VIDEO SURVEILLANCE RACEWAYS AND BOXES

A. Refer to Section 26 0533 for additional information and requirements.

B. Device Back Boxes:

(1) Dimensions: Minimum 4" square, 2-1/8" deep

(2) Plaster Ring Size: Refer to device manufacturer's product data and installation instructions

C. Conduit:

(1) Minimum 1" trade size.

(2) No flexible conduit of any type.

(3) No conduit bodies or conduit outlet bodies of any type.

2.10 VIDEO SURVEILLANCE SURFACE RACEWAYS

A. Refer to 26 0533 for additional information and requirements.

B. Size device back box per applicable code, in accordance with device manufacturer's recommendations, and to match form factor of device.

C. Minimum raceway capacity equivalent to 1" trade size conduit.

PART 3 EXECUTION

3.01 CONFIGURATION AND PROGRAMMING COORDINATION MEETING

A. After Section 28 2000 shop drawings have been approved, Contractor shall arrange and conduct a configuration and programming coordination meeting to review and coordinate each of Video Surveillance device and equipment configuration and programming.

(1) At a minimum, attendees shall include: TBD Owner's request

3.02 GENERAL

A. Refer to Section 28 0000 for additional information and requirements.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 28 0000 for additional information and requirements.

3.04 LOCATIONS OF WORK

A. Refer to Section 28 0000 for additional information and requirements.

3.05 FLOOR, WALL, CEILING, AND ROOF OPENINGS

A. Refer to Section 28 0000 for additional information and requirements.

3.06 EQUIPMENT ACCESS

A. Refer to Section 28 0000 for additional information and requirements.

3.07 EQUIPMENT SUPPORTS

A. Refer to Section 28 0000 for additional information and requirements.

3.08 SUPPORT PROTECTION

A. Refer to Section 28 0000 for additional information and requirements.

3.09 CABLE AND CONDUCTOR PROTECTION

A. Refer to Section 28 0000 for additional information and requirements.

3.10 HOUSEKEEPING PADS

A. Refer to Section 28 0000 for additional information and requirements.

3.11 INSTALLATION

A. Refer to Section 28 0000 for additional information and requirements.

B. General

(1) Integrate new work under this project into Owner's existing system.

C. Video Surveillance Cameras

(1) Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.

(2) Coordinate locations with Owner and Division 26 Contractor prior to the commencement of work on site.

(3) Camera Mounting:

(a) Cameras and mounting accessories shall be rigidly attached to back boxes rigidly attached to structural members.

(b) Cameras installed in accessible ceiling tiles:

1) Shall be supported by a tile bridge or other approved means

2) Shall not be supported by the ceiling tile

3) Shall be equipped with a safety cable secured to camera housing and structural member above

(c) Mount exterior cameras with stainless steel fasteners.

(4) Provide media conversion for cameras whose cabling exceeds maximum allowable length per applicable standards.

(5) Provide surge suppressors for exterior cameras, including exterior cameras connected via media converters.

(a) Surge suppression not required for cameras mounted directly to side of building at least one story below roof line at exterior wall

(6) Cable, terminate, configure, program, test, adjust, and make completely ready for use.

(7) Field-coordinate field of view, aim, and focus with Owner prior to commencement of final testing.

(a) Prior to final testing, Contractor shall, at no cost to Owner, make minor adjustments to camera locations and placement to address unanticipated obstructions to the field of view and/or unanticipated spatial interference.

1) For the purposes of these adjustments, "minor" is defined as adjustments requiring relocation of up to six (6) feet from the location coordinated with the Owner during the Configuration and Programming Coordination Meeting.

(8) Where camera is mounted to a pole, column, or out-building, provide surge suppressor at point where cable enters building as specified above and at camera.

(9) Properly ground surge suppressors per applicable code and manufacturer's instructions. Refer to Section 27 0526 for additional information and requirements.

(10) Note locations of surge suppressors on As-Built Drawings and Record Drawings.

D. Video Surveillance Cable

(1) Provide 25-foot service loop in video surveillance camera cables.

(a) Locate service loop at first J-hook where device conduit terminates.

(b) Coil service loop in figure 8 configuration with minimum bend radius compliant with manufacturer's recommendations and applicable standards, and store neatly.

(c) Provide shorter service loop where necessary to ensure total installed cable length does not exceed 295 feet (8991.6 cm).

(2) Install in conduit from device location to [cable tray below nearest accessible floor or above nearest accessible ceiling.

(3) Install in pathways provided, or as designated on floor plans, and support from building structure.

(a) Where installed in free-air, support cables using J-hook type cable supports. Refer to Section 27 0528.29 - Hangers and Supports for Communications Systems for installation requirements.

1) J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.

2) Route cable/hooks at right angles, parallel to construction.

(b) Where installed in Cable Tray, lay cables neatly in tray.

1) Do not tie.

2) Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.

(4) Terminate video surveillance camera cables with jack, no faceplate, in camera back box.

(5) Identification:

(a) Label system device cabling with unique alphanumeric identifiers that include:

(b) Video surveillance camera location:

1) UARK labeling and identifications standards.

(c) Refer to Section 27 0553 for additional information and requirements.

E. Video Surveillance Raceways and Boxes

(1) Refer to Section 280000 for additional information and requirements.

(2) Conduits:

(a) At Contractor's option, Video Surveillance conduit home runs from system devices to Security Equipment Rooms may be consolidated in to larger conduits.

1) Where conduit home runs are consolidated, size larger conduits to provide conduit capacity equal to or greater than cumulative capacity of the smaller conduits being combined.

2) Prior to the commencement of work on site, prepare and submit for review shop drawings documenting proposed conduit consolidation, including proposed conduit sizing, junction boxes, and conduit routes coordinated with work by other trades.

3) Prior to rough-in, field-coordinate final routing of larger conduits on site with work by other trades.

F. Video Surveillance Surface Raceways

(1) Refer to 280000 for additional information and requirements.

G. Configuration and Programming

(1) Coordinate each aspect of configuration and programming with Owner.

(2) Coordinate IP address and other Ethernet networking requirements with Owner a minimum of six weeks prior to commencement of programming work.

3.12 INSPECTION AND TESTING

A. Refer to Section 28 0000 for additional information and requirements.

B. Demonstration

(1) After successful completion of testing and prior to final acceptance, demonstrate field of view, aim, focus, and each facet of operation of each video surveillance camera and each point of integration with equipment and/or devices of other building systems and/or equipment on site with Owner for Owner's approval. Where deficiencies are observed, repair or replace deficient work and/or materials at no additional cost to Owner and repeat demonstration until Owner approves work and/or materials.

(2) Coordinate demonstration schedule to align with overall project schedule and accommodate attendees' schedules.

(3) Coordinate attendance and participation in demonstration by at least one representative of Owner and each trade whose work is integrated with Video Surveillance.

(4) Document results of each facet of demonstration, including observed deficiencies, remediation, and re-demonstration results.

C. Verification Follow-Up Visits

(1) Contractor shall include in their bid a minimum of two (2) unique visits to the site to review and adjust field of view, aim, and focus of each video surveillance camera with Owner.

(2) Schedule of Visits:

(a) The first of these visits will occur within six (6) months of substantial completion, or at Owner's request, whichever comes first.

(b) The second of these visits will occur within twelve (12) months of substantial completion, or at Owner's request, whichever comes first.

(c) Contractor shall tentatively coordinate scheduling for both visits upon substantial completion of work on site, but before final acceptance of the project.

(3) At a minimum, Contractor shall provide for an average of twenty (20) minutes per video surveillance camera installed under this project or a total of eight (8) hours on site for each visit, whichever is longer.

(4) After each visit, Contractor shall prepare a report detailing observation of each camera's operation, discussion about each camera with Owner, and adjustments made.

(5) Contractor's bid shall include all labor costs associated with visits, to include:

(a) Off-site pre-preparation time

(b) On-site time

(c) Travel time

(d) Off-site report preparation time

3.13 START-UP

A. Refer to Section 28 0000 for additional information and requirements.

3.14 DOCUMENTATION

A. Refer to Section 28 0000 for additional information and requirements.

3.15 CLEANING

A. Refer to Section 28 0000 for additional information and requirements.

3.16 ATTIC STOCK

A. Provide attic stock per manufacturers and Owner's recommendations.

3.17 TRAINING

A. Refer to Section 28 0000 for additional information and requirements.

B. Contractor shall provide to Owner's designated representative(s) a minimum of one 4-hour on-site training session related to work under this section within time frame: TBD of days of substantial completion.

END OF SECTION 28 20 00

SECTION 28 46 10 - ADDRESSABLE FIRE DETECTION AND ALARM SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 14 2400 - Hydraulic Elevators

B. Section 21 13 14 - Automatic Fire Sprinkler System

C. Section 23 09 93 - Control Sequences

D. Section 26 00 00 - General Electrical Requirements

E. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

F. Section 26 05 26 - Grounding and Bonding for Electrical Systems

G. Section 26 05 33 - Raceway and Boxes for Electrical Systems

H. Section 26 05 53 - Electrical Systems Identification

1.02 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.03 DESCRIPTION

A. In general, work consists of:

(1) Furnish and install complete Multiplexed Fire Alarm System with one-way voice communication system as shown on plans and specified here-in.

(2) Engineer of Record:

(a) Contractor shall be Engineer of Record. Contractor shall produce stamped and sealed installation drawings, which are also referred to as shop drawings in this Section, based on design criteria listed in this Section and drawings furnished by Engineer. Contract drawings show intent of fire alarm systems as it relates to architecture, structure, and mechanical/electrical systems.

(3) System shall:

(a) Be an intelligent analog addressable system.

(b) Allow for loading and editing special instructions and operating sequences as required.

(c) Be capable of on-site programming to accommodate system expansion and facilitate changes in operation.

(d) Be wired, connected, and left in operating condition.

(e) Utilize independently addressable relay modules, control modules, monitor modules, audio amplifiers, and communications systems.

(f) Meet approval of applicable national, state, and local codes and AHJs.

(g) Be solid state, microprocessor based.

(h) Be UL listed for all intended uses.

(i) Be UL listed to UL 864. Be UL Listed for Releasing Service of fire suppression system devices.

(j) Be a Power Limited Fire Alarm system.

(k) Be UL listed UOJZ for complete system.

(l) Use addressable relay modules and monitor modules to interface with building automation system (BAS) for closing of smoke dampers upon reduction of air flow in duct work to velocities below detection level of duct detectors when fans are reduced in power or shut down.

(m) Use addressable input monitor modules to interface with fire pump(s) controller(s) for status monitoring.

(n) Use addressable output relay modules and addressable input monitor modules to interface with sprinkler system waterflow switches, valve supervisory switches, pressure switches, pre-action system control panels, aspirating smoke detection control panels, waterflow alarm indication devices.

(o) Use addressable output relay modules and addressable input monitor modules to interface with building security system door hardware devices at control panels and individual doors for control and releasing by fire alarm system.

(p) Use addressable output relay modules and addressable input monitor modules to interface with elevator equipment control panels for elevator recall functions.

(q) Interface with elevator equipment control panels for one-way voice communication system.

(4) System includes:

(a) Fire Alarm Control Panel(s)

(b) Remote Annunciator Panel(s)

(c) Multi-Channel audio, one-way voice communications system and controls

(d) Manual Stations
(e) Heat Detectors
(f) Smoke Detectors
(g) Duct Smoke Detector System
(h) Fire Pump Monitoring
(i) Sprinkler Valve Supervisory Monitoring
(j) Sprinkler System Waterflow Monitoring
(k) Notification Appliance Circuit Power Supplies and Batteries
(l) Transponder/Data Gathering/Remote Control Panels
(m) Relay Modules (Addressable Output Module Device)
(n) Control Modules (Addressable Output Module Device)
(o) Monitor Modules (Addressable Input Module Device)
(p) Audio Amplifiers for One-way Voice Communications System
(q) Visual Graphics Display Terminal(s)
(r) Alarm Notification Audible and/or Visual Devices
(s) Terminations and Labeling
(t) All necessary materials for complete operating systems
(u) Power supplies and batteries

(5) Software operations shall be stored in non-volatile programmable memory within fire alarm control panel. Loss of primary and secondary power shall not erase instructions stored in memory.

1.04 REFERENCE STANDARDS

A. IBC - International Building Code Year 2021
B. IFC - International Fire Code Year 2021
C. NECA 305 - Standard for Fire Alarm System Job Practices
D. NFPA 72 - National Fire Alarm and Signaling Code Year 2019
E. NFPA 70 - National Electrical Code, 2020
F. UL 268 - Smoke Detectors for Fire Protective Signaling Systems, Latest Edition
G. UL 497B - Protectors for Communications and Fire Alarm Circuits, Latest Edition
H. UL 521 - Heat Detectors for Fire Protective Signaling Systems, Latest Edition
I. UL 864 - Control Units for Fire Protective Signaling Systems, Latest Edition
J. UL 1480 - Speakers for Fire Protective Signaling Systems, Latest Edition
K. UL 1481 - Power Supplies for Fire Protective Signaling Systems, Latest Edition
L. UL 1711 - Amplifiers for Fire Protective Signaling Systems, Latest Edition

1.05 QUALIFICATIONS

A. Equipment shall be supplied by company specializing in fire alarm and smoke detection systems with 5 years documented experience.
B. Work shall be performed by licensed Contractor, regularly engaged in installation and servicing of fire alarm systems.
C. Contractor shall be located within 100 miles (160 km) of Project site.

1.06 DOCUMENT ACCESSIBILTY

A. Assemble the following documents to be stored in a document cabinet adjacent to the main fire alarm panel per NFPA 72 requirements:

(1) Record drawing/As-builts
(2) Fire alarm equipment technical data sheets
(3) Alternative means and methods, variances, appeals and approvals for this fire alarm system
(4) Any performance-based design documentation
(5) Risk analysis documentation
(6) Emergency response plan
(7) Evaluation documentation
(8) Software and firmware control documentation
(9) Emergency communication system documentation

1.07 SUBMITTALS

A. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA72.

B. Shop Drawings shall be prepared by persons with the following qualifications:

(1) Trained and certified by manufacturer in fire alarm design.

(2) NICET-certified fire-alarm technician, Level IV minimum .

C. All submitted drawings shall be created using computer drafting software, and shall be coordinated so that terminal numbering, circuit designation and equipment or device designations are the same on all drawings. All drawings must be submitted and approved by the engineer before ordering or fabrication starts. Approval will not waive any specification requirements unless specifically stated.

D. Submittals shall be organized as follows. (Electronic submittals shall utilize bookmarks instead of tabs.)

(1) Cover Sheet indicating name of project, name of supplier, name of installer and date of submittal preparation.

(2) The Table of Contents shall appear immediately behind the Cover Sheet, and shall contain a complete listing of all the tabs contained within the binder/booklet.

(3) Tabbed index sheets shall be inserted into each of the binders, such that each binder is clearly sub-divided into sections. _

(a) Tabbed sections shall be provided, at minimum, for the following, one section per building:

1) One section for manufacturer’s data sheets – divided into sub-sections for the following:

1. Panel Equipment (Panels, Panel Components/Modules, Printers, Annunciators, etc.)
2. Addressable Field Devices (Initiating and Relay/Control/Monitoring/Isolation)
3. Non-Addressable Field Devices (Initiating Devices, Relays, etc.)
4. Notification Appliances

E. The Contractor shall purchase no equipment for the system specified herein until the Owner has approved the project submittals in their entirety and has returned them to the Contractor It is the responsibility of the Contractor to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the Contractor to proceed with the installation and shall not be construed to mean that the Contractor has satisfied the requirements of these specifications.

F. Submit the following to Engineer for review prior to ordering any equipment and prior to submittal to AHJ:

(1) Prepare submittals per IBC, NFPA 72, fire alarm submittal requirements.

(2) A complete equipment list of all components, including the following: Quantity, Manufacturer, Part Number, and Description. If the supplier uses different part numbers from those of the actual manufacturer, the actual manufacturer and part numbers as they appear – marked on the shipping box/packages, shall also be identified on this list.

(a) Each equipment List shall include a complete listing of the modules, components, and software included for each modular Fire Alarm Control Panel, Network Panel, Transponder Panel, Data Gathering Panel, Remote Panel or Annunciator. Such items shall be listed in a manner that clearly indicates that such items are parts of/components of a larger unit. Simply stating a single part number and description for such panels shall be unacceptable.

(b) Include a separate list for each section, with items grouped by system.

(c) List Spare Parts separately, and identify clearly as “Spare Equipment”.

(3) Manufacturer's product data sheets and equipment description for all system components. These data sheets shall be highlighted or suitably marked, so that included items and options are indicated. On data sheets that include multiple products, products that are not used shall be crossed out.

(4) Floor plans as follows:

(a) Scale shall match architectural floor plan scale.

(b) Indicate location of all devices, parts, and equipment.

(c) Notification device number (address), zone, and circuit shall be indicated on floor plans.

(d) Candela rating shall be indicated on all floor plans with notification devices shown

(e) Include all Panel location(s) on plan drawings.

(f) Locations of new Junction Boxes.

(g) Proposed routing of new raceways.

(h) Conduit and raceway sizes.

(i) Wire/cable type and size.

(j) Initiation, Control Module, Monitor Module, Relay Module Device Addresses

(5) Indicate audible device sound level output @ 10 ft.

(6) Diagrams as follows:

(a) Block diagrams showing layout and operation of entire system. Include description for all system operations.

(b) Separate riser drawing for each system. Each System Riser shall illustrate all fire alarm circuits and shall incorporate the following information, in a clear, concise format:

1) Point of origin of each circuit (usually a Panel, or a Module within a panel).

2) Circuit type and labeling.

3) Area served by each circuit.

4) Wire/cable type and size.

5) The following information for each Field Device:

1. Device Type.
2. Circuit(s) to which device is connected.
3. Locations of any End-Of-Line Resistor (EOLR) (and the circuit terminated by any such EOLR).

(7) Details as follows:

(a) Detailed layout and elevation of all control panels, annunciators, and visual graphics displays (as applicable).

(b) Voice Alarm signaling-service equipment rack or console layout, grounding schematic, sound amplifier power calculation, and single-line connection diagram.

(c) Component and module wiring diagrams intended to illustrate terminations and wiring connections to each typical Field Device (Detectors, Notification Appliances, etc.), and each typical panel component/module utilized within the system. This set of drawings shall only include diagrams for modules and components, which are actually used in the provided system(s).

(d) Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

(e) Calculations

1) Audio sound amplifier, strobe NAC power supply, and battery calculations showing current draws for every device and module during standby, alarm and trouble conditions.

2) Voltage drop calculations for Signaling Line Circuits (SLC)s, initiating circuits, audio circuits, and notification appliance circuits. This calculation should cover the “worst case” (longest and/or most heavily loaded circuits including loading of future devices using spare capacity) NAC(s) as installed within the facility. These calculations should mathematically prove that all devices on the circuit will receive acceptable power for proper operation. This calculation should follow a “spreadsheet” format, and should clearly indicate the following:

1. The name of the circuit.
2. Point of origin of the circuit.
3. Complete list of all devices served by the circuit, including location and type of each device
4. Alarm Current Draw for each device, at the applied voltage.
5. Applied Voltage (Based on anticipated battery voltage after specified stand-by & alarm operation).
6. Acceptable Operating Voltage for each type of device on circuit. Calculated Voltage at each device on circuit.

3) Standby battery power calculations.

1. Proof of 5 years documented experience and factory authorization to furnish and install equipment proposed.

(8) Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

(9) Prior to programming system, submit list of device addresses with location labeling as they will appear in 2-line, 40 character display of fire alarm panel and annunciator. List will be modified as needed by Owner and returned to Contractor for final programming.

G. Incomplete submittals will be rejected and returned without review.

H. Shop drawings and submittals shall be reviewed by Engineer prior to submission to AHJs for approval. Include sufficient time in project schedule to allow for reviews, resubmittals (as required) prior to submittal to AHJ.

I. Submission to Authority Having Jurisdiction (AHJ):

(1) Submittals to AHJ shall include all drawings and documentation required by code International Building Code Fire Alarm and Detection Systems and NFPA 72.

(2) After obtaining A/E approval, prepare the required fire alarm shop drawings, floor plans, and riser diagrams that will ultimately go to the AHJ in quantities and format as required by code and the AHJ.

(3) Contractor shall be responsible for providing additional devices, relocating devices, changing types of devices and/or any other modifications required by the AHJ in order to provide a complete and approved system.

(4) Approval is required prior to the start of construction. The Contractor shall prepare and submit the required documents in a timely fashion to meet this requirement. If the Contractor starts construction before approval is given by the AHJ, the Contractor is responsible for all additional fees required by the AHJ.

1.08 INSPECTIONS

A. Once the Permit Application form has been received, processed, and accepted by AHJ and proper permits issued, construction may begin.

B. Coordinate and provide for all inspections required by the AHJ.

1.09 OPERATION AND MAINTENANCE MANUAL

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

B. In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

(1) A material guide, which shall contain the replacement part numbers and description of all components used. If this information is included in an instruction section for any of the equipment, it will not be necessary to duplicate the list. In either case, the parts list shall be associated with its respective chassis, modules or kit wherein it is found. A total listing of parts without such grouping will not be acceptable.

(2) Catalog data or literature

(3) Manufacturer's operating instructions.

(4) Manufacturer's maintenance instructions

(5) Installation instructions

(6) Name, address and telephone number of source for parts (i.e. keys, guards, etc.) not supplied by the Fire Alarm Manufacturer

(7) Copies of all approved shop drawings.

(8) Upon completion of the project the Owner shall be provided with a hard copy printout of the system software database and an electronic version of the system program and database with all required passwords.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Multiplex Analog Addressable Fire Alarm Systems

(1) Edwards EST4

B. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm), access control, and smoke control system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

C. The Contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components, which comply, with the requirements of these Specifications. Equipment or components, which do not provide the performance and features required by these specifications are not acceptable, regardless of manufacturer.

D. Strict conformance to this specification is required to ensure that the installed and programmed system will function as designed and will accommodate the future requirements and operations of the building Owner. All specified operational features must be met without exception.

E. All control panel assemblies and field appliances connected to the system shall be provided by the same System Supplier and shall be designed and tested to ensure that the system operates as specified. All equipment and components shall be installed in strict compliance with the manufacturer's recommendations.

F. Equipment proposed to be supplied will be considered only if it meets all performance requirements identified in this specification. Any deviations of system performance will only be considered when the following requirements have been met:

(1) A complete description of proposed alternate system shall be submitted to the Owner for approval with three (3) copies of applicable working drawings not less than ten (10) calendar days prior to the scheduled date for submission of bids.

(2) The supplier of alternate equipment shall furnish evidence that the proposed alternate system performance is equal to or superior to- the system operation stated in the specification. Such evidence shall be submitted to the Owner, not less than ten (10) calendar days prior to the scheduled date for submission of bids.

(3) The supplier shall submit a point-by-point statement of compliance for all sections in this specification. The statement of compliance shall consist of a list of all paragraphs within these sections. Where the proposed system complies fully with the paragraph as written, placing the word "comply" opposite the paragraph number shall indicate such. Where the proposed system does not comply with the paragraph as written, and the supplier feels the proposed system will accomplish the intent of the paragraph, a full description of the function as well as a full narrative description of how its proposal will meet its intent shall be provided. Any submission that does not include a point-by-point statement of compliance as described herein shall be disqualified. Where a full description is not provided, it shall be assumed that the proposed system does not comply.

(4) The supplier of alternate equipment shall submit a list from the alternate manufacturer on the manufacturer's letterhead indicating the names and addresses of all authorized suppliers in the area. Proprietary products will not be considered.

(5) The acceptability of any alternate proposed system or manufacturer shall be the sole decision of the Owner or Owner's authorized representative.

G. The acceptability of any alternate proposed system or manufacturer shall be the sole decision of the Owner or Owner's authorized representative.

2.02 SYSTEM OPERATIONS

A. Alarm Initiation For Buildings One-Way Voice Based Systems or Horn Systems With Immediate Temporal-3 Based Evacuation

(1) Alarm Sequence of Operation: Actuation of automatic fire initiating device (smoke, heat, monitored pre-action system, aspirating smoke detection panel, or sprinkler waterflow) or manual initiating device, shall place system in alarm mode, which causes the following operations:

(a) Appropriate initiating device circuit red LED shall flash on Control Panel, and remote annunciator(s) until the alarm has been acknowledged.

1) Once acknowledged at Control panel or annunciator(s), this same LED shall latch on.

2) Subsequent alarm received after acknowledging shall flash subsequent zone alarm LED on Control Panel, and remote annunciator(s).

3) Acknowledgment of alarm shall not reset activated device.

4) Pulsing alarm tone shall occur within Control Panel and remote annunciators until event has been acknowledged.

(b) Indicate alarm initiating device type, location and address at the local fire alarm control panel.

(c) Indicate individual device alarm zone(s) at the respective fire alarm annunciators.

(d) Activate all strobes and audible devices (temporal-3 evacuation tone) throughout the building.

(e) Transmit alarm signal to UL Central Station via off site alarm communications transmission devices.

(f) Transmit signals by zone to associated smoke dampers fire alarm relay modules for activation of fire/smoke response as required and as defined on plans.

(g) Transmit signals by zone to associated door hold-open devices for door hold-open release on floor of alarm. WON Doors dividing occupancies will close upon any building alarm in either occupancy.

(h) Transmit signals to associated electric egress path and stairwell door lock relay modules for door lock release as defined on plans.

(i) Display point information and location at the visual graphics display terminals and printers.

(2) Trouble Sequence of Operation: System or circuit trouble places system in trouble mode, which causes the following system operations:

(a) Visual and audible trouble signal indicated by zone at the fire alarm control panel and remote annunciator(s).

(b) Indicate individual device type, location, with trouble at the fire alarm control panel and fire alarm annunciators.

(c) Manual acknowledge function at fire alarm control panel or remote annunciator(s) silences audible trouble alarm.

(d) Visual alarm is displayed until initiating failure or circuit trouble is cleared.

(e) Display point information and location at the visual graphics display terminals and printers.

(f) Transmit trouble signal to UL Central Station via off site alarm communications transmission devices.

(3) Supervisory Sequence of Operation: System or circuit supervisory signal places system in supervisory mode, which causes the following system operations:

(a) Visual and audible supervisory signal indicated by zone at the fire alarm control panel and remote annunciator(s).

(b) Indicate individual device supervisory device type, location, at the respective fire alarm control panel and remote annunciator(s).

(c) Manual acknowledge function at fire alarm control panel or remote annunciator(s) silences audible trouble alarm.

(d) Visual alarm is displayed until initiating failure or circuit supervisory signal is cleared.

(e) Display point information and location at the visual graphics display terminals and printers.

(f) Transmit supervisory signal to UL Central Station via off site alarm communications transmission devices.

(4) Non-Fire Input Sequence of Operation: System or circuit non-fire signal places system in non-fire operation mode, which causes the following system operations:

(a) Visual Other Event (Non-Fire) signal indicated by zone at the fire alarm control panel and remote annunciator(s).

(b) Indicate individual device Non-Fire device type, location at the fire alarm control panel and fire alarm annunciators.

(c) Manual acknowledge function at fire alarm control panel or remote annunciator(s) silences audible Non-Fire alarm.

(d) Visual alarm is displayed until Non-Fire Event is cleared.

(e) Display point information and location at the visual graphics display terminals and printers.

(f) Perform output function associated with Non-Fire event input such as monitoring of security or other systems noted to be transmitted to fire alarm system and generate corresponding output function from fire alarm, but not activate building fire alarm notification devices.

(5) System duct smoke detectors and sprinkler system valve supervisory switch monitoring shall be connected to the fire detection system.

(6) Device type shall be distinguishable for all types of initiation devices in the zone and displayed individually on the Fire Alarm Control Panel, and remote annunciators.

(7) Refer to drawings for additional sequence of fire alarm system operation under general alarm, and One-way voice evacuation alarm.

(8) System shall have single key to allow operator to display alarms, troubles, and supervisory service conditions including time and date of each occurrence.

(9) Alarm description shall be displayed on Fire Alarm Control Panel and Annunciators with an 80-character LCD display as follows:

(a) 40 characters for:

1) Point address and loop number

2) Type of device

3) Point status

(b) 40 characters for:

1) Custom location label

(c) Alarm audible-indicating devices shall sound in temporal-3 pattern until silenced by alarm silence switch at Control Panel and remote annunciator.

(d) Visual alarm indicating devices shall operate in continuous flashing pattern until system is reset.

(10) System shall have single key to allow operator to display alarms, troubles, and supervisory service conditions, including time and date of each occurrence.

B. Acknowledgement

(1) Two methods of acknowledgment for each abnormal condition shall be provided:

(a) Acknowledge one event at a time from an unacknowledged list of events.

(b) Pressing acknowledge button shall display first unacknowledged condition in list (either alarm, supervisory or trouble), and require another acknowledge button. Press to acknowledge only displayed point.

(2) After all points have been acknowledged, LEDs shall glow steadily and alarm will be silenced. Total number of alarms, supervisory and trouble conditions shall be displayed.

(3) Pressing appropriate acknowledge button shall acknowledge all points

(4) Acknowledge functions shall be behind locked door or pass-code protected.

C. Silencing

(1) Alarm audible indicating devices shall be silenced by operating alarm silence switch and fire alarm control panel or by use of key operated switch at remote annunciator(s).

(2) Strobes shall remain active until system is reset.

(3) Subsequent zone alarm shall reactivate alarm signals.

(4) If trouble conditions exist in system and "Trouble Silence" button has been pressed, audible trouble signal shall cease, but shall resound at timed intervals to act as reminder that fire alarm system is not in normal operating mode.

(5) Sprinkler system valve supervisory signals shall be non-silenceable.

D. Reset

(1) System Reset button shall return system to its normal state after an alarm condition has been remedied.

(2) Should an alarm condition continue to exist, system shall provide indication that resetting cannot be completed and shall remain in an abnormal state.

(3) Sonalert and Alarm LED shall remain activated.

(4) Display shall indicate total number of alarms and troubles present in system along with prompt to use ACK keys to review points.

(5) Points shall not require acknowledgment if they were previously acknowledged.

(6) Should Alarm Silence Inhibit function be active, system shall ignore all key presses. An indication of enabling and disabling inhibit state shall be provided as feedback to operator.

E. Supervision

(1) System shall independently supervise:

(a) Initiating device circuits.

(b) Signaling line circuits.

(c) Strobe Notification Appliance Circuits (NAC)s.

(d) One-way voice system speaker circuits and equipment.

(e) DACT and other fire alarm off-site communications devices.

(f) All network communications circuits.

(g) Independently supervise circuits for fire alarm speakers.

(h) Auxiliary manual controls. "Off normal" position of any switch shall cause an "off normal" system trouble.

(i) Auxiliary circuits for addressable relay modules. Blown fuse or open in circuit shall be visibly and audibly annunciated.

(j) Remote annunciator panel(s). Any ground, short, or open in the wiring to fire alarm Control Panel, as well as malfunction of the annunciator panel or remote-control panels/data gathering panels/transponders, etc. shall be annunciated at control panel.

(k) Incoming power. Power failure shall be audibly and visually indicated at Control Panel and remote annunciators. Green "power on" LED shall be displayed continuously while incoming power is present.

(l) System Modules for module placement. Should modules become disconnected, system trouble indicator shall illuminate and audible trouble signal shall sound.

(m) System batteries. Low battery condition or disconnection of battery shall be audibly and visually indicated at Control Panel and remote annunciators.

(n) System power supplies and battery chargers.

(o) All system devices as required by NFPA 72.

(2) Device activation shall be annunciated at Control Panel, and remote annunciator(s), and visual graphics display terminals.

(3) Independently supervised circuits shall include visible amber "Trouble" LED to indicate disarrangement conditions per circuit.

(4) Disarrangement conditions of any circuit shall not affect operation of other circuits.

(5) Alarm activation of any initiation circuit shall not prevent subsequent alarm operation of any other initiation circuit.

(6) System shall have provisions for disabling and enabling circuits individually for maintenance or testing purposes.

F. Power Requirements

(1) Provide separate power connections, batteries, battery chargers, system supervision, and monitoring of the Fire Alarm Detection System and One-Way Voice Communication System .

(2) Provide 120V power to each Fire Alarm Control Panel, NAC Panel, Transponder, Data Gathering Panels, Remote Control Panels, and peripheral device requiring 120V power.

(3) Provide 120 VAC power via dedicated branch circuit in NEC Article 700 panelboard.

(4) Provide branch circuit "breaker lock" to prevent accidentally de-energizing of power to fire alarm panel.

(5) Provide branch circuit breaker painted red and labeled "FIRE ALARM".

(6) Provide disconnect switch for AC power near panel or within Fire Alarm Control Panel itself. Switch shall be labeled "Fire Alarm Power Disconnect".

(7) Provide series connected power surge and transient protection for each branch circuit serving a fire alarm component.

(8) Provide back-up battery capacity to operate entire system in normal quiescent standby mode for period of 24 hours with 15 minutes of alarm operation at maximum connected load at end of standby period. Include spare capacity requirements in calculations.

(9) System shall automatically transfer to standby batteries upon power failure.

(a) Battery charging and recharging operations shall be automatic.

(b) Batteries shall be sealed lead-calcium.

(10) Provide power limited, filtered and regulated battery charger.

(a) Charger shall:

1) Be combination high rate/float maintenance type.

2) Charge fully discharged battery to 80% in 12 hours.

3) Be capable of fully recharging within 48 hours after single discharge.

4) Monitor for AC fail/disconnect, low/no battery, and high battery level.

5) Include switches and associated LEDs for high rate and AC disconnect.

6) Provide 5 amps of regulated 24VDC for peripheral devices requiring ± 5% regulation and 8 amps at 24VDC for standard peripheral devices.

7) Be compatible with lead acid batteries.

8) Meet all requirements of NFPA 72.

(11) External circuits requiring system operating power shall be 24VDC and shall be individually supervised and fused at Control Panel.

(12) Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

G. Smoke Detection Operation

(1) Smoke detector alarms shall be processed and reported immediately.

(2) Upon building completion, alarm verification shall be added to detector(s) as directed by project engineer. Provide fire alarm system capable of alarm verification mode.

(3) Fire Alarm Control Panel shall:

(a) Be capable of displaying number of times (tally) detector has gone into verification mode from the system history

(b) Download alarm set point to detector

(c) Determine condition of each detector by comparing detector's value to stored values.

(d) Maintain moving average of detectors' smoke chamber value to automatically compensate for dust and dirty conditions

(e) Continuously perform an automatic self-test routine on each detector

(f) Have capability of being programmed for pre-alarm or two-stage function

(g) Clear "detector dirty" trouble after detector has been removed from its base cleaned and replaced

(4) System shall maintain constant smoke obscuration sensitivity for each detector by compensating for environmental factors.

(5) Photoelectric detector's smoke obscuration sensitivity shall be adjustable to within 0.3% of either limit of UL window (0.5% to 4.0%) to compensate for any environment.

(6) System shall indicate when individual detector needs cleaning. When detector's average value reaches predetermined level, trouble MESSAGE shall be audible and visibly indicated at Control Panel. LED on detector base shall glow steady giving visible indication.

(7) For scheduling of maintenance, Control Panel shall generate MESSAGE indication for any detector approaching trouble condition due to dirt or contamination.

(8) Operator shall have capability to manually access the following information for each detector:

(a) Primary status

(b) Device type

(c) Present average value

(d) Present sensitivity value selected

(e) Detector range (normal, dirty, etc.)

(9) Values at Control Panel shall be in "percent of smoke obscuration" format, so that no interpretation is required by operator.

(10) Operator shall be able to manually control following for each detector:

(a) Enable or disable detector

(b) Establish alarm sensitivity

(c) Control detector's relay driver output

(11) It shall be possible to program Control Panel to automatically change sensitivity settings of each detector based on time-of-day and day-of-week. There shall be 3 sensitivity settings available for each detector.

H. Elevator Recall Operation

(1) Elevator recall function shall be as required by the IBC, IFC, and any referenced standards/codes such as ASME A17.1, requiring detectors in each elevator lobby, elevator shaft/hoistway, or elevator machine/control space for recall activation. Elevator recall function and activation of relay modules for recall functions shall be capable of adjustable time delay of from 0-30 seconds.

(2) Detectors shall be installed as indicated on plans in elevator lobbies, shafts/hoistway, and machine/control spaces separated by a minimum of 5’ and installed a maximum of 12’ from the centerline of any elevator within the lobby.

(3) When elevator lobby fire detectors are activated, it shall cause Phase I Emergency Recall Operation according to following sequence:

(a) If detectors are in a lobby on any floor other than main level of egress, all elevator cars serving that lobby shall be recalled to main level of egress.

(b) If detectors are in a lobby on main level of egress, all elevator cars serving that lobby shall be recalled to predetermined alternate recall level as determined by Owner and Authorities Having Jurisdiction.

(4) When elevator machine room or shaft/hoistway fire detectors are activated, it shall cause Phase I Emergency Recall Operation according to following sequence:

(a) All elevator cars with equipment in that machine room or elevator shaft/hoistway shall be recalled to main level of egress.

(5) Elevator shaft/hoistway, machine room, and lobby fire detectors shall annunciate individually at Fire Alarm Control Panel, and remote annunciator, and visual graphics display terminal on individual separate zones from all other devices.

(6) A relay module shall be provided to signal each individual elevator controller and group controller upon detection of fire detectors in each elevator machine room to activate elevator recall indicator “fire hat” in elevator car(s) with machinery located in the machine room where fire detectors have been activated. Activation of fire detectors in elevator machine rooms shall also active elevator recall to main level of egress.

(7) Relay modules shall be provided within 3’ of each individual elevator controller and group controller to actuate elevator recall operation. Individual relay modules shall be provided for each elevator car for main egress level recall, alternate egress level recall, and machine room “fire hat” operation.

(8) Upon reset of Fire Alarm Control Panel, elevators shall be allowed to resume normal operations. Manual reset of elevator controllers may be required.

I. Elevator Power Shunt Trip

(1) After elevator machine room or elevator shaft heat detector is activated, the elevator control panel shall activate shunt trip operator on breaker or switch supplying power to elevator, removing power from the elevator equipment.

(2) Specific elevator shaft zone shall be put into alarm and sound general fire alarm.

(3) Provide fire alarm monitor module to monitor presence of shunt trip voltage at shunt trip operator. Loss of shunt trip voltage shall be indicated as a Supervisory condition.

J. System Response

(1) Maximum elapsed time from sensing fire at initiating device until it is recorded at Control Panel and remote annunciator(s) shall not exceed 10 seconds, and not exceed 90 seconds for transmission and display of alarm at supervising station.

K. Sprinkler System Operation/Interface

(1) Activation of any standpipe or sprinkler system tamper switch shall activate system supervisory service audible signal and illuminate LED at Control Panel and remote annunciator(s).

(a) Control Panel shall provide differentiation between switch operation and opens and/or grounds on initiation circuit wiring.

(b) Pressing acknowledge key will silence audible signal while maintaining supervisory service LED "on" indicating off-normal condition.

(c) Restoring valve to normal position shall cause supervisory service audible signal to pulse indicating restoration to normal position.

(d) Acknowledge key shall silence audible signal.

(2) Activation of any standpipe or sprinkler system water flow switch shall activate system alarm audible signal and illuminate LED at Control Panel and remote annunciator(s).

(a) Pressing acknowledge key will not silence audible signal.

(b) Applicable alarm notification signals will continue to sound until the Alarm Silence key is activated, or the System Reset key is activated.

(3) Each sprinkler water flow and valve supervisory switch shall be annunciated individually at fire alarm control panel, annunciator, and visual graphics display terminal. Device and sprinkler zone identifier name shall be coordinated with Fire Protection Contractor.

L. Manual Evacuation (Drill) Operation

(1) Manual evacuation (drill) switch shall be provided to operate alarm indicating appliances without causing other control circuits to be activated.

(2) Should true alarm occur, alarm functions would occur.

M. LED and LCD Test Operation

(1) Activation of Lamp Test switch shall turn on all LED indicators, LCD display, and the local sounder and then return to previous condition.

N. System Diagnosis

(1) System shall include special software to detect, diagnose and report failures and isolate such failures to printed circuit board level.

O. Watch-Dog Timers

(1) System shall include independent "Watch-Dog" timers to detect and report failure of any microprocessor circuit, memory, or software.

P. Walk Test Operation

(1) Actuation of "Walk Test" switch/program at Control Panel shall activate "Walk Test" mode of system, which shall cause following to occur:

(a) Off-site fire alarm/supervisory/trouble transmission circuit connection shall be bypassed.

(b) Fire alarm control relay functions shall be bypassed, including door holder release and elevator recall or capture.

(c) Audio and visual circuits shall be bypassed.

(d) Control Panel shall show trouble condition.

(e) Alarm activation of initiation device shall cause audible signals to sound for 2 seconds.

(f) Control Panel shall automatically reset itself after signaling is complete.

(g) Momentary opening of initiating or indicating appliance circuit wiring shall cause audible signals to sound for 2 seconds indicating trouble condition.

(h) If system becomes inactive for period of longer than 5 minutes, Control Panel shall default to normal fire alarm functions.

(i) Activation of any initiation device shall be silently logged as an alarm condition in historical data file.

(2) Panel shall have capability of dividing system into distinctive walk test groups minimum of 8 groups.

Q. One-Way Voice Communications

(1) Automatic voice notification sequence shall be as follows:

(a) Audio alarm signal shall consist of optional alarm tone for minimum of 0 seconds and maximum of 10 seconds (length as directed by AHJ) followed by coded human voice digital signal indicating floor, zone, and device type in a numerical, coded format. Coded signal shall repeat a minimum of three times (or quantity as required by AHJ) and be configured to be able to sound until alarm silence switch at Fire Alarm Control Panel or the remote annunciator has been operated.

(b) Audio alarm operations of speaker circuit selection and alarm tone timing variations shall be activated by system software so that required future changes to evacuation sequence or re-arrangements of audio circuits can be facilitated by authorized personnel without additional components or rewiring.

(c) System shall be configured to allow for "All Call" and selective zone voice paging from the main Control Panel and remote annunciator panel(s).

(2) Selective Paging:

(a) Upon activation of any speaker manual control switch (es), optional alarm tone (minimum of 0 seconds and maximum of 10 seconds, length as directed by AHJ) shall sound over selected speakers. At end of this tone, operator shall be able to make announcements via push-to-talk paging microphone over pre-selected speakers.

(b) Strobes shall flash on all floors/zones or on selected floors/zones as selected by the user.

(c) Each floor, each stairwell and elevator car shall be separate selectable zones.

(3) All Call:

(a) Upon activation of "All Call" switch, optional alarm tone (minimum of 0 seconds and maximum of 10 seconds, length as directed by AHJ) shall sound over all speakers in system. At end of this tone, the operator shall be able to make announcements via push-to-talk paging microphone overall system speakers.

(b) Strobes shall flash in all areas or floors.

(c) System shall default to normal operations if the microphone becomes inactive for more than 1 minute.

R. Automatic Transfer Switch and Generator Monitoring

(1) Fire alarm control panel shall monitor the status and position of all building automatic transfer switches to indicate if switch is in the normal or emergency position.

(2) Fire alarm control panel shall monitor when generator as running.

(3) Fire alarm monitoring of transfer switches and generator shall be monitor only and not alarm, supervisory, or trouble.

S. Fire Pump Monitoring

(1) Fire alarm control panel shall monitor the status of the fire pump running.

(2) Fire alarm control panel shall monitor the following fire pump points as Supervisory:

(a) Loss of Phase

(b) Phase Reversal

(c) Pump on Generator or Alternate Source

(d) Pump Controller Trouble Alarm

(e) Alternate Source Switch or Circuit Breaker Open or Tripped

2.03 ENCLOSURE

A. Provide cabinets of sufficient size to accommodate equipment.

B. Cabinet shall be equipped with door, with lock and transparent door panel, providing tamper proof enclosure and allowing full view of various lights and controls.

2.04 FIRE ALARM CONTROL PANEL

A. Control Panel shall be modular, expandable with solid state, microprocessor-based electronics.

B. Control Panel shall provide the following features:

(1) Support intelligent (analog addressable) detection devices.

(2) Number of initiating device signaling line circuit (SLC) loops required for specified quantity of initiating devices plus 1 spare loop for each 3 active loops. Each active loop shall include 25% spare capacity.

(3) Number of audible notification device (horns or speaker) circuits required for quantity of horns or speakers in alarm, plus one (1) spare circuit for each 5 active circuits. Each active circuit shall include 20% spare capacity.

(4) Number of visual notification device (strobe) circuits required for specified quantity of strobes plus one (1) spare circuit for each 5 active circuits. Each active circuit shall include 20% spare capacity.

(5) 80-character liquid crystal display

(6) Printer interface

(7) History log file with minimum of 600 events

(8) Field programmable

(9) Drift compensation

(10) Sensitivity display in %

(11) Sensitivity adjustment

(12) Day/night sensitivity adjustment

(13) Auto detector test

(14) Alarm verification with tally counter

(15) Silent walk test

(16) Maintenance alerts

C. System shall provide ability to recall alarms and trouble conditions in chronological order.

D. Under normal condition viewing window shall display "System is Normal" message and current time and date.

E. When an abnormal condition occurs appropriate LED (Alarm, Supervisory or Trouble) shall flash.

F. Audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

G. Panel shall display the following information relative to abnormal condition of a point in system prior to acknowledgement:

(1) 40 characters for:

(a) Point address and loop number

(b) Type of device (i.e. smoke, pull station, water-flow)

(c) Point status (i.e. alarm, trouble)

(2) 40 characters for:

(a) Custom location label (i.e. 4th Floor - Room 444)

H. Keyboards or keypads shall not be required to operate the system during fire alarm conditions.

I. Following software functions shall be provided:

(1) Setting of time and date

(2) LED testing

(3) Alarm, trouble, and abnormal condition listing
(4) Enabling and disabling of each monitor point separately
(5) Activation and deactivation of each control point separately
(6) Changing operator access levels
(7) Walk Test enable
(8) Running diagnostic functions
(9) Displaying historical logs
(10) Point listing

J. Following hardware functions shall be provided:
(1) Acknowledge alarm or trouble
(2) Silence alarm or trouble
(3) Reset system after alarm
(4) Fire alarm/supervisory/trouble off-site transmission circuit disconnect/switch
(5) Provide manual evacuation (drill)
(6) Allow computer interface

2.05 REMOTE CONTROL, TRANSPONDER, OR DATA GATHERING PANELS

A. Remote control panels (also known as data gathering or transponder panels) may be used to provide and extend fire alarm system components such as SLCs, NACs, and communications to auxiliary devices such as printers, visual graphics display terminals, and other network components. All communication between Fire Alarm Control Panel and Remote Control Panels shall be digital communications on a supervised network riser and communications wiring system. Remote control panels shall be monitored and any failure in communication from Fire Alarm Control Panel shall be displayed audibly and visually at the Fire Alarm Control Panel.

B. Addressable devices shall transmit data to the Fire Alarm Control Panel through the SLC. An LED indicator shall be provided for the SLC in each Remote Control Panel and an additional LED shall indicate normal communications with the Fire Alarm Control Panel.

C. Failure of loss of communication of any Remote Control Panel shall not affect any devices or any other system component or network device which is not connected directly to the Remote Control Panel which has failed.

D. An open or short between the Fire Alarm Control Panel and Remote Control Panel shall be indicated as a trouble at the Fire Alarm Control Panel and Remote Annunciators.

E. Where multiple sections of Remote Control Panels are required, factory made interconnections shall be made with pre-made wiring harnesses installed at the factory such that no additional field wiring is required.

F. An open or short or other trouble condition on the Remote Control Panel shall be displayed on individual trouble indicator LEDs at the Fire Alarm Control Panel and Remote Annunciator and visual graphics display terminals. The visual trouble signal shall indicate devices and circuits affected by the trouble signal.

G. Remote Control Panels, amplifiers, NAC panels, and any other distributed system components shall be installed in 2 hour rated rooms only.

2.06 FIRE ALARM CONTROL PANEL STATUS INDICATORS AND DISPLAYS

A. Audible device shall sound during Alarm, Trouble or Supervisory conditions.

B. Audible device shall sound during each key-press.

C. Visual display shall distinguish between alarm, trouble and supervisory conditions.

D. Indicators and displays to be visible:
(1) One red system alarm LED
(2) One yellow supervisory service LED
(3) One yellow trouble LED
(4) Green "power on" LED
(5) Eighty-character LCD

E. Fire Alarm Control Panel shall provide:
(1) LCD display of each individual intelligent device name and identifier.
(2) When activated, red LED shall flash rapidly until acknowledged and remain lit constantly until fire alarm system is restored to normal operation.
(3) When device or zone is in trouble condition, yellow LED shall flash rapidly until acknowledged and remain lit constantly until fire alarm system is restored to normal operation.
(4) When device or zone is in supervisory condition, yellow LED shall flash rapidly until acknowledged and remain lit constantly until fire alarm system is restored to normal operation.

F. 2-line by 40-character LCD shall be backlit.

G. Cursor shall be visible on LCD when entering information.

H. Scrolling through menu options shall be in self-directing manner in which prompting messages shall direct user.

I. Controls shall be located behind an access door.

J. Status data to be available on display:

(1) Initiating device circuits
(2) Indicating device circuits
(3) Auxiliary relays
(4) Primary State of point
(5) Zone information
(6) Class "A" Status (if Class A used)
(7) Current priority of outputs
(8) Disable/Enable status
(9) Automatic/Manual Control Status of output points
(10) Acknowledge status

2.07 FIRE ALARM CONTROL PANEL CONTROLS

A. Controls (one switch per function per system) visible through front viewing window:

(1) Alarm Acknowledge key
(2) Trouble Acknowledge key
(3) Alarm Silence key
(4) System Reset key

B. Controls accessible with front door open:

(1) Keypad for data input and microprocessor control
(2) Manual evacuation (drill)
(3) Bypass audible and visible notification signal operation
(4) Fire alarm/supervisory/trouble off-site transmission circuit disconnect/switch
(5) One-Way Voice Communication System controls and microphone
(6) Elevator recall and shunt trip bypass
(7) Fan and damper shut down override/bypass switches
(8) Door holder release bypass

2.08 LED SUPERVISION

A. Slave module LEDs shall be supervised. When problem occurs, LCD shall display module and LED location.

2.09 ACCESS LEVELS

A. Provide 4 access levels with level 4 being highest level. Level 1 actions shall not require pass-code.

B. Pass-codes shall consist of up to 5 digits.

C. Pass-code digits entered shall be displayed as an X to indicate that digit has been accepted.

D. Key presses shall be acknowledged by local audible sound.

E. When correct pass-code is entered, system shall indicate to operator "Access Granted."

F. Access level shall be in effect until operator manually logs out or keypad has been inactive for 5 minutes.

G. Operator entering invalid code shall be notified with message "Incorrect Pass- Code" and shall be allowed three chances to enter valid code. After three unsuccessful tries, the message "Access Denied" shall be displayed.

H. Following keys/switches shall have associated access levels:

(1) Alarm Silence
(2) System Reset
(3) Set Time/Date
(4) Manual Control
(5) On/Off/Auto Control
(6) Disable/Enable
(7) Programming functions
(8) Clear Historical Alarm Log
(9) Clear Historical Trouble Log

(10) Walk Test

(11) Change Alarm Verification

I. Acknowledge keys shall require pass code access to acknowledge points. If operator presses an (ACK) key with insufficient access, an error message shall be displayed.

2.10 POINT LISTING

A. Point list menu includes:

(1) All points list by address

(2) Monitor point list

(3) Signal/speaker list

(4) Auxiliary control list

(5) Feedback point list

2.11 HISTORY LOGGING

A. System shall be capable of logging and storing the last 400 events (alarm and trouble) in history log. These events shall be stored in battery protected random access memory.

B. Following historical alarm log events shall be stored:

(1) Alarms

(2) Alarm Acknowledgment

(3) Alarm Silence

(4) System Reset

(5) Alarm Historical log cleared

C. Following historical trouble log events shall be stored:

(1) Trouble conditions

(2) Supervisory alarms

(3) Trouble acknowledgment

(4) Supervisory acknowledgment

(5) Alarm Verification tallies

(6) Walk Test results

(7) Trouble Historical log cleared

2.12 FIELD PROGRAMMING

A. System shall be fully programmable, configurable, and expandable in field and shall not require replacement of memory IC's.

B. Programming may be accomplished through Control Panel keyboard or keyboard at printer, or use of PC.

C. Programs shall be stored in non-volatile memory.

D. Programming or reprogramming shall be done by supplier at no charge until system is accepted by Owner.

2.13 TERMINAL/PRINTER INTERFACE

A. Control Panel shall be capable of operating remote monitors and/or printers.

B. Output shall be ASCII from RS-232-C connection with an adjustable baud rate.

C. Each RS-232-C port shall be capable of supporting and supervising up to 4 remote CRTs and Printers.

D. Data amplifiers shall be used to increase CRT or printer line distance.

2.14 INTELLIGENT NETWORK

A. Provide one intelligent device input Signaling Line Circuit (SLC) loop , per floor. Floors divided into zones per floor indicated on plans. Size loop for quantity of devices per zone with spare capacity for 25% future devices. Provide multiple SLC loops as required to meet spare capacity requirements.

B. System shall provide communications with intelligent initiating and control devices individually.

C. Devices shall be individually annunciated at control panel.

D. Annunciation shall include the following conditions for each point:

(1) Alarm

(2) Trouble

(3) Open

(4) Short

(5) Device missing/failed

E. Devices shall have capability of being disabled or enabled individually.

F. There shall be no limit to number of detectors, stations, or addressable modules, which may be activated or "in alarm" simultaneously.

G. Multiple intelligent devices shall be connected to a single pair of wires.

H. Communication format must be completely digital poll/response protocol to allow t-tapping of circuit wiring.

2.15 ONE-WAY VOICE COMMUNICATION SYSTEM

A. Provide central audio control module for:

(1) Alarm message/tone generation

(2) Main and remote microphone connections

(3) Mixer/pre-amplifier circuits

(4) Continuous supervision shall be provided for all circuits, amplifiers and modules.

(5) The voice communication system shall be eight (8) channel audio evacuation systems, to allow the ability to have eights simultaneous announcements/paging. The audio channels shall be design as such:

(a) Pre-Recorded Coded Tone and Messages

(b) General Alarm

(c) Manual Paging

(d) Elevator Message

(e) Stairwell Message

(f) Security/Weather Threat

(6) The system custom digital voice message shall provide a minimum of 100 minutes and be created as a .wav file format. All messages shall be able to be created on-site without any special tools or burning of memory chips. Provide as minimum one supervised audio amplifier per paging zone with spare amplifier. Actual amplifier size to be determined per devices installed and these specifications. The system software shall be capable of selecting the required audio source signal for amplification. To enhance system survivability, each audio amplifier shall automatically provide an internally generated local 3-3-3, 1000 Hz temporal pattern output upon loss of the audio signal from the one-way emergency audio control unit, during a general alarm condition.

(7) Audio amplifiers shall be power limited and protected from short circuits conditions on the audio circuit wiring. Each amplifier output shall be a supervised, dedicated, selectable 25/70 VRMS output.

(8) Provide a standby audio amplifier, per paging zone, that will automatically sense the failure of any primary amplifier installed in the same panel and replace the function of the failed amplifier.

B. Hand-held, push-to-talk microphone:

(1) Recessed in panel-mounted enclosure

(2) Dynamic communication type with frequency range of 200 Hz to 4000 Hz

(3) Equipped with self-winding 5 ft (1.5 m) coiled cable

(4) LED indicator shall be provided to indicate microphone push-to-talk button has been pressed and speaker circuits are ready for transmission.

(5) Supervised for disconnection.

C. One-Way Voice Communications System control switch module in Fire Alarm Control Panel:

(1) Provide manual access to audio operations personnel.

(2) Provide switches for individually selecting audio zones based on each floor, stairwell, and elevator car.

(3) Provide switches for individually selecting visual device (strobes) zones based on each floor.

(4) Provide LED indicators for indication of manually selected audio and visual zones.

(5) Provide output to system printer of zone(s) selected.

(6) Selection of floor audio zone shall activate visual device (strobes) for that floor.

(7) Include "All call" switch, "Aux Tone" switch and tone generator stop switch.

(8) Include “All call” switch for activating all visual devices on all floors.

(9) Switches and LED indicators shall be supervised for disarrangement on failure.

(10) Include a separate selector switch labeled “MANUAL” to defeat any automatically selected speaker and visual circuits and provide only for manual control of visual and audible circuits from the One-Way Voice Communications System Panel.

(11) Provide an emergency One-Way Voice Communication System with the following design features:

(a) An audio control unit with Microphone for One-Way Paging.

(b) Provide 3-position switch for each floor, stairwell, and elevator car, with "Voice", "Auto" and “EVAC” positions identified and two LED status indicators for each audio visual evacuation signaling "zone", one red and one yellow.

(c) Individual LEDs shall illuminate to indicate respectively:

1) Evacuation signals activated (red),
2) Trouble in audio (speaker) or visual (strobe) circuit(s) (yellow).

(12) Provide 2-position switch for “All-Call” to activate all the evacuation signaling zones, with "Voice" and "Auto" positions identified and two LED status indicators for each audio visual evacuation/smoke zone signaling "zone", one red and one yellow.

(a) Individual LEDs shall illuminate to indicate respectively:

1) Evacuation signals activated (red)
2) Trouble in audio (speaker) or visual (strobe) circuit(s) (yellow).

D. Self-contained speaker and switching arrangement shall provide testing of message(s) without disturbing occupants of the facility.

E. Provide custom audio messages, approved by Authority Having Jurisdiction.

F. Audio power amplifiers:

(1) Provide digital audio for the playing of digital audio files used as coded pre-recorded alarm.
(2) Be furnished with self-contained filtered 24 VDC power supply, transformer and amplifier monitoring circuits
(3) Provide 25VRMS and 70VRMS output with frequency response of 100 Hz to 7000 Hz
(4) Be constantly monitored
(5) Be provided with battery backup.
(6) Be current limited or disconnected from circuit should a short develop on speaker circuit
(7) Individual speaker circuits shall not be loaded more than 70%of rated amplifier power output.

G. Provide amplifiers and batteries to operate all system speakers at 1-watt tap minimum (or higher values as indicated on plans) simultaneously plus 33% reserve capacity.

H. Provide at least one back-up amplifier capable of automatically replacing any failed amplifier. Stand-by amplifier shall be rated at same output capacity as the largest amplifier in evacuation system.

I. Speaker and strobe circuits shall be zoned by floor or as noted on plans, with isolating module on each circuit.

J. The Fire Alarm System shall include back-up amplifiers within each Amplifier-Equipped FACP or Amplifier-Equipped Remote Equipment Cabinet. These back-up amplifiers shall be configured such that upon failure of any one Fire Alarm Audio Power Amplifier:

(1) A back-up amplifier shall be automatically routed into the signal path, such that the back-up amplifier shall functionally replace the failed amplifier. Back-up amplifier shall be at least as large in capacity as the largest amplifier at that FACP or remote equipment cabinet where amplifiers are located.
(2) A Trouble event shall be logged by the Fire Alarm System. This Trouble event shall indicate that an amplifier failure has occurred. If the system contains multiple amplifiers, the Trouble event message shall indicate which specific amplifier has failed.

K. Speaker and strobe circuits shall be zoned by smoke zones on each floor, speakers in each stairwell, and speakers in each elevator car. If floor is not subdivided into smoke zones then the entire floor shall be a zone. Each smoke zone on each floor, stairwell, and elevator car shall have an individually addressable zone for use on One-way voice communication system, selectable by pushbutton from One-way voice communications system control panel.

L. Upon selecting a zone or zones for one-way audible and visual device activation, the corresponding LED indicating each individual zone shall activate on the One-Way voice communications system panel.

M. Audio Evacuation Supervision:

(1) Each speaker circuit, amplifier, preamplifier, and power supply shall be supervised for component or circuit failure.
(2) A trouble light LED, per speaker zone, shall be provided in One-Way voice communications system panel.
(3) Detection of amplifier failure shall automatically cause substitution of stand-by amplifier and shall activate trouble light and audible signal at console and initiate trouble alarm on fire alarm system.
(4) Provide minimum of one speaker circuit for each floor, stairwell, elevator car and other area of distinct communication.

N. Manual Voice Paging Sequence

(1) System shall allow selective voice paging by speaker circuit.
(2) An "All Call" switch shall be provided to allow for activation of all speakers.
(3) An “All Call” switch shall be provided to allow for activation of all strobes.
(4) Manual operation shall be controlled at Fire Alarm Control Panel, or remote annunciator(s) microphone if provided.

O. Tones

(1) Main evacuating tone shall be NFPA 72 standard temporal code-three.

(2) Optional tones shall include:
(a) Hi/Lo
1) Free running tone with high frequency of 544 Hz and low frequency of 440 Hz
2) "On time" (Hi) shall be 100 milliseconds while the "off time" (Lo) is 400 milliseconds.
(b) Slow whoop
1) Slowly ascending tone from 200 to 830 Hz in 2.5 seconds
(3) One primary and one secondary tone generator shall be furnished.
(a) Automatic transfer to secondary unit should primary unit fail.
(b) Trouble signals shall indicate a failure of either primary or secondary unit.

2.16 REMOTE ANNUNCIATOR PANEL

A. Provide remote annunciators for the project as indicated on plans. Refer to floor plans for locations.

B. The remote annunciators at all locations shall contain a panel that shall display and house any equipment necessary for system operation for the Fire Detection System, Remote Annunciator, and One-Way Voice Communication System .

C. Provide 80-character LCD remote annunciator panel and individual LED lamp annunciator to indicate intelligent analog device name, floor, zone, and identifier.
(1) LED annunciators with individual indication of devices shall be provided as listed below.

D. The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the building.

E. Manufacturers' standard control switches shall be acceptable if they provide the required operation, including performance, supervision and position indication. If the manufacturers' standard switches do not comply with these requirements, fabrication of UL Listed custom manual controls acceptable to the Owner is required.

F. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 85 dBA at 10 feet.

G. The fire detection and voice command panels shall contain the following system status indicators:
(1) Graphical backlit LCD display indicating system status and alarm, supervisory, and trouble conditions.

H. Provide an emergency One-Way Voice Communication System with the following design features:
(1) An audio control unit with Microphone for One-Way Paging.
(2) Provide 3-position switch for each floor, stairwell, and elevator car, with "Voice", "Auto" and “EVAC” positions identified and two LED status indicators for each audio visual evacuation signaling "zone", one red and one yellow.
(3) Individual LEDs shall illuminate to indicate respectively:
(4) Evacuation signals activated (red),
(5) Trouble in audio (speaker) or visual (strobe) circuit(s) (yellow).

I. Provide 2-position switch for “All-Call” to activate all the evacuation signaling zones, with "Voice" and "Auto" positions identified and two LED status indicators for each audio visual evacuation/smoke zone signaling "zone", one red and one yellow.
(1) Individual LEDs shall illuminate to indicate respectively:
(2) Evacuation signals activated (red)
(3) Trouble in audio (speaker) or visual (strobe) circuit(s) (yellow).

J. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions

K. Annunciator shall provide:
(a) LCD display of each individual intelligent device name and identifier.
(2) When activated, red LED shall flash rapidly until acknowledged and remain lit constantly until fire alarm system is restored to normal operation.
(a) When device or zone is in trouble condition, yellow LED shall flash rapidly until acknowledged and remain lit constantly until fire alarm system is restored to normal operation.
(3) When device or zone is in supervisory condition, yellow LED shall flash rapidly until acknowledged and remain lit constantly until fire alarm system is restored to normal operation.

L. Reset

(1) System reset at fire alarm annunciator panels shall be accomplished via password entry into annunciator via keypad. Provide printed password for system reset in Fire Department Knox Box located at Fire Department response point.

(2) Upon activation of system reset, a coded digital audio file with human voice recording shall be broadcast throughout the building indicating “Code Green” or other such code acceptable to the Authorities Having Jurisdiction that the fire alarm system has been reset.

M. Annunciator shall communicate to Control Panel over one shielded twisted pair cable and be supervised and powered from Control Panel.

N. Identifiers and names for all devices and zones indicated in control panel and remote annunciators shall be as approved by the AHJ.

O. Annunciator shall provide:

(1) Control push-button switches for; alarm silence, trouble silence, system reset and LED and LCD test.

(2) Tone Alert - Duplicates Control Panel tone alert during alarm and trouble conditions

(3) System trouble LED

(4) System alarm LED

(5) Power on LED

(6) 4 spare future programmable control switches for other functions.

(7) To accommodate and facilitate job site changes control switches shall have capability of being programmed on site to provide additional or nonstandard operations and functions.

P. Operating power shall be 24VDC and be fused at control panel.

Q. Wiring between annunciator panel and Control Panel shall be supervised for opens, grounds and shorts.

R. Under normal operating conditions, LCD shall indicate time, date and "SYSTEM IS NORMAL" label.

S. During abnormal conditions, LCD shall indicate type and number of abnormal conditions such as alarms, troubles, and supervisory services.

2.17 NOTIFICATION APPLIANCE CIRCUIT POWER SUPPLIES

A. The NAC power supply shall be independent unit that will provide power to visual strobe notification appliances. It shall be possible to configure the NAC panels to follow the main panel’s NAC or activate from intelligent synchronized modules. The booster NAC panels must be configurable to operate independently at any one of the following rates: continuous, synchronized, or 3-3-3 temporal. Fault conditions on the power supply shall not impede alarm activation of host NAC circuits or other power supplies. The NAC power supply must be able to provide concurrent power for notification devices, security devices, access control equipment and auxiliary devices such as door holders. All the NAC Power Supplies shall be synchronized. Batteries shall be provided per Part 2.

(1) Power supply shall be minimum of 10 amps and UL 864 Listed.

(2) Four independent 3amp NAC circuits. Each being configurable as auxiliary power.

(3) Power supply output shall be 24VDC.

B. All circuits shall be synchronized.

C. Strobe circuit loading shall be calculated at 75 cd tap for all devices, except in mechanical, interstitial spaces where circuit loading shall be calculated at 110 cd tap.

D. Provide NAC panel power supplies and batteries to provide power for all devices at calculated values plus 25% spare capacity.

E. Where they are used, “NAC Power Booster Panels” shall be individually supervised. Interconnecting NAC Booster Panels in a manner, which prevents identification of individual panel TROUBLE conditions, shall not be approved. NAC Booster Panels shall be wired to dedicated branch circuits.

F. Remote Control Panels, NAC panels, and any other distributed system components shall be installed in 2 hour rated rooms only.

2.18 MULTIPLEXED PERIPHERAL DEVICES

A. Devices shall be supervised for trouble conditions.

B. Failure of device shall not hinder operation of other system devices.

C. Device Identification

(1) Each intelligent device shall be identified by an address code.

(2) Location of end-of-line device shall be indicated on device that containing same.

(3) System must verify that proper type device is in place and matches software configuration.

D. Intelligent Detector Bases

(1) Either base or head shall contain electronic circuits that communicate detector's status (normal, alarm, sensitivity status, trouble) to Control Panel over two wires. Same two wires shall also provide power to base and detector.

(2) Contacts between base and head shall be of bifurcated type using spring-type, self-wiping contacts.

(3) Base shall have locking capability. Locking feature must be field removable when not required.

(4) Upon removal of detector's head, trouble signal shall be transmitted to Control Panel.

(5) Detector base shall be sealed against rear airflow entry.

(6) Detector base or head shall contain LED(s) that flash when detector is being scanned by Control Panel.

(7) LED(s) shall turn on steady when detector is in alarm condition.

(8) Removal of detector from base shall not affect operation of other devices on loop.

E. Intelligent Detector Heads - General

(1) Intelligent detector heads shall be low-profile type.

(2) Bases or detectors shall include a test mode for smoke detectors to transmit sensor analog detection percentage and verification mode to Fire Alarm Control Panel and printer.

(3) Heads shall be plug-in units, which mount to common base.

(4) Heads shall be 24 VDC type.

(5) Heads may be reset by actuating Control Panel reset switch.

(6) To minimize false alarms, voltage and RF transient suppression techniques shall be employed.

(7) Smoke detectors:

(a) Listed for sensitivity testing from Control Panel. Sensitivity test results shall be logged and downloaded to printer.

(b) Include an insect screen.

(c) Communicate actual smoke chamber values to Control Panel.

(d) Be provided with and covered with device manufacturer provided plastic cones after installation to maintain cleanliness. Cones shall be red for quick visual identification for removal at time of occupancy.

(8) Install smoke detectors on circuits with alarm verification possible. Only enable fire alarm verification mode when directed by project engineer after occupancy.

F. Intelligent Photoelectric Smoke Detectors

(1) Detectors:

(a) Contain no radioactive material

(b) Be of solid state photoelectric type and shall operate on light scattering photodiode principle using pulsed infrared LED light.

(c) Have sensitivity monitored to determine changes in environmental conditions. Value of smoke density for each detector shall be transmitted to Fire Alarm Control Panel.

(d) UL 268, 8th Edition multi-criteria based detectors.

G. Intelligent Heat Detectors

(1) Detectors shall:

(a) Be a combination rate-of-rise and fixed temperature 135°F (57°C) (unless noted otherwise on plans).

(b) Sense within temperature range of -32°F to 158°F (-35°C to 70°C). The control panel shall be capable of sensing either a set point of 135°F (57°C), or a rate-of-rise of 15°F (8.3°C) per minute for fire sensing.

H. Intelligent Duct Smoke Detectors:

(1) Duct detectors shall be of photoelectric type.

(2) Provide each duct detector with duct mount housing sampling tubes sized according to duct width in which detector is installed. Verify characteristics of ductwork with Mechanical Contractor prior to purchase and installation. Tubes 48” and shorter shall be supported at far end by support inside duct. Tubes longer than 48” shall be supported with strap hanger. Supports shall not cover tube sampling holes.

(3) Detectors shall be rated for temperature and air velocity in ductwork in which they are installed. Verify characteristics with Mechanical Contractor prior to purchase and installation.

(4) Duct Smoke Detectors: Installation shall comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

(5) It shall be possible to initiate duct detector alarm condition by using remote or local test switch.

(6) Provide remote test switch and alarm LED indicator for each duct smoke detector.

(7) It shall be possible to clean sampling tubes by access through duct housings front cover.

(8) Provide addressable output relay modules within 36” of motor controller or starter where fan motor control is noted on plans.

(9) Remote keyed test switch and LED alarm indicator for each duct detector shall be provided in nearest corridor and grouped together for all duct detectors located within 30' of each other. A black engraved label with white letters shall be affixed to each test switch/indicator to list air handler system associated with duct and closest room number/location of detector.

(10) In mechanical rooms, alarm LED indicators and test switches shall be grouped together so devices are readily visible and neatly organized.

(a) Mount adjacent to main mechanical room door.

(b) Each LED shall be labeled with detectors loop and address.

(c) Floor plan of room showing detectors and addresses shall be located adjacent to cover plate.

(d) Provide Plexiglas cover over plan.

(e) A black engraved label with white letters shall be affixed to each test switch/indicator to list air handler system associated with duct.

I. Manual Stations

(1) Manual stations:

(a) Double-action mechanism pull down type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

(b) Activate building coded alarm condition when pulled.

(c) Be provided with a key operated mechanism to sound building fire alarm.

(d) Be constructed of high impact, red Lexan with raised white lettering and smooth high gloss finish. Recessed backbox mounted.

(e) Contain circuits that communicate station's status (alarm, normal) to Control Panel over 2 wires.

(f) Mechanically latch upon operation and remain so until manually reset. Stations, which use Allen wrenches or special tools to reset shall not be accepted.

(g) Station Reset: Key operated switch shall match the control panel key.

(h) Be fitted with screw terminals for field wire attachment.

(i) The manual pull station shall have an addressable intelligent module integral of the unit.

(j) Manual pull stations that initiated an alarm condition by opening the unit are not acceptable.

(2) Address shall be field programmable on station.

J. Interface Modules - General

(1) Interface Modules:

(a) Receive 24 VDC power from separate two wire circuit

(b) Available in either Class B or Class A supervision version

(c) Supervised and identified by Control Panel

(d) Capable of being programmed for its "address" location

(e) Compatible with addressable manual stations and intelligent detectors on same intelligent initiating circuit

(2) Class A wiring shall be looped back and connected to module.

(3) Class B wiring shall be supervised by an end-of-line device.

(4) Should interface module become non-operational or removed, trouble signal shall be transmitted to Control Panel.

(5) Interface module LED's shall be clearly visible on the face of the trim plate.

K. Interface Modules – Addressable Output Modules (Supervised Control and Relay Modules)

(1) Addressable Output Modules shall be supervised and used for AHU system interface, building automation system interface, smoke damper control, door security interface and other relay modules as indicated on plans.

(2) Addressable Output Control Modules shall be supervised and used for control of indicating appliances, and other internal fire alarm system functions.

(3) For signals, speakers, and other device control interface module shall provide double-pole/double-throw relay switching that can connect any of the following through 2 amp fuses:

(a) Zone of signals to power source

(b) Speakers to audio source

(c) Strobes to power supply

(d) Variety of controlled devices to appropriate controlling circuits.

(4) Interface addressable output relay modules shall:

(a) Communicate supervised wiring status (normal, trouble) to fire alarm control panel.

(b) Receive from fire alarm control panel command to transfer relay.

(c) Be provided with red LED which shall flash each time relay module communicates with fire alarm control panel polling.

(5) All relay modules shall be provided with minimum two sets of contacts rated for the intended connected load. One set of contacts shall be used for the intended control function and the other set used for secondary functions such as monitoring or confirmation of contact closure by the building automation system. Provide addressable control relay circuit modules shall provide two (2) form C dry relay contacts rated at 120Vac and 24Vdc @ 2 amps to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware. The module shall be suitable for mounting on North American 2-1/2" (64 mm) deep 1-gang boxes and 1-1/2" (38 mm) deep 4” square boxes with 1-gang covers.

(6) Where loads connected to relay or control modules exceed standard contact ratings, provide additional relay with contact/voltage ratings sufficient for the connected load. Such sub-relays shall be driven by fire alarm addressable relay/control module and shall be listed for use in fire alarm systems.

L. Interface Modules – Addressable Input Monitor Modules (Supervised Monitor Modules)

(1) Interface Monitor Modules shall:

(a) Be suited for monitoring of waterflow, building automation system, automatic transfer switches, generator status, fire pump status, valve tamper, non-intelligent detectors and other functions indicated on plans.

(b) Addressable interface module shall be provided for interfacing normally open direct-contact devices to an intelligent initiating circuit.

(c) Provide power to and monitor status of zone consisting of conventional 2-wire smoke or heat detectors and N/O contact devices.

(d) Communicate zone's status (normal, alarm, trouble) to Control Panel.

(e) Be provided with red LED which shall flash each time relay module communicates with fire alarm control panel polling.

(2) Supervision of zone wiring shall be Class A or Class B as required by type of loop installed on.

(3) No t-taps of monitor module wiring shall be permitted.

2.19 AUDIBLE/VISUAL DEVICES

A. Combination Speaker/Strobe Devices

(1) Speakers, Strobes, and Speaker/Strobe devices shall be wall or ceiling mount as indicated on plans.

(2) Speakers:

(a) Operate on 25 VRMS circuit to match fire alarm system amplifiers

(b) Include separate wire leads for in/out wiring for each leg of associated signal circuit. T tappings of Class A signal device conductors shall not be acceptable.

(c) Be suitable for rear mounting behind audio-visual assemblies, which shall be flush or semi-flush mounted, with manufacturer back boxes and flush trim ring.

(d) Have field adjustable output taps, 4 taps minimum. 1/4W, 1/2W,1W, 2W.

(e) Provide minimum sound pressure level of 87 dBA (UL Listed Reverberant) at 10 ft (3 m) using 1-watt tap. 80dBA @ 1/4W, 84dBA @ 1/2W, 87dBA @ 1W, 90dBA @ 2W. All measurements at 3m (10’).

(f) Speakers located in mechanical rooms shall have 4 taps minimum with 8W (98dBA Reverberant at 10 ft (3 m) being the highest.

(g) Include a blocking capacitor for line supervision and screw terminal for in-out wiring.

(h) T tappings of Class A signal device conductors shall not be acceptable.

(3) Strobes shall be:

(a) Operate at 24VDC circuit separate from Horn or Speaker circuit.

(b) Multi-tap units with taps at 15, 30, 75, and 110 cd.

(c) Tapped at 15-candela peak power or as noted on drawings.

(d) Have flash synchronization module on circuit when more than one strobe is visible at a time from any location.

(e) T tappings of Class A signal device conductors shall not be acceptable.

(f) On separate supervised circuit from speaker circuit.

(4) Clear Lexan lens

(5) Shall have "FIRE" in red lettering visible from a 180° field of view on each side of wall mounted devices and 360° field of view on ceiling mounted devices.

(6) Have white semi flush housing for ceiling or wall mounted devices in finished areas.

(7) White baffle with surface mounted back box, furnished by speaker manufacturer, where installed in unfinished areas.

(8) Cast metal grille and back box where installed in mechanical/interstitial spaces.

B. Speaker Only Devices

(1) Speakers without strobe units:

(a) Include features for speakers listed under Combination Speaker/Strobe Devices.

(b) T tappings of Class A signal device conductors shall not be acceptable.

C. Strobe Only Devices

(1) Strobes without strobe units:

(a) Include features for strobes listed under Combination Speaker/Strobe Devices.

(b) Operate at 24VDC circuit separate from Horn or Speaker circuit.

(c) Multi-tap units with taps at 15, 30, 75, and 110 cd.

(d) Tapped at 15-candela peak power or as noted on drawings.

(e) Have flash synchronization module on circuit when more than one strobe is visible at a time from any location.

(f) T tappings of Class A signal device conductors shall not be acceptable.

(g) On separate supervised circuit from horn or speaker circuit.

2.20 CONVENTIONAL PERIPHERAL DEVICES

A. Sprinkler Waterflow Switches - Wet Systems

(1) To be furnished and installed by Fire Protection Contractor under Division 21. Devices shall be monitored by fire alarm system via addressable monitor module.

(2) To prevent false alarms, flow switch shall incorporate adjustable time delay mechanism between the paddle-operated stem and alarm initiating contacts.

(3) Tapped 1/2” (16 mm) conduit connection

B. Sprinkler Valve Tamper Switches - Wet Systems

(1) Sprinkler valve tamper switches shall be furnished and installed by Fire Protection Contractor under Division 21. Devices shall be monitored by fire alarm system via addressable monitor module. Supervisory signal.

(2) Switch shall be provided with either 1 or 2 sets of S.P.D.T. micro switches as required.

C. Two-Way Radio Firefighter System Radio Monitoring

(1) Provide addressable monitor modules for supervisory monitoring at locations indicated on plans for monitoring of two-way firefighter radio system.

(a) Donor antenna malfunction

(b) Active RF emitting device failure

(c) Low-Battery capacity indication

(d) System component failure

(e) Loss of normal power

(f) Failure of battery charger

D. Door Holders

(1) Magnetic door holders:

(a) Provided by the General Contractor. Refer to Door Hardware Specification.

(b) Capable of being surface, flush, or semi-flush mounted as required by wall construction. Provide flush or semi-flush mounting in finished spaces.

(2) Power for door holders shall be 24 VDC.

(3) Power for door holders shall be accounted for in battery calculations and power provided to door holders from the fire alarm battery system to maintain doors open during any power outage. Include all door holder power requirements in battery calculations

E. Fault Isolator Module

(1) Provide Fault Isolator Module (FIM) on initiating device circuits in following situations:

(a) Loop extends to another floor

(b) Loop extends to another building

(c) For each 25 devices on a loop

(2) Fault Isolator Module shall:

(a) Automatically re-connect isolated section of loop upon correction of fault conditions.

(b) Not require any address setting

(c) Operations shall be totally automatic. It shall not be necessary to replace or reset FIM after its normal operation.

(d) Include LED, which shall flash under normal operation and illuminate steady to indicate short circuit.

2.21 ISOLATED LOOP CIRCUIT PROTECTORS (ILCP)

A. Fire Alarm Control Panel shall include Isolated Loop Circuit Protector (ILCP) on circuits which extend beyond building. Circuits include, initiating device circuits, alarm notification appliance circuits, and signaling line circuits.

B. ILCP shall:

(1) Be located as close as practical to point where circuits leave or enter building.

(2) Have line-to-line response time of less than 1 nanosecond.

(3) Have #12 AWG grounding conductor with maximum length of 25 ft (7.6 m). It shall be run in straight line and connected to building grounding electrode system.

C. Spark gap devices or devices incorporated in or installed within control panel in lieu of ILCP are not acceptable.

2.22 DACT TRANSMITTER

A. Provide digital alarm communicator transmitter for fire alarm signal transmission to UL listed central station monitoring system.

(1) Performance Based Compliance

(a) Equipment provided shall monitor the integrity of the transmission technology and communication path between the protected premises and the central station.

1) Equipment relying on a single communications path shall be supervised at an interval of not more than 60 minutes. Failure to complete signal transmission shall be annunciated at the protected premises.

2) Equipment relying on multiple communications paths shall meet the following requirements:

1. Each path shall be supervised within not more than 6 hour intervals

2. The failure of any path shall be annunciated at the supervising station within not more than 6 hours.

3. The failure to complete a signal transmission shall be annunciated at the protected premises.

(2) DACT shall employ one telephone line and one of the following technologies:

(a) One-way private radio alarm system

(b) Two-way RF multiplex system

(c) Transmission means complying with performance requirements.

B. Transmitter shall transmit alarm, supervisory, and trouble conditions to monitoring system.

C. Fire Alarm Control Panel shall be provided with Alarm, Supervisory, and Trouble signals to communicate with DACT communications device.

2.23 DOCUMENTATION ACCESSIBILITY.

A. Provide a documentation cabinet at the system control unit or at another approved location at the protected premises.

(1) The documentation cabinet shall be sized so that it can contain all necessary documentation.

(2) Cabinet shall be a tamper proof hinged enclosure, equipped with locking door,

(3) All record documentation shall be stored in the cabinet included but not limited to:

(a) Record drawings (as-builts)

(b) Equipment technical data sheets

(c) Alternative means and methods, variances, appeals, and approvals, and so forth

(d) Performance-based design documentation

(e) Risk analysis documentation

(f) Emergency response plan

(g) Evaluation documentation

(h) Software and firmware control documentation

(4) Where the documentation cabinet is not in the same location as the system control unit, its location shall be identified at the system control unit.

(5) The documentation cabinet shall be prominently labeled SYSTEM RECORD DOCUMENTS.

(6) Emergency communications system and fire alarm system record documentation shall be permitted to be maintained together in the same documentation cabinet.

PART 3 EXECUTION

3.01 GENERAL

A. Set strobe intensity of all strobe at rating indicated on plans. Set all speaker intensities at 1W tap unless otherwise indicated on plans.

B. Circuits Requirements:

(1) Signaling Line Circuits for Risers, Audio Riser, Network Communications, Communications to transponder, data gathering, or remote control panels, and NAC Power Supply Signaling Line Circuit wiring.

(a) Class B

(2) Signaling Line Circuits for Intelligent Analog Addressable Loop Serving a Floor:
  (a) Class B
  (b) No more than 200 detectors or 200 relay or monitor modules installed on a loop.
(3) Audible Speaker Device Circuit Serving Each Zone:
  (a) Class B
(4) Strobe Notification Appliance Circuit Serving Each Zone:
  (a) Class B
  (b) Maximum circuit loading to 2 amps for visuals.
(5) Horn Notification Appliance Circuit Serving Each Zone:
  (a) Class B
  (b) Maximum circuit loading to 2 amps for audibles.

C. Installation shall be done in neat, workmanlike manner in accordance with manufacturer's recommendations.

D. Smoke detectors shall not be mounted until construction is completed.

3.02 RACEWAYS

A. Fire Alarm System Wiring shall be in conduit system separate from other building wiring. See Section 26 05 33 - Raceway and Boxes for Electrical Systems.

B. Fire alarm conduit shall be red along the entire length of each piece of conduit with red color applied at factory as a standard finish available on conduit from manufacturer.

C. All Class A and Class X wiring methods shall use a separate conduit pathway for outgoing and return path. Minimum separation shall be 48” for horizontal wiring and 12” for vertical wiring

D. Minimum 3/4” (21 mm) steel raceway.

E. Contractor shall size conduit and boxes by circular mil size of cable in conduit or box.

F. Surface access to existing alarm initiating circuits in public areas shall be via surface metal raceways (minimum equivalent to 3/4” (21 mm) conduit) and box extensions.

G. Existing conduit and surface metal raceway that are not 3/4” (21 mm) size may be reused if found to have adequate space for existing and new conductors and meet all other specification and code requirements.

3.03 CONDUCTORS

A. Cables and wires shall be provided per manufacturer shop drawings. Cables shall be copper with stranded or solid conductors. Provide grounded shielding on conductors as recommended by manufacturer to eliminate interference and to provide required system performance.

B. All wiring and installations of the systems specified in this specification shall be installed in accordance with all provisions of the National Electrical Code Article 760 and International Building Code and International Fire Code as adopted by the AHJ.

C. Wiring between contacts provided by devices being monitored by fire alarm system through monitor modules shall be provided and terminated by fire alarm Contractor.

D. Fire Alarm system wiring, visual strobe circuit wiring, and one-way voice communication system wiring shall be separately and individually zoned per smoke zones per floor indicated on fire alarm plans. Dedicated conduits and wiring per zone shall be provided.

E. All horizontal fire alarm system wiring, visual strobe circuit wiring, and one-way voice communication system wiring originating or traveling through a smoke zone other than the zone being served shall be installed in conduit with UL 2196 Listed 2 hour rated Fire Alarm cable circuit protective system listed for fire alarm wiring applications or other architectural or structural methods recognized by applicable versions of NFPA 72 for 2 hour protection of the wiring.

F. All vertical fire alarm system wiring, visual strobe circuit wiring, and one-way voice communication system and system riser wiring shall be installed in conduit in 2 hour rated construction shafts, enclosures, or spaces or rooms dedicated to 2 hour rated protection of electrical equipment and wiring. Where vertical fire alarm system wiring, visual strobe circuit wiring, and one way voice communication system and system risers are outside of 2 hour rated construction shafts, enclosures, or spaces or rooms dedicated to 2 hour rated protection of fire alarm equipment and wiring, the wiring shall be installed in conduit with UL 2196 Listed 2 hour rated Fire Alarm cable circuit protective system listed for fire alarm wiring applications. Cables shall be rated for use in risers.

G. Upon entering the smoke zone served on the floor, for the horizontal fire alarm system wiring, visual strobe circuit wiring, and one-way voice communication system wiring and conduit entering the smoke zone on the floor being served, standard insulation fire alarm wiring conductors in conduit may be provided for that portion of the wiring that remains entirely in the smoke zone after terminating on the first device in the smoke zone being served.

H. Conductors shall be color-coded. Coding shall be consistent throughout facility. Match existing building color code in existing buildings.

I. Green wire shall be used only for equipment ground.

J. Control Panel power wiring shall be #12 AWG.

K. Control Panel shall have #12 AWG equipment ground wire.

L. Where fire alarm circuits enter or leave building, additional transient 75 to 90 V gas tube protection shall be provided for each conductor.

M. Cable Detector Loops shall be twisted pair with shield jacket. Shield shall be connected to earth ground only at control panel.

N. Detector wiring shall not be in same conduit with 120/240 VAC wiring or other high current circuits.

O. T-taps or branch circuit connections allowed for Class B intelligent loop circuits.

P. Leave 8” (200 mm) wire tails at each device box and 36” (900 mm) wire tails at Control Panel and Remote Annunciator Panel(s).

Q. Cable for RS 232-c devices (CRT, PRINTER) shall be two, shielded twisted pair.

R. Cable for RS 485 devices (Remote Annunciators) shall be shielded-twisted pair for data signal.

S. Wiring of initiating device circuits, horn circuits, speaker circuits, and strobe circuits shall be #14 AWG minimum.

T. Fire alarm cable shall be held in place at device box by means of 2-screw connector, (do not use squeeze or crimp type connectors).

U. Splices or connections shall be made within approved junction boxes and with approved fittings.

V. Boxes shall be red and labeled "FIRE ALARM SYSTEM" by decal or other approved markings.

W. Speaker and strobe circuits shall have separate conductors, and shall operate independently of each other.

X. All wiring methods provided for cables and conduits requiring 2 hour protection shall be provided with the specific conduit, supports, hangers, boxes, materials, raceway couplings, connectors, and installation methods as required to obtain the UL listing for 2 hour protection. These products may differ from those provided for other DIVISION 26 or DIVISION 28 wiring but shall be provided to maintain 2 hour protection per UL.

3.04 DEVICE MOUNTING

A. Recommended mounting heights, and requirements are as follows:

(1) Fire Alarm Control Panels

(a) Mount control panel so visual indicators and controls at maximum 60” (1530 mm) above floor level.

(2) Remote Annunciators

(a) Mount panel so visual indicators and controls at maximum 60” (1530 mm) above floor level.

(b) Install multi-gang box as required by manufacturer, flush or surface mounted. Provide flush mounted in finished spaces. Surface mount only acceptable in unfinished spaces such as mechanical rooms or electrical rooms.

(3) Audio-Visual Devices

(a) Install wall mounted visual only and visual/audible devices flush, semi-flush or surface mount devices 80” (2030 mm) from bottom of device to finished floor and 6” minimum below finished ceiling. Verify with heights indicated on drawings. Semi-flush mounting shall be provided in finished spaces. Surface mount not allowed in finished spaces.

(b) Install wall mounted audible only flush, semi-flush, or surface mount devices 80” (2030 mm) from bottom of device to finished floor and 6” minimum below finished ceiling, verify with heights indicated on drawings. Semi-flush mounting shall be provided in finished spaces. Surface mount not allowed in finished spaces.

(c) Surface mount devices acceptable only in unfinished spaces such as mechanical rooms, electrical rooms, shell spaces.

(d) No devices protruding 4” (100 mm) or more shall be installed lower than 80” (2030 mm).

(e) Audio/visual devices may be installed on the ceilings in accordance with NFPA 72. Refer to plans for mounting locations.

(f) Use manufacturer recommended backboxes.

(g) For surface mounting, use manufacturer-supplied backboxes and trim plates.

(h) Mark each device with its circuit number.

(4) Manual Stations

(a) Manual stations shall be in unobstructed locations.

(b) For surface mounting, use manufacturers supplied backboxes and trim plates

(c) Mark unit’s address on inside and outside of housing.

(5) Heat and Smoke Detectors

(a) Location of detectors shown on plans is schematic only. Detectors must be located according to code requirements.

(b) Surface mounted detectors shall be installed using back boxes equal to base size. Standard octagon and square boxes are not acceptable.

(c) Detectors shall be located on the highest part of smooth ceiling so that edge of detector is no closer than 4” (100 mm) from sidewall.

(d) Ceilings with beams, joists or soffits that exceed 8” (200 mm) in depth require special planning and closer spacing.

(e) Mount detectors on sidewalls with top of detector no closer than 4” (100 mm) from ceiling and no further away than 12” (300 mm).

(f) Smoke detectors shall not be installed closer than 3 ft (1 m) from air supply diffusers.

(g) No detectors shall be installed in direct airflow.

(h) Mark zone number and ranking of each detector on its base.

(i) Mark address and loop number on each detector's base.

3.05 ADDITIONAL DEVICES

A. Per NFPA 72, in addition to smoke detectors illustrated on plans, provide a smoke detector located within 5’ of each fire alarm system control panel such as NAC panels, transponders, data gathering panel, remote control panels, power supplies, fire alarm control panel, remote annunciators, and all other electrical system components which comprise the system described in this specification.

B. Plan drawings do not show all devices, modules and components required to accomplish specified system operation. Provide all materials necessary for a fully functioning system.

C. Provide 2 additional alarm initiating devices of each type (smoke detector, heat detector, pull station) completely wired and programmed per floor. Devices and appliances to be located in the field by the engineer during the construction period.

D. Provide 2 additional notification appliances (of each type – strobe only, speaker only, combination speaker/strobe) completely wired and programmed per floor. Devices and appliances to be located in the field by the engineer during the construction period.

3.06 DEMOLITION

A. Existing equipment that is removed shall be inventoried and turned over to Owner

B. Upon inspection by Owner, Contractor shall dispose of equipment that is deemed useless to Owner.

C. Contractor shall remove abandoned devices and conduit not being reused.

3.07 IDENTIFICATION LABELS

A. Junction boxes shall be painted red and labeled "Fire Alarm.”

B. All wiring must be labeled with name of circuit and area being served by circuit. Provide labels within 6” of wiring termination within panels and enclosures.

(1) Labels shall be permanent, and be machine generated. Handwritten or non-permanent labels will not be accepted.

(2) Labels shall be self-laminating, white/transparent vinyl and be wrapped around each cable or cable sheath when grouped together in sheath.

(3) Flag type labels are not allowed.

(4) Labels shall be of adequate size to accommodate circumference of cable being labeled and properly self-laminate over full extent of printed area of label.

C. Label each initiating device using machine printed label to indicate device address. Provide label with black text on white background.

D. Label each notification device using machine printed label to indicate circuit supplying that device. Provide label with black text on white background. Label shall separately indicate strobe circuit and speaker circuit. Provide EOL label for devices that contain end of line resistors.

E. Adhesive type labels not permitted except for phase and wire identification.

F. Wiring color code shall be maintained throughout installation.

G. Green wire shall be used only for equipment ground.

3.08 MANUFACTURER'S SERVICES

A. Supervision of installation shall be provided by trained service technician from manufacturer of fire alarm equipment.

B. Technician shall be US certified and have had minimum of 2 years of service experience in fire alarm industry.

C. Technician's name shall appear on equipment submittals, and letter of certification from fire alarm manufacturer shall be sent to project engineer.

D. Manufacturer's service technician shall be responsible for following items:

(1) Pre-installation visit to job site to review equipment submittals and verify method by which system shall be wired.

(2) Make periodic job site visits to verify installation and wiring of system.

(3) Upon completion of wiring, final connections shall be made under supervision of technician.

(4) At time of final checkout, technician shall give operational instructions to Owner and/or his representative.

(5) Job site visits shall be dated and documented in writing and signed by Electrical Contractor.

(6) Discrepancy shall be noted on document and copy kept in system job folder, which shall be available to project Engineer any time during project.

3.09 TESTING

A. Manufacturer's authorized representative shall perform complete functional test of each system and submit written report to Contractor attesting to proper operation of completed system prior to final inspection.

B. Contractor shall test each device in system before system is considered substantially complete.

C. Completed fire alarm system shall be fully tested by Contractor in presence of Owner's representative and local Fire Marshal.

D. Upon completion of successful test, Contractor shall:

(1) Certify system to Owner in writing

(2) Complete NFPA 72 record of completion form

(3) Provide as-builts and O&M manuals

3.10 WARRANTY

A. Warrant completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of 2 years from the date of substantial completion of project.

B. Post warranty period along with company’s name and telephone number inside fire alarm panel.

C. Warranty service for equipment shall be provided by system supplier's factory trained representative.

D. Warranty shall include parts, labor, and necessary travel.

E. Occupied facility shall not be without UL and NFPA approved and fully operational fire alarm system for period longer than 2 hours. Emergency response shall be provided within 2 hours of notification, to Contractor, of failure of system to perform operationally per UL and NFPA standards.

F. Non-emergency service calls shall be responded to within 24 hours of notification to Contractor.

G. Repairs and/or replacement shall be completed within 72 hours of time of notification. Other than emergency, actual repairs and/or replacement shall be provided during normal working hours, Monday through Friday, excluding holidays.

H. If repair and/or replacement cannot be made within prescribed time, other means and methods of protection shall be provided to ensure safety of building occupants during which time system is not in compliance with standards. This may involve up to and include hiring Owner approved qualified personnel to stand fire watch, at Contractor's expense.

3.11 TRAINING

A. Contractor shall provide minimum of 8 hour system operation training for Owner, Architect/Engineer, and fire department personnel.

B. Training session shall be at a time to be stipulated by Owner.

C. Training shall be completed prior to final inspection.

3.12 MAINTENANCE CONTRACT

A. Equipment manufacturer shall make available to Owner, maintenance contract proposal to provide minimum of 2 inspections and tests per year in compliance with NFPA-72 Codes.

3.13 SPARE PARTS

A. Contractor shall provide the following spare parts in quantities shown, with a minimum of 1/item:

Quantity	Type of Device Present
10%	Photoelectric smoke detectors
10%	Heat detectors
10%	Smoke and heat detector bases
10%	Addressable Input Monitor Modules

Quantity	Type of Device Present
10%	Addressable Output Control and Relay Modules
1%	Duct detectors with housing and sample tubes
1%	Speaker Units (each type)
1%	Speaker/strobe Units
1%	Strobe Units
1%	Manual Stations

END OF SECTION 28 46 10

END OF DIVISION 28

DIVISION 31 - EARTHWORK

SECTION 31 11 00 – CLEARING AND GRUBBING

SECTION 31 20 00 – EARTH MOVING

SECTION 31 22 16 – FINE GRADING

SECTION 31 23 16 – EXCAVATION – NO BLASTING

SECTION 31 25 00 – EROSION AND SEDIMENTATION CONTROLS

SECTION 31 63 29 – DRILLED CONCRETE PIERS

SECTION 3 05 – UNIT PAVING

SECTION 31 1100 - CLEARING AND GRUBBING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Clearing and grubbing site and street right-of-way.

B. Disposing of removed material

1.02 RELATED WORK

A. Section 31 2000 – Earth Moving.

1.03 SUBMITTALS

A. See Related Work

PART 2 PRODUCTS

A. No Products included

PART 3 EXECUTION

3.01 SITE PREPARATION & PROTECTION

A. Protection of Existing Improvements.

1. Provide protections necessary to prevent damage to existing improvements indicated to remain in place.
2. Protect improvements on adjoining properties.
3. Restore damaged improvements to their original condition, as acceptable to Architect/Engineer or other parties having jurisdiction.

B. Protection of Existing Trees and Vegetation:

1. Protect existing trees and other vegetation, indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bank, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.
2. Water trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.
3. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in manner acceptable to the Architect/Engineer. Employ qualified tree surgeon/arborist to repair damage to trees and shrubs.

3.02 SITE CLEARING

A. General: clear construction areas of trees, vegetation, improvements, debris, or other obstructions interfering with installation of new construction. Remove such items elsewhere on site or premises as specifically indicated. Tree removals include the removal of root balls and roots.

B. Removal of Improvements: Remove above-grade and below-grade improvements necessary to permit construction, and other work as indicated.

C. Abandonment or removal of certain underground pipe or conduits may be shown on mechanical or electrical drawings, and is included under work of this section. Removal of all other abandoned underground piping or conduit interfering with construction is included under this section.

3.03 DISPOSAL OF WASTE MATERIALS

A. Burning is not permitted on Owner's property.

B. Remove cleared waste materials from Owner's property and dispose of at an off site location secured by the contractor.

END OF SECTION 31 11 00

SECTION 31 20 00 - EARTH MOVING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Stripping and stockpiling surface layer of topsoil and organic matter in building and traffic areas and in all cut and fill areas.

B. Removing and disposing of material unsuitable for use in controlled fill.

C. Excavating site to required subgrade for controlled fill and grading site to required slopes.

D. Placing and compacting excavated material and borrow material to required density and at required subgrade and slope for structures, pavement areas, and other controlled fills.

1.02 RELATED WORK

A. Section 31 2216 – Fine Grading.

B. Section 33 0516 – Manholes and Structure.

1.03 REFERENCE STANDARDS

A. ASTM D422 – Particle Size Analysis of Soils.

B. ASTM D4318 – Test for Liquid Limit of Soils.

C. ASTM D4318 – Test for Plastic Limit of Soils.

D. ASTM D2216 – Method of Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures.

E. ASTM D3017 – Moisture Content on Soil Aggregates in Place by Nuclear Methods (Shallow Depth).

F. ASTM D698 – Standard Test Method for Moisture Density, Relations of Soils, and Soil Aggregate Mixtures Using 5.5 lb Rammer and 12” Drop.

G. ASTM D1557 – Standard Test Methods for Moisture Density Relations of Soils and Soil Aggregate Using 10 lb. Rammer and 18” Drop.

H. ASTM D2922 – Density of Soil and Soil Aggregates in Place by Nuclear Method (Shallow Depth).

1.04 SUBMITTALS

A. See Related Work

1.05 SITE CONDITIONS

A. Establish positive surface drainage during and following clearing and grading activities using proper ditching and sloping methods.

B. Provide erosion control measures to prevent mud and slit from flowing onto adjacent property.

C. Erect sheeting, shoring, and bracing as necessary for protection of persons, utilities improvements, and excavations.

PART 2 PRODUCTS

2.01 SUITABLE MATERAILS FOR CONTROLLED FILL

A. On site excavated soils:

1. Unified Soils Classification Systems Soils.
    a. Class SC
    b. Class GC
    c. Class CL
2. Soils having Liquid Limit of less than 45, Plasticity Index (PI) of 20 or less.
3. Other soils approved by the Engineer.

B. Borrow Material:

1. Soils meeting the requirements of sub-paragraph A.1 of this Article.

C. Material meeting the requirements of selected material as described in Section 210 of the Arkansas State Highway Department’s Standards Specifications for Highway Construction, Edition of 2003.

2.02 UNSUITABLE MATERIAL FOR CONTROLLED FILL

A. All areas: Organic top soils, soils containing roots, vegetable matter, or trash, and silts (ML) and clays (CH), and cobbles and fractured rock more than 3 inches in greatest dimension.

PART 3 EXECUTION

3.01 SUBSURFACE INVESTIGATION

A. The Contractor is responsible for having a thorough knowledge of all Drawings, Specifications, General and Supplementary Conditions, existing site conditions, and other Contract Documents. Failure to acquaint himself with this knowledge does not relieve him of the responsibility for performing his work in a manner acceptable to the Owner. No additional compensation will be allowed because of conditions that occur due to failure by the Contractor to familiarize himself and all workers with this knowledge.

B. Protection of Existing Trees and Vegetation:

1. Protect existing trees and other vegetation, indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bank, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.
2. Water trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.
3. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in manner acceptable to the Architect/Engineer. Employ qualified tree surgeon to repair damage to trees and shrubs.

3.02 PREPARATION

A. Complete clearing work, removing visible unsuitable materials from site.

B. Protect benchmarks, site corner pins and existing street paving from damage by equipment.

C. Stake the work:

D. Before starting the excavation, establish location and extent of underground utilities occurring in work area.

E. Notify utility companies of lines which are in the way of excavation.

F. Protect existing utility lines to remain which pass through the work area.

G. Protect utility services uncovered by excavation.

H. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

I.Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

3.03 EXCAVATION PROCEDURES

A. Excavation General:

1. Strip topsoil in cut and fill areas to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material. Remove and dispose of heavy growth of grass and surface debris from areas prior to stripping topsoil.
    a. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to main root system.
2. Stockpile topsoil in storage piles in areas shown, or where directed. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent wind-blown dust.
3. Remove soft or spongy material at the exposed sub-grade of cut and fill areas and replace with approved material and compact.
4. Use all suitable excavated material, as far as practicable, in the formation of controlled fills and fill slopes.
5. Keep all excavations dry by pumping or draining water from the Work.
6. In cut areas where fill is not required proof roll the areas with a loaded tandem axle dump truck or similar equipment to aid in identifying soft areas. Remove soft soils and replace with controlled fill. Scarify exposed sub-grade soils to a depth of at least 8 inches, adjust the soil mixture, and recompact to the same density as required for each layer of controlled fill.
7. Grade excavated slopes to a neat, smooth condition with no loose material or scars left on the surface.
8. Dispose of debris, excess topsoil, excess fill material and unsuitable material at an off site location secured by the contractor.

3.04 CONTROLLED FILL

A. After excavation and before fill placement, proof roll fill areas with a loaded tandem axle dump truck or similar equipment to aid in identifying soft areas. Remove soft areas and replace with controlled fill.

B. Scarify cleared surface in fill areas to a depth of at least 8 inches, adjust the soil mixture, and recompact to the same density as required for each layer of controlled fill.

C. Place fill material in lifts no greater than 8-inch loose-lift uniform thickness and compact to 95% MAX Dry Density as determined by the Modified Proctor Test, ASTM D1557.

1. Aerate material when too wet by manipulation with suitable equipment before compacting.
2. Add water when soil is too dry and mix with the material before compacting.

D. Complete excavation and controlled fill elevations to match finish grade, less the depth of topsoil specified for sodded and seeded areas in the landscape plan.

3.05 FIELD QUALITY CONTROL

A. Field density tests will be performed per ASTM D6938.

B. Frequency of Tests:

1. Tests shall be made every day fill is being placed and representative lifts tested.
2. At least one test per 2,500 sq. ft. under buildings and structural areas.
3. At least one test per 5,000 sq. ft. under paved areas.
4. At least one test per 10,000 sq. ft. in general areas.
5. Contractor to notify engineer when fill work is in progress.
6. Test locations will be selected at random by engineer with an effort made to select areas of questionable compaction.
7. Retesting required because of nonconformance to specified requirements shall be performed by the same agency on instruction from the engineer.
8. Retesting required because of nonconformance to specified requirements shall be paid for by the contractor. Payment for retesting or re-inspection will be charged to the contractor by deducting testing charges from the contact sum/price.

END OF SECTION 31 20 00

SECTION 31 22 16 - FINE GRADING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Stripping and stockpiling surface layer of topsoil and organic matter in all cut and fill areas.

B. Excavating and grading open drainage ditches.

C. Placing and compacting excavated material or borrow material to required density and at required subgrade and slope for roadway embankment and other compacted fills.

D. Removing and disposing of excess excavated material.

1.02 RELATED WORK

A. Section 31 2000 – Earth Moving.

B. Section 33 0516 – Manholes and Structure.

1.03 SUBMITTALS

A. See Related Work

1.04 SITE CONDITIONS

A. Establish positive surface drainage during and following stripping, embankment construction, and roadway grading by proper ditching or slopping.

B. Provide measures to prevent mud and silt from flowing onto adjacent property.

C. Erect sheeting, shoring, and branching as necessary for protection of persons, improvements, and excavations.

PART 2 PRODUCTS

2.01 SUITABLE MATERIAL FOR COMPACTED EMBANKMENT

A. On site excavated soils:

1. Unified Soils Classification Systems Soils.
    a. Class SC
    b. Class GC
    c. Class CL
2. Soils having Liquid Limit of less than 45, Plasticity Index (PI) of 20 or less.
3. Other soils approved by the Engineer.

B. Borrow Material:

1. Soils meeting the requirements of sub-paragraph A.1 of this Article.

C. Material meeting the requirements of selected material as described in Section 210 of the Arkansas State Highway Department's Standards Specifications for Highway Construction, Edition of 2014.

2.02 UNSUITABLE MATERIAL FOR COMPACTED EMBANKMENT

A. All areas: Organic topsoil's, soils containing roots, vegetable matter, or trash, and cobbles and fractured rock more than 3 inches in greatest dimension.

PART 3 EXECUTION

3.01 PREPARATION

A. Remove visible unsuitable materials from the site before beginning stripping and site grading operation.

B. Notify Architect/Engineer when work is ready to be staked.

C. Notify the geotechnical engineer representing the Owner's selected testing laboratory at least 48 hours before planned time to begin placing embankment material.

3.02 EXCAVATION PROCEDURES

A. Excavation, General:

1. Strip topsoil in cut and fill areas to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material. Remove and dispose of heavy growth of grass and surface debris from areas prior to stripping topsoil.
2. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to main root system.
3. Stockpile topsoil in storage piles in areas shown, or where directed. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent wind-blown dust.
4. Remove soft or spongy material at the exposed sub-grade of cut and fill areas and replace with approved material and compact.

5. Use all suitable excavated material, as far as practicable, in the formation of controlled fills and fill slopes.
6. Keep all excavations dry by pumping or draining water from the work site.
7. Grade excavated slopes to a neat, smooth condition with no loose material or scars left on the surface.
8. Protect existing asphalt paving and structures designed to remain from drainage by excavation and grading operations.
9. Dispose of debris, excess topsoil, excess fill material and unsuitable material at an off-site location secured by the contractor.

B. Excavation, roadway:

1. Excavate and grade to within ±0.1 foot of required subgrade elevations.
2. Grade back slopes to the slope shown on the Drawings.
3. Remove soft or spongy material at the exposed subgrade of cut and fill areas and replace with select material and compact to the same density as required for compacted fill. Identify soft areas by proof rolling with a loaded tandem axle dump truck or similar equipment.
4. DO not allow subsoil in roadbed area to become saturated. Maintain positive surface drainage during and following excavation, grading, and filling operations.
5. Where compacted fill is required, scarify stripped surface to a depth of at least 8 inches, adjust the soil moisture, and recompact to the same density as required for each layer of compacted fill.

3.03 COMPACTED EMBANKMENT

A. Start embankment full width of bottom of embankment cross-section and construct to specified grade over full width in uniform layers.

B. Place fill material in lifts no greater than 8 inch loose-lift uniform thickness and compact to a minimum of 95% of maximum dry density at or near optimum moisture content as determined by the Modified Compaction Procedures, ASTM D1557.

1. Add Water when soil is too dry and mix the material before compacting.
2. Aerate material when too wet by manipulation with suitable equipment before compacting.

C. Do not place next lift until the in-place density and moisture content of the preceding lift has been verified.

D. Geotechnical engineer will inspect and test soil for suitability for use in embankment and for need to perform additional “Proctors” as soil composition changes during progress of excavation. Do not compact layer of soil that geotechnical engineer has determined to be a “change in soil composition” until it has been determined to be suitable and a “Proctor” has been run.

E. Coordinate with the geotechnical engineer and provide the necessary assistance to perform the tests. Initial soil testing costs shall be paid for as outlined in the testing specification of the front-end documents. Should the tests be unsatisfactory, the Contractor shall be responsible for obtaining and paying for additional tests, which will be performed by an independent laboratory approved by Owner and Engineer.

F. Maintain stability of compacted embankment. Replace or repair portions which have eroded due to elements or to Contractor negligence.

G. Grade for slopes and other embankment areas not to be paved, to neat, smooth conditions with no loose material or scars left on surface. Fill and grade slopes to within three inches of finish grade elevations to allow for topsoil, sod and other landscaping.

3.04 PROTECTION

A. As soon as embankment is completed, proceed with riprap work and notify architect/Engineer that slopes are ready for erosion protection by landscaping contractor.

END OF SECTION 31 22 16

SECTION 31 23 16 - EXCAVATION

PART 1 GENERAL

1.01 WORK INCLUDED

A. Excavating rock encountered during trenching for utility lines and excavating for manholes by mechanical methods. Blasting is not allowed.

B. Disposing of excavated rock material.

1.02 RELATED WORK

A. Section 33 1100 – Water Utility Distribution Piping.

B. Section 33 3100 – Sanitary Utility Sewerage Piping.

C. Section 33 3900 - Sanitary Utility Sewerage Structures.

D. Section 33 0516 – Manholes and Structures.

1.03 SUBMITTALS

A. See Related Work

PART 2 PRODUCTS

2.01 MATERIALS

A. Definition of rock: All solid rock formation that, in the opinion of the Engineer, cannot be excavated by using power shovels or other power excavators which are of recognized manufacture and design, of adequate size and operated by qualified operators without continuous and systematic blasting, barring or wedging. It shall include boulders or pieces of detached rock exceeding one cubic yard in volume and solid rock formations which are interspersed with strata of clay or other material provided however that the solid rock constitutes at least 75% of the total volume of the particular formation. The conventional heavy-duty excavating equipment may be defined as a Caterpillar D-6 bulldozer with single tooth ripper, a Caterpillar 325 track excavator equipped with a single tooth ripper and rock teeth, or equipment of similar power and capability. Rock excavation volumes should be determined based on in-place measurements via cross sectioning. If excavation is to be unclassified, the contractor must be responsible for assessing rock excavation requirements.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify site conditions and note irregularities affecting work of this section.

B. Beginning work of this section means acceptance of existing condition.

3.02 ROCK EXCAVATION – GENERAL

A. Excavate rock encountered in excavating for manholes and trenching for water and sewer lines.

B. De-watering: Provide temporary adequate de-watering equipment to keep excavations free of standing water during rock excavation.

3.03 ROCK EXCAVATION – MECHANICAL METHOD

A. Excavate for and remove rock by the mechanical method.

B. Cut away rock at excavation bottom to form level bearing.

C. Remove shaled layers to provide sound and unshattered base for subgrade levels.

D. Remove Excavated Material from Site.

END OF SECTION 31 23 16

SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS

PART 1 GENERAL

1.01 WORK INCLUDED

A. This work shall consist of temporary erosion control measures needed to control erosion and water pollution, through the use of berms, sediments basins, sediments dams, silt fences, silt dikes, and temporary seeding.

B. Temporary erosion control measures shall be performed promptly when problems occur or when potential problems are anticipated in certain areas in order to minimize soil erosion. The temporary erosion control measures shall be properly maintained until permanent erosion control features are functioning properly.

C. The Contractor shall comply with all Federal, State, and Local laws and regulations controlling pollutions of the environments. The Contractor shall take necessary precautions to prevent pollution of streams, lakes, ponds and reservoirs with fuel, oils, bitumens, chemicals, soil sedimentation or other harmful materials and to prevent pollution of the atmosphere from particulate gaseous matter.

1.02 RELATED WORK

A. Section 31 1100 –Clearing and Grubbing

B. Section 31 2000 – Earth Moving

1.03 SUBMITTALS

A. See Related work.

1.04 QUALITY ASSURANCE

A. Prior to start of the construction, the Contractor shall submit, to the Owner and Engineer, his schedule for temporary and permanent erosion control work based on the Engineer's erosion control base plan, as is applicable for clearing & grubbing, grading and trenching. The location of the project, type of soil, topography and proximity to watercourses shall be considered when imposing such limitations.

PART 2 PRODUCTS

2.01 FILTER FABRIC

A. The filter fabric for silt fence shall be as indicated on the drawings.

PART 3 EXECUTION

3.01 PERMITTING

A. The Contractor shall file the Notice of intent to discharge storm water associated with the planned construction activity in accordance with the State of Arkansas NPSES General Permit ARR10A000 48 hours before starting construction. The Contractor shall develop a Storm Water Pollution Prevention Plan (SWPPP) document for submittal to ADEQ.

B. The Contractor shall be responsible for preparing all required permit applications and payment of all permitting fees as may be necessary for this project.

3.02 EROSION CONTROL

A. The Contractor shall schedule and conduct his operations in such a manner as to insure good erosion control practices so as to minimize soil erosion and prevent the contamination of and depositing of sediment in adjacent streams or other water courses, lakes, ponds, and other areas of water impoundment. Temporary erosion control measures which will contribute to the control of erosion and sedimentation shall be carried out in conjunction with clearing & grubbing, grading, and trenching operations.

B. Permanent erosion control devices or measures shall consist of culvert pipe, terraces, gutters, bituminous curb, sectional drains, permanent slope drains, and the establishment of permanent vegetation (seeding), and when included in the contract they shall be incorporated in the construction with the least delay. Trenched areas shall be seeded as the excavation proceeds to the extent considered necessary by the Engineer as desirable or practicable.

C. The Contractor shall also conform to the following practices and controls:

1. When the material is trenched, erosion of the slopes shall be controlled both during and after completion of the work, that erosion will be minimized, and sediment will not enter streams, wetlands or other bodies of water. Haul roads shall be located and constructed in a manner that will keep sediment from entering streams.
2. Pollutants such as fuels, lubricants, bitumens, raw sewage and other harmful materials shall not be discharged into or near rivers, streams or impoundments or into natural or manmade channels leading thereto. Wash water or waste from concrete mixing operation shall not be allowed to enter live streams.
3. All applicable regulations of agencies and statutes relating to the prevention and abatement of pollution shall be complied within the performance of the contract.
4. Dust Control:

a. Implement dust control methods to control dust creation and movement on construction sites and roads and to prevent airborne sediment from reaching receiving streams or storm water conveyance systems, to reduce on-site and off-site damage, to prevent health hazards, and improve traffic safety.

b. Control blowing dust by suing one or more of the following methods:

1. Mulches bound with chemical binders.
2. Temporary vegetative cover.
3. Spray-on adhesives on mineral soils when not used by traffic.
4. Tillage to roughen surface and bring clods to surface.
5. Irrigation by water sprinkling.
6. Barriers using solid board fences, snow fences, burlap fences, crate walls, bales of hay, or similar material.

c. Implement dust control methods immediately when dust is observed blowing on Site.

D. All temporary erosion and sediment control structures shall be constructed in accordance with the Storm Water Pollution Prevention Plan. All temporary structures shall be maintained in proper operating condition during the construction period. The temporary structures shall be removed, and the site cleaned up only after the end of the construction activity and the seeding and fertilizing operation has been completed and the grass has been established.

E. The contractor shall follow the general guidelines for placement of erosion and sediment control as indicated on the Erosion Control Plan as part of his SWPPP. The Contractor shall add any required additional erosion and/or sediment control devices as necessary to control erosion and sediment on the project site. The contractor shall use the Engineer's erosion control plan to comply with the SWPPP and it shall include as a minimum the following items:

1. Time scheduling for the various phases of the work designed to limit the time between the clearing and the temporary seeding and fertilizing to a reasonable period of time.
2. Temporary erosion control measures shall be included in the plan in accordance with the temporary erosion control details as included on the Erosion Control Plan.
3. A time schedule shall be included in the plan detailing when each erosion control structure shown on the plans is to be constructed. Each structure should be constructed as soon as practical after access to the site has been achieved and prior to major grading operations.
4. Temporary erosion control structures shall be maintained to function satisfactorily and all sediment and debris removed and disposed of in a manner acceptable to the Engineer.

3.03 INSPECTION

A. The Contractor shall appoint a qualified person(s) to conduct regularly scheduled inspections during his contract. Inspections shall be conducted, with a minimum frequency of every seven (7) calendar days or within 24 hours following the end of at least a 0.5-inch (1/2 inch) rainfall event, whichever is earliest. During the inspection, the following areas (as a minimum) will be inspected:

1. Disturbed Areas – All areas of disturbed soil i.e., bare soil with no ground cover shall be inspected for signs of washing and erosion.
2. Material Storage Area – All central storage areas where materials/chemicals are stored for signs of spill, leaks and possible contamination.
3. Erosion and Sediment Control Measures – Inspect all erosion and sediment control measures for signs of wear, damage, remaining capacity level, usefulness, etc.
4. Discharge Locations – Immediately following, and possibly during a significant rainfall event, inspect all discharge locations to ascertain the effectiveness of the control measures.
5. Entrance/Exit Locations –Inspect all exit points from the site for evidence of vehicle tracking.

B. The inspector shall complete an inspection form for each inspection performed. As a minimum, the inspection form shall contain the following information:

1. Name and location of project.
2. Name and title of the inspector.
3. Date and time of the inspection.
4. Condition of each of the above locations.

3.04 MAINTENANCE OF ROADWAYS

A. The existing paved roadways adjacent to the permitted entrance locations shall be maintained in a clean and passable condition by the Contractor. When required or as requested by the Owner of the Engineer, the Contractor shall broom or wash the existing paved roadways to remove excess mud or dirt at the intersection

and for a reasonable length of the existing roadway beyond the intersection. The work shall not be paid for directly but shall be considered incidental to the other items of work and the cost included as a part of the work.

3.05 PAYMENT

A. Payment for the work in this section shall be included as part of the lump sum contract.

END OF SECTION 31 25 00

SECTION 31 63 29 – DRILLED CONCRETE PIERS AND SHAFTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

(1) Drilled Piers.
(2) All work normally related to the above or specified under the Section.

B. Related Sections:

(1) Section 013200 “Construction Progress Documentation” for recording preexisting conditions and drilled-pier progress.
(2) Section 015000 “Temporary Facilities and Controls.”
(3) Section 311000 “Site Clearing” for preparation of subgrade for drilled-pier operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface.

C. Work installed but furnished under other Sections:

(1) Drilled Pier Reinforcing and Dowels: Furnished under Division 3, Section “Cast-in-Place Concrete.”
(2) Concrete for Drilled Pier: Furnished under Division 3, Section “Cast-in-Place Concrete.”
(3) Anchor Rods: Furnished under Division 3, Section for “Precast Concrete” and Division 5, Section for “Structural Steel.”

1.03 UNIT PRICES

A. Unit prices are included in Section 012200 “Unit Prices.”
B. Drilled Piers: Actual length of drilled piers in place and approved. Actual length may vary, to coincide with elevations where satisfactory bearing strata are encountered. Adjustments will be made on net variation of total quantities, based on design length for shafts.

(1) Base bids on indicated number of drilled piers and, for each pier, the design length from top elevation to bottom of shaft, and the diameter of shaft.
(2) Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, and other items for complete drilled-pier installation.

C. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed outside dimensions of drilled piers cast against rock. Unit prices for rock excavation include replacement with approved materials.
D. Trial Drilled Pier: Unit price as indicated for drilled pier, including backfilling.

1.04 SUBMITTALS

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

(1) Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Shop Drawings: For concrete reinforcement detailing fabricating, bending, supporting, and placing.
D. Qualification Data: For qualified Installer.
E. Welding certificates.
F. Material Certificates: For the following, from manufacturer:

(1) Cementitious materials.
(2) Admixtures.
(3) Steel reinforcement and accessories.

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

(1) Aggregates.

H. Field quality-control reports.
I. Other Informational Submittals:

(1) Record drawings.

J. Methods Statement: When ground surface elevation at time of drilling is more than 24 inches above top of drilled pier concrete elevation. See requirements herein.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.

(1) The Owner's testing and inspection agency shall be the project geotechnical engineer.

B. Testing Agency Qualifications: Qualified according to ASTM C1077, ASTM D3740, and ASTM E329 for testing indicated.
C. Welding Qualifications: Qualify procedures and personnel according to the following:

(1) AWS D1.1/D1.1M, "Structural Welding Code – Steel."
(2) AWS D1.4, "Structural Welding Code – Reinforcing Steel."

D. Drilled-Pier Standard: Comply with ACI 336.1, latest edition, unless modified in this Section.
E. Trial Drilled Pier: Construct trial drilled pier of diameter and depth and at location indicated or, if not indicated, of same diameter and depth as largest drilled piers, located at least three diameters clear of permanent drilled piers, to demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.
(1) Install reinforcement, fill with concrete, remove temporary casings, and terminate trial drilled pier 24 inches below subgrade and leave in place.
(2) Install permanent casings, excavate bell, excavate rock socket, and place slurry, as required for permanent drilled piers.
(3) If Architect determines that trial drilled pier does not comply with requirements, excavate for and cast another until it is accepted.
F. Preinstallation Conference: Conduct conference at Project site.
(1) Review methods and procedures related to drilled piers including, but not limited to, the following:
(a) Review geotechnical report.
(b) Discuss existing utilities and subsurface conditions.
(c) Review coordination with temporary controls and protections.
(d) Review testing and inspection requirements.
(e) Discuss concrete placement method.
(f) Installation of reinforcing.
(g) Drilling, casing (if necessary), cleaning and dewatering (if necessary) drilled shafts.
(h) Ground elevation at time of drilling relative to top of drilled pier concrete elevation.
(i) Drilling slurry.

1.06 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
(1) Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.
B. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
(1) Notify Architect no fewer than two days in advance of proposed interruption of utility.
(2) Do not proceed with interruption of utility without Architect's written permission.
C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of the geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
(1) Make additional test borings and conduct other exploratory operations necessary for drilled piers.
(2) The geotechnical report is included elsewhere in the Project Manual.
(a) The boring log and accompanying report are believed to be accurate; however, neither the owner, architect, or structural engineer guarantees the information contained therein, nor do they guarantee the conditions indicated to exist at the locations of the test holes will prevail at other locations on the site.
D. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
(1) Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.01 STEEL REINFORCEMENT

A. Meet the requirements of Section 033000, "Cast-in-Place Concrete."
B. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

2.02 CONCRETE MATERIALS

A. Meet the requirements of Section 033000, "Cast-in-Place Concrete."

2.03 STEEL CASINGS

A. Steel Pipe Casings: ASTM A283/A283M, Grade C, or ASTM A36/A36M, carbon-steel plate, with joints full-penetration welded according to AWS D1.1/D1.1M.
B. Corrugated-Steel Pipe Casings: ASTM A929/A929M, steel sheet, zinc coated.
C. Liners: Comply with ACI 336.1.

2.04 SLURRY

A. Slurry: Pulverized bentonite, pulverized attapulgite, or polymers mixed with water to form stable colloidal suspension; complying with ACI 336.1 for density, viscosity, sand content, and pH.

2.05 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.
C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
D. Proportion normal-weight concrete mixture as follows:
   (1) Compressive Strength (28 Days): 5000 psi.
   (2) Maximum Water-Cementitious Materials Ratio: 0.50.
   (3) Minimum Slump: Capable of maintaining the following slump until completion of placement:
      (a) 4 inches for dry, uncased, or permanent-cased drilling method.
      (b) 6 inches for temporary-casing drilling method.
      (c) 7 inches for slurry displacement method.
   (4) Air Content: Do not air entrain concrete.

2.06 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's “Manual of Standard Practice.”

2.07 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.
   (1) When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.
B. Ground surface at time of drilling shall preferably be within 24 inches of top of drilled pier. If ground surface at time of drilling is more than 24 inches above top of drilled pier elevation, contractor shall submit a methods statement explaining how top of concrete will be kept free of debris and how drilled pier and dowels will be protected from damage during subsequent excavation.

3.02 EXCAVATION

A. Construct drilled piers to indicated diameter and length with penetration into bearing material as indicated or directed by the on-site project geotechnical engineer. Use of permanent casing is not permitted.
B. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
   (1) Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time will be authorized for removal of obstructions.
C. Classified Excavation: Excavation is classified as standard excavation, special excavation, and obstruction removal and includes excavation to bearing elevations as follows:
   (1) Standard excavation includes excavation accomplished with conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work.
   (2) Special excavation includes excavation that requires special equipment or procedures above or below indicated depth of drilled piers where drilled-pier excavation equipment used in standard excavation, operating at maximum power, torque, and downthrust, cannot advance the shaft.
      (a) Special excavation requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation.
      (b) Earth seams, rock fragments, and voids included in rock excavation area will be considered rock for full volume of shaft from initial contact with rock.
   (3) Obstructions: Payment for removing unanticipated boulders, concrete, masonry, or other subsurface obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work will be according to Contract provisions for changes in the Work.
D. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
E. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.
   (1) Excavate bottom of drilled piers to level plane within 1:12 tolerance.
   (2) Remove water from excavated shafts before concreting.
   (3) Excavate rock sockets of dimensions indicated.
   (4) Cleaning and Dewatering: Shafts shall be thoroughly cleaned and dewatered prior to placing concrete. Pumps, in operating condition, shall be provided of proper type and capacity with sufficient hose to carry water away

from excavations. Shafts shall be dewatered such that no more than 3 inches of standing water remains at the time of concrete placement. If there is more than 3 inches of standing water in the shaft, then place concrete in shaft as indicted in “Wet Method” concrete placement procedures.

(5) If specified or directed by project geotechnical engineer cut series of grooves about perimeter of shaft to height from bottom of shaft, vertical spacing, and dimensions indicated. If specified or directed by project geotechnical engineer roughen sides of shaft.

F. Notify and allow project geotechnical engineer to inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.

(1) Do not excavate shafts deeper than elevations indicated unless approved by Architect.
(2) Payment for additional authorized excavation will be according to Contract provisions for changes in the Work.

G. End-Bearing Drilled Piers: Probe with auger to a depth below bearing elevation, equal to diameter of the bearing area of drilled pier. Determine whether voids, clay seams, or solution channels exist.

(1) Test first three drilled piers and one of every six drilled piers thereafter.
(2) Fill augur-probe holes with grout.

H. Excavate shafts for closely spaced drilled piers (those within 3 diameters center-to-center) and for drilled piers occurring in fragile or sand strata only after adjacent drilled piers are filled with concrete and allowed to set. Set is achieved when concrete reaches 500 psi compressive strength.

I. Slurry Displacement Method: Stabilize excavation with slurry maintained a minimum of 60 inches above ground-water level and above unstable soil strata to prevent caving or sloughing of shaft. Maintain slurry properties before concreting.

(1) Excavate and complete concreting of drilled pier on same day if possible, or redrill, clean, and test slurry in excavation before concreting.
(2) Clean bottom of each shaft before concreting.

J. The use of mud slurry (such as that made with on-site soils) to seal off water or lubricate temporary casings will be allowable only with the prior written approval of the project geotechnical & structural engineers.

K. Temporary Casings: Where necessary, install watertight steel casings of sufficient length and thickness to prevent soil collapse or water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls. Casing inside diameter shall equal specified drilled pier diameter to within tolerances specified in ACI 336.1. Casing shall conform to ACI 336.1 requirements.

(1) Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.

L. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances as amended below.

(1) Shaft Diameter Tolerance, in inches:

Specified Diameter	Undersize Tolerance	Oversize Tolerance
12"	0	+1
18" to 42"	-1	+1
48" to 96"	-2	+1

(2) Top Elevation Tolerance: Plus 0 inches, minus 2 inches.
(3) If tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.

M. Entire shaft shall be excavated and completely filled with concrete within the same day.

3.03 PERMANENT STEEL CASINGS

A. Install steel casings of minimum wall thickness indicated and of diameter not less than diameter of drilled pier.

(1) Install casings as excavation proceeds, to maintain sidewall stability.
(2) Fabricate bottom edge of lowest casing section with cutting shoe capable of penetrating rock and achieving water seal.
(3) Connect casing sections by continuous penetration welds to form watertight, continuous casing.
(4) Remove and replace or repair casings that have been damaged during installation and that could impair strength or efficiency of drilled pier.
(5) Fill annular void between casing and shaft wall with grout.

B. Corrugated-Steel Casings: Provide corrugated-steel casings formed from zinc-coated steel sheet.

(1) Corrugated casings may be delivered in sections or panels of convenient length and field connected according to manufacturer's written instructions.

3.04 STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's “Manual of Standard Practice” for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit. Place cage prior to concreting. One and two bar bundles in center of shaft may be placed after concreting if bars are inserted plumb and centered in shaft.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement. Bottom 12" of shaft may be unreinforced.
E. Use templates to set dowels, anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.
F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.05 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by the project geotechnical engineer. Owner's independent testing and inspecting agency.
   (1) Place concrete in one continuous operation without construction joints for full pier height.
B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking earth at sides of shaft.
   (1) Where concrete cannot be directed down shaft without striking earth at side of shaft, place concrete with chutes, tremies, or pumps.
   (2) Vibrate top 60 inches of concrete.
C. Wet Method: When dry method can not be used place concrete by pumping with end of pump hose at bottom of hole. Leave end of hose at bottom hole until entire shaft is full of concrete.
D. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no fewer than 60 inches into concrete and that flow of concrete is continuous from bottom to top of drilled pier.
E. Casing Removal: Pull temporary casing with a slow and smooth vertical motion maintaining a plumb position. Casing shall not be pulled until concrete has been placed to a minimum of five feet above external water, slurry, or unstable soil level. During pulling, maintain concrete level a minimum of five feet above external water, slurry, or unstable soil level. Vibrate top five feet of concrete after casing is removed.
F. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.
   (1) Vibrate top 60 inches of concrete after withdrawal of temporary casing.
G. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation. Enlargement or “mushrooming” at the top of the pier is not permitted.
H. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.
   (1) Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   (2) Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.
I. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 deg F.
   (1) Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.06 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on drawings.

3.07 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property. Material removed during shaft drilling operations shall not be used for fill.

END OF SECTION 31 63 29

DIVISION 32 - LANDSCAPE

SECTION 32 05 23 – CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

SECTION 32 05 24 – MONUMENT CONCRETE

SECTION 32 12 00 – FLEXIBLE PAVEMENT

SECTION 32 13 13 – CONCRETE PAVING

SECTION 32 13 73 – CONCRETE PAVING JOINT SEALANTS

SECTION 32 13 76 – SIDEWALKS

SECTION 32 14 00 – UNIT PAVING

SECTION 32 15 42 – STONE FINES SURFACING

SECTION 32 16 13 – CONCRETE CURB & GUTTER

SECTION 32 17 23 – PAVEMENT MARKINGS

SECTION 32 33 00 – SITE FURNISHINGS

SECTION 32 57 30 – SITE DECORATIVE METAL RAILINGS & METAL GUARDRAIL

SECTION 32 91 13 – SOIL PREPARATION

SECTION 32 91 16 – SOIL STABILIZATION

SECTION 32 92 00 – TURF AND GRASSES

SECTION 32 93 00 – PLANTS

SECTION 32 94 13 – METAL EDGING

SECTION 32 05 23 - CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Formwork, complete with required shoring, bracing and anchorage.

B. Control joints and expansion joints.

C. Concrete joints and expansion joints.

D. Cast-in-place concrete.

1.02 RELATED WORK

A. Section 01 4529 – Testing Laboratory Services.

B. Section 32 1373 – Concrete Paving Joint Sealants

C. Section 32 1376 - Sidewalks

D. Section 33 0516 – Manholes and Structures.

E. Section 33 4000 – Storm Drainage Utilities.

1.03 SUBMITTALS

A. See Related Work

1.04 QUALITY ASSURANCE

A. Perform cast-in-place concrete work in accordance with ACI 301, unless specified otherwise in this Project Manual.

B. Keep copy of ACI 301-99 in field office for duration of project.

C. Fly ash shall not be used in concrete with integral color.

1.05 TESTING AGENCY

A. Field testing of the concrete mix will be performed by an independent testing laboratory in accordance with Sections 01 4529.

B. Provide free access to work and cooperate with the appointed laboratory.

C. Tests of cement and aggregates may be performed to ensure conformance with requirements state herein.

1.06 REFERENCE STANDARDS

A. ACI-301-99, Specifications for Structural Concrete.

B. ACI Manual of Concrete Practice, Parts 1, 2, and 3.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Allowable Concrete Mix Temperatures: ACI 301 -99 Section 4.2.2.7.

1. Cold Weather: Minimum 35 degrees F.
2. Hot Weather: Maximum 95 degrees F.

B. Do not place concrete during rain, sleet, or snow unless protection is provided.

C. Keep accurate thermometer in area where work is proceeding.

PART 2 PRODUCTS

2.01 CEMENT (ACI 301-99 Section 4.2).

A. Portland Cement: ASTM C150, Type 1.

B. Use one brand and type of cement throughout project unless otherwise specified.

2.02 ADMIXTURES (ACI 301-99 Section 4.2)

A. Add air-entraining agent as indicated in ACI 301-99 Section 4.2.1.4.

B. Use of accelerating admixtures such as salts, chemicals, or other foreign materials in cold weather will not be allowed. Use no other admixtures without prior approval of the Architect/Engineer.

C. Use of set – retarding admixtures during hot weather will not be allowed.

2.03 STRENGTH (ACI 301-99 Section 1.7.4)

A. Provide concrete of following strength: Compressive strength (28day): 3,500 psi, except where noted otherwise in the Contract Documents

2.04 AIR ENTRAINMENT (ACI 301-99 Section 4.2.1.4)

A. Add air-entraining agent to concrete mix for concrete work exposed to exterior.

2.05 SLUMP (ACI 301-99 Section 4.2.2.2)

A. Contractor shall provide slump cone and test slump for each load of concrete.

B. Minimum, slump for all concrete work: 3 inches.

C. Slump for consolidation by vibration: 4 inches maximum.

D. Slump for slabs and consolidation other than by vibration: 5 inches maximum.

2.06 PROPORTIONS

A. Selection of proportions for normal weight concrete: Method 1, Method 2, or Method 3, Contractor's Option.

B. Fine aggregate shall conform to the requirements of ASTM Specification C-33, latest edition, and shall consist of clean, fresh water sand graded uniformly to conform to Paragraph 4 of the above referenced Specification C-33.

C. Coarse aggregate shall conform to the requirements of ASTM Specification C-33, latest edition, using standard grading size 1 -1/2" to No. 4 of washed gravel or crushed stone meeting requirements above and soundness requirements of ASTM C-33.

D. Water: Clean and free of injurious amounts of oil, acids, alkalis, organic materials, or other deleterious substances.

2.07 REINFORCING STEEL (ACI 301-99 Section 3), where applicable.

A. Where shown on plans and details.

B. Reinforcing Steel: 60 ksi yield grade; deformed billet steel bars, ASTM A615; plain finish.

C. Welded Steel Wire Fabric: plain type, ASTM A 185; in coiled rolls, plain finish, 6x6-W1.4 x W1.4 or 6x6 – W2.9 X W2.9 as shown on the Drawings.

2.08 ACCESSORIES

A. Pre-molded expansion joint fillers: ASTM D1751, See plans and details for width / thickness of joint. Refer to ACI 301-99 Section 10.2.5.

2.09 CONCRETE MIX

A. Mix concrete in accordance with ASTM C94.

B. Mix concrete until there is a uniform distribution of the materials and the mass is homogeneous in consistency and colors. Continue mixing for at least 1 -1/2 minutes after all the ingredients are in the mixer.

PART 3 EXECUTION

3.01 GENERAL

A. Notify Architect/Engineer for inspection at least 24 hours before the planned time to pour concrete.

B. Inspection:

1. Ensure that excavation and formwork are completed and within the allowed tolerances.
2. Ensure that ice and excess water are removed, no frost is present, and that ground is not frozen.
3. Check that reinforcement is secured in place.
4. Verify that insulation, anchors, and other embedded items are secured in position.

C. Install concrete work in accordance with ACI 301-99 except as amended by this section.

3.02 FORMWORK (ACI 301-99 Section 2)

A. Obtain Architect/Engineer's review for use of earth forms. When using earth forms, hand-trim sides and bottoms, and remove loose dirt prior to placing concrete.

B. Tolerances for Formed Services: (Comply with ACI 301-99 Section 2)

3.03 FORM SURFACES PREPARATION (ACI 301-99 Section 2)

A. Apply form release agent on formwork in accordance with manufacturer's recommendations. Apply prior to placing reinforcing steel, anchoring devices and embedded parts. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are affected by agent.

3.04 FINISHING FORMED SURFACES

A. Formed Surfaces Finishes: Provide rough form finish (ACI 301-99 Section 2) at all surfaces not exposed to view. Provide smooth rubbed finished (ACI 301-99 Section 2) at all surfaces exposed to view.

3.05 REMOVAL OF FORMS (ACI 301-99 Section 2)

A. Do not remove forms, shores, and bracing until concrete has gained sufficient strength to carry its own weight, construction loads, and design loads which are liable to be imposed upon it. Verify strength of concrete by compressive test results.

3.06 PLACING REINFORCING

A. Reinforcing shall be unpainted and uncoated, free from rust or scale and shall be cleaned and straightened before being shaped and in position.

B. Position reinforcing accurately and tie securely.

C. Support foot reinforcing on support chairs or concrete grout at maximum 3 feet on center each way to insure proper depth from bottom.

D. Wire dowels to longitudinal bars and place top bars in perfect alignment by the use of wood templates placed 2 inches from the top of the form.

E. Support wire mesh on support chairs, or other approved means, at no greater than three feet on center way to hold reinforcing in the center of the slab or as shown on the drawings.

1. Do not depend on lifting mesh as concrete is being poured.
2. Lap sides and ends not less than one wire spacing in slabs on grade and not less than 12 inches in structural slabs.

F. Provide 3 inches of concrete between reinforcing and the ground, unless detailed otherwise, where concrete is poured against the ground.

G. If, after the removal of forms, concrete surfaces are to be in contact with the ground or exposed to the weather:

1. Bars larger than No.5: Protect with 2 inches of concrete.
2. No. 5 bars and smaller: Protect with 1 1/2 inches of concrete.

H. Concrete covering for any reinforcing at surfaces not exposed directly to the ground or weather: Protect with 1 -1/2 inches of concrete.

3.07 PLACING CONCRETE

A. Convey concrete from mixer to final position by method which will prevent separation or loss of material.

B. Maximum height of concrete free fall; 60 inches.

C. Regulate rate of placement so concrete remains plastic and flows into position.

D. Deposit concrete in continuous operation until panel or section is completed.

E. Do not use concrete that has set and do not re-temper or use concrete that has been mixed for more than 1½ hours.

3.08 CONSOLIDATING CONCRETE:

A. Use mechanical vibrating equipment for consolidation.

B. Vertically insert and remove hand-held vibrators at points 18 inches to 30 inches apart, inserting to within 6 inches of bottom of freshly poured concrete.

C. Do not use vibrators to transport concrete forms.

D. Minimum vibrators frequencies: 6000 impulses per minute.

E. Vibrate concrete minimum amount required for consolidation.

F. Keep spare vibrator on hand during concrete placing operation.

G. Make sure the concrete is thoroughly worked around the reinforcing, the embedded items, and into corners of forms.

3.09 SLABS (ACI 301-99 Section 5)

A. Finish concrete slab surfaces in accordance with ACI 301-99 Section 5:

1. Uniformly spread, screed, and float slabs. Do not use grate tampers or mesh rollers. Do not spread concrete by vibration.
2. Light broom finish exterior surfaces, expect exposed aggregate.

B. Sidewalks: Finish sidewalks in accordance with Section 32 13 76.

3.010 CURING

A. Cure Slabs: Use damp method as per ACI 301-99 Section 5.

B. Cure Walls above Grade: Use moisture-retaining covering as approved by Architect/Engineer in accordance with ACI 308.

3.011 WELDING (ACI 301-99 Section 3)

A. Welding Reinforcing Steel: Not allowed.

3.012 CONSTRUCTION JOINTS

A. Install control expansion joints in accordance with ACI 301-99 Section 5

B. Place expansion and contraction joints shown on plans. Where joints are not illustrated, provide control joints for every 100 SF of surface area and expansion joints for every 400 SF of surface area. Where possible, make joints coincide with joints in adjacent concrete.

C. Fit joints with filler of required profiles. Recess ¼ inch below finished concrete surface.

3.013 INSERTS, EMBEDDED PARTS AND OPENINGS

A. Provide formed openings where required for pipes, conduits, sleeves and other work to be embedded in and passing through concrete members.

B. Coordinate work of other sections and cooperate with trade involved in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

3.014 REPAIR OF SURFACE DEFECTS (ACI 301-99 Section 5.3.7)

A. Allow Architect/Engineer to inspect concrete surfaces immediately upon removal of forms.

B. Modify or replace concrete not conforming to required lines, detail, and elevation.

C. Repair or replace concrete not properly placed resulting in excessive honeycombing and other defects. Do not patch, repair, or replace exposed architectural concrete except upon express direction of Architect/Engineer.

3.015 FIELD QUALITY CONTROL

A. Four (4) concrete test cylinders will be taken by the testing laboratory for every 40 cu. yds., or fraction thereof, of concrete placed. Not less than one (1) set of test cylinders shall be taken for each day's pour.

B. One (1) additional test cylinder will be taken during cold weather concreting and be cured on job site under same conditions as concrete it represents.

C. One (1) slump test will be taken by the testing laboratory for each set of test cylinders taken and for each separate batch of concrete placed.

D. Compression test cylinders: Test cylinders shall be cast on the project site by a representative of the testing laboratory.

1. Make cylinders according to ASTM C31.
2. Make additional sets of test cylinders for curing under job conditions:
    a. When it is needed to determine when to remove forms.
    b. When to put a structure into service.
    c. When temperature extremes are expected during the curing test period.
3. Make test cylinders in the presence of Architect/Engineer.
4. Properly marked prepared test cylinders and fill out the card supplied by the testing laboratory with instructions on when to make test breaks and where to send the test results.
5. Transport in a protected condition, each set of prepared and marked test cylinders to the designated testing laboratory for curing and testing as soon as the cylinders can be transported without damage.

E. Compression Testing concrete Cylinders ASTM C-39: by commercial testing laboratory.

1. Cure cylinders in laboratory until time for testing.
2. Test each set of cylinders at 7 days and 28 days after pouring.
3. Tabulation of breakage schedule and action:

Specified strength of 3,500 psi at 28 days

	Test Break	Action
7 day	Less than 2400 psi	Contractor notify A/E
	2400-3500 psi	Break 28 day cylinder
	Over 3500 psi	Stop Testing
28 day	Less than 3500 psi	Contractor notify Architect, investigate reason for low break and report in writing to AE.

4. For testing cylinders for specified compressive strength other than 3,500 psi, see the Architect/Engineer.

F. In Case of Low Compression Test Results:

1. Architect/Engineer will have right to order change in the mix design, costs to be borne by the contractor.
2. Architect/Engineer will have right to order core tests of the concrete in accordance with SCI C42, or load tests of the structure, the cost to be borne by the Contractor for either test.

3.016 PROTECTION OF COMPLETED WORK

A. During curing period, protect the concrete from damaging mechanical disturbances, water flow, loading, shock, and vibration.

END OF SECTION 32 05 23

SECTION 32 05 24 - MONUMENT CONCRETE

PART 1 GENERAL

1.01 ENVIRONMENTAL CONSIDERATIONS: This project is designed and constructed with practices and procedures to meet the project's environmental considerations and goals. These considerations and goals are to establish a facility which is environmentally responsible, profitable, and a healthy place to live and work. To guide this process, this project is pursuing LEED Certified certification per the 2009 Green Building Design and Construction Reference Guide for New Construction. Compliance with all credits and prerequisites shown in the checklist attached to section 01 3514.01 is required. All team members will be required to perform some amount of associated documentation. Refer to Sections listed below for environmental considerations and goals, and applicable paragraphs of this specification section. The Contractor shall ensure that the requirements related to these considerations and goals, as defined in the Contract Documents, are implemented to the fullest extent.

1.02 WORK INCLUDED

A. Formwork, complete with required shoring, bracing and anchorage.

B. Control joints and expansion joints.

C. Concrete joints and expansion joints.

D. Cast-in-place concrete.

E. Work associated to Senior Walks.

1.03 RELATED WORK

A. Section 01 4529 – Testing Laboratory Services.

B. Section 32 1376 - Sidewalks

1.04 SUBMITTALS

A. Concrete mix design and strength test results for each specified strength.

1.05 QUALITY ASSURANCE

A. Perform cast-in-place concrete work in accordance with ACI 301, unless specified otherwise in this Project Manual.

B. Keep copy of ACI 301-99 in field office for duration of project.

1.06 TESTING AGENCY

A. Field testing of the concrete mix will be performed by an independent testing laboratory in accordance with Sections 01 4529.

B. Provide free access to work and cooperate with the appointed laboratory.

C. Tests of cement and aggregates may be performed to ensure conformance with requirements state herein.

1.07 REFERENCE STANDARDS

A. ACI-301-99, Specifications for Structural Concrete.

B. ACI Manual of Concrete Practice, Parts 1, 2, and 3.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Allowable Concrete Mix Temperatures: ACI 301 -99 Section 4.2.2.7.

1. Cold Weather: Minimum 35 degrees F.
2. Hot Weather: Maximum 95 degrees F.

B. Do not place concrete during rain, sleet, or snow unless protection is provided.

C. Keep accurate thermometer in area where work is proceeding.

PART 2 PRODUCTS

2.01 CEMENT (ACI 301-99 Section 4.2).

A. Portland Cement: ASTM C150, Type 1.

B. Use on brand and type of cement throughout project unless otherwise specified.

2.02 ADMIXTURES (ACI 301-99 Section 4.2)

A. Add air-entraining agent as indicated in ACI 301-99 Section 4.2.1.4.

B. Use of accelerating admixtures such as salts, chemicals, or other foreign materials in cold weather will not be allowed. Use no other admixtures without prior approval of the Architect/Engineer.

C. Use of set – retarding admixtures during hot weather will not be allowed.

D. Class F fly ash may be used with approval from owner.

2.03 STRENGTH (ACI 301-99 Section 1.7.4)

A. Provide concrete of following strength: Compressive strength (28 day): 6,000 psi, except where noted otherwise in the Contract Documents

2.04 AIR ENTRAINMENT (ACI 301-99 Section 4.2.1.4)

A. Add air-entraining agent to concrete mix for concrete work exposed to exterior.

2.05 SLUMP (ACI 301-99 Section 4.2.2.2)

A. Contractor shall provide slump cone and test slump for each load of concrete.

B. Minimum, slump for all concrete work: 3 inches.

C. Slump for consolidation by vibration: 4 inches maximum.

D. Slump for slabs and consolidation other than by vibration: 5 inches maximum.

2.06 PROPORTIONS

A. Selection of proportions for normal weight concrete: Method 1, Method 2, or Method 3, Contractor's Option.

B. Fine aggregate shall conform to the requirements of ASTM Specification C-33, latest edition, and shall consist of clean, fresh water sand graded uniformly to conform to Paragraph 4 of the above referenced Specification C-33.

C. Coarse aggregate shall conform to the requirements of ASTM Specification C-33, latest edition, using standard grading size 1 -1/2" to No. 4 of washed gravel or crushed stone meeting requirements above and soundness requirements of ASTM C-33.

D. Water: Clean and free of injurious amounts of oil, acids, alkalis, organic materials, or other deleterious substances.

E. No aggregate that will affect the surface of the concrete will be allowed. Examples are that no chert can be within the mix.

2.07 REINFORCING STEEL (ACI 301-99 Section 3)

A. Reinforcing Steel: 60 ksi yield grade; deformed billet steel bars, ASTM A615; plain finish.

B. Welded Steel Wire Fabric: plain type, ASTM A 185; in coiled rolls, plain finish, 6x6-W1.4 x W1.4 or 6x6 – W2.9 X W2.9 as shown on the Drawings.

2.08 ACCESSORIES

A. Premolded expansion joint fillers: ASTM D1751, See plans and details for width / thickness of joint. Refer to ACI 301-99 Section 10.2.5.

2.09 CONCRETE MIX

A. Mix concrete in accordance with ASTM C94.

B. Mix concrete until there is a uniform distribution of the materials and the mass is homogeneous in consistency and colors. Continue mixing for at least 1 -1/2 minutes after all the ingredients are in the mixer.

PART 3 EXECUTION

3.01 GENERAL

A. Notify Architect/Engineer for inspection at least 24 hours before the planned time to pour concrete.

B. Inspection:

1. Ensure that excavation and formwork are completed and within the allowed tolerances.
2. Ensure that ice and excess water are removed, no frost is present, and that ground is not frozen.
3. Check that reinforcement is secured in place.
4. Verify that insulation, anchors, and other embedded items are secured in position.

C. Install concrete work in accordance with ACI 301-99 except as amended by this section.

3.02 FORMWORK (ACI 301-99 Section 2)

A. Obtain Architect/Engineer's review for use of earth forms. When using earth forms, hand-trim sides and bottoms, and remove loose dirt prior to placing concrete.

B. Tolerances for Formed Services: (Comply with ACI 301-99 Section 2)

3.03 FORM SURFACES PREPARATION (ACI 301-99 Section 2)

A. Apply form release agent on formwork in accordance with manufacturer's recommendations. Apply prior to placing reinforcing steel, anchoring devices and embedded parts. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are affected by agent.

3.04 FINISHING FORMED SURFACES

A. Formed Surfaces Finishes: Provide rough form finish (ACI 301-99 Section 2) at all surfaces not exposed to view. Provide smooth rubbed finished (ACI 301-99 Section 2) at all surfaces exposed to view.

3.05 REMOVAL OF FORMS (ACI 301-99 Section 2)

A. Do not remove forms, shores, and bracing until concrete has gained sufficient strength to carry its own weight, construction loads, and design loads which are liable to be imposed upon it. Verify strength of concrete by compressive test results.

3.06 PLACING REINFORCING

A. Reinforcing shall be unpainted and uncoated, free from rust or scale and shall be cleaned and straightened before being shaped and in position.

B. Position reinforcing accurately and tie securely.

C. Support foot reinforcing on support chairs or concrete grout at maximum 3 feet on center each way to insure proper depth from bottom.

D. Wire dowels to longitudinal bars and place top bars in perfect alignment by the use of wood templates placed 2 inches from the top of the form.

E. Support wire mesh on support chairs, or other approved means, at no greater than three feet on center way to hold reinforcing in the center of the slab or as shown on the drawings.

1. Do not depend on lifting mesh as concrete is being poured.
2. Lap sides and ends not less than one wire spacing in slabs on grade and not less than 12 inches in structural slabs.

F. Provide 3 inches of concrete between reinforcing and the ground, unless detailed otherwise, where concrete is poured against the ground.

G. If, after the removal of forms, concrete surfaces are to be in contact with the ground or exposed to the weather:

1. Bars larger than No.5: Protect with 2 inches of concrete.
2. No. 5 bars and smaller: Protect with 1 1/2 inches of concrete.

H. Concrete covering for any reinforcing at surfaces not exposed directly to the ground or weather: Protect with 1 -1/2 inches of concrete.

3.07 PLACING CONCRETE

A. Convey concrete from mixer to final position by method which will prevent separation or loss of material.

B. Maximum height of concrete free fall; 60 inches.

C. Regulate rate of placement so concrete remains plastic and flows into position.

D. Deposit concrete in continuous operation until panel or section is completed.

E. Do not use concrete that has set and do not re-temper or use concrete that has been mixed for more than 1½ hours.

3.08 CONSOLIDATING CONCRETE:

A. Use mechanical vibrating equipment for consolidation.

B. Vertically insert and remove hand-held vibrators at points 18 inches to 30 inches apart, inserting to within 6 inches of bottom of freshly poured concrete.

C. Do not use vibrators to transport concrete forms.

D. Minimum vibrators frequencies: 6000 impulses per minute.

E. Vibrate concrete minimum amount required for consolidation.

F. Keep spare vibrator on hand during concrete placing operation.

G. Make sure the concrete is thoroughly worked around the reinforcing, the embedded items, and into corners of forms.

3.09 SLABS (ACI 301-99 Section 5)

A. Finish concrete slab surfaces in accordance with ACI 301-99 Section 5:

1. Uniformly spread, screed, and float slabs. Do not use grate tampers or mesh rollers. Do not spread concrete by vibration.
2. See plans for type of finished surface.

B. Sidewalks: Finish sidewalks in accordance with Section 32 13 76.

3.010 CURING

A. Cure Slabs: Use damp method as per ACI 301-99 Section 5.

B. Cure Walls above Grade: Use moisture-retaining covering as approved by Architect/Engineer in accordance with ACI 308.

3.011 WELDING (ACI 301-99 Section 3)

A. Welding Reinforcing Steel: Not allowed.

3.012 CONSTRUCTION JOINTS

A. Install construction joints in accordance with ACI 301-99 Section 5

B. Place expansion at 30 feet intervals and contraction joints at 15 feet (maximum) intervals. Where possible, make joints coincide with joints in adjacent concrete.

C. Fit joints with filler of required profiles. Recess ¼ inch below finished concrete surface.

3.013 INSERTS, EMBEDDED PARTS AND OPENINGS

A. Provide formed openings where required for pipes, conduits, sleeves and other work to be embedded in and passing through concrete members.

B. Coordinate work of other sections and cooperate with trade involved in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

3.014 REPAIR OF SURFACE DEFECTS (ACI 301-99 Section 5.3.7)

A. Allow Architect/Engineer to inspect concrete surfaces immediately upon removal of forms.

B. Modify or replace concrete not conforming to required lines, detail, and elevation.

C. Repair or replace concrete not properly placed resulting in excessive honeycombing and other defects. Do not patch, repair, or replace exposed architectural concrete except upon express direction of Architect/Engineer.

3.015 FIELD QUALITY CONTROL

A. Four (4) concrete test cylinders will be taken by the testing laboratory for every 40 cu. yds., or fraction thereof, of concrete placed. Not less than one (1) set of test cylinders shall be taken for each day's pour.

B. One (1) additional test cylinder will be taken during cold weather concreting and be cured on job site under same conditions as concrete it represents.

C. One (1) slump test will be taken by the testing laboratory for each set of test cylinders taken and for each separate batch of concrete placed.

D. Compression test cylinders: Test cylinders shall be cast on the project site by a representative of the testing laboratory.

1. Make cylinders according to ASTM C31.
2. Make additional sets of test cylinders for curing under job conditions:
    a. When it is needed to determine when to remove forms.
    b. When to put a structure into service.
    c. When temperature extremes are expected during the curing test period.
3. Make test cylinders in the presence of Architect/Engineer.
4. Properly marked prepared test cylinders and fill out the card supplied by the testing laboratory with instructions on when to make test breaks and where to send the test results.
5. Transport in a protected condition, each set of prepared and marked test cylinders to the designated testing laboratory for curing and testing as soon as the cylinders can be transported without damage.

E. Compression Testing concrete Cylinders ASTM C-39: by commercial testing laboratory.

1. Cure cylinders in laboratory until time for testing.
2. Test each set of cylinders at 7 days and 28 days after pouring.
3. Tabulation of breakage schedule and action:

Specified strength of 6,000 psi at 28 days

	Test Break	Action
7 day	Less than 4200 psi	Contractor notify A/E
	4200-6000 psi	Break 28 day cylinder
	Over 6000 psi	Stop Testing
28 day	Less than 6000 psi	Contractor notify Architect, investigate reason for low break and report in writing to AE.

4. For testing cylinders for specified compressive strength other than 6,000 psi, see the Architect/Engineer.

F. In Case of Low Compression Test Results:

1. Architect/Engineer will have right to order change in the mix design, costs to be borne by the contractor.
2. Architect/Engineer will have right to order core tests of the concrete in accordance with SCI C42, or load tests of the structure, the cost to be borne by the Contractor for either test.

3.016 PROTECTION OF COMPLETED WORK

A. During curing period, protect the concrete from damaging mechanical disturbances, water flow, loading, shock, and vibration.

END OF SECTION 32 05 24

SECTION 32 12 00 - FLEXIBLE PAVEMENT

PART 1 GENERAL

1.01 WORK INCLUDED

A. Prepare subgrade to receive base course.

B. Provide compacted base course.

C. Prime base course and place asphaltic concrete hot mix (ACHM) binder course.

D. Tack base course and place ACHM surface course.

1.02 RELATED WORK

A. Section 31 2000 – Earth Moving.

B. Section 32 1613 – Concrete Curb and Gutter

C. Section 33 4000 – Storm Drainage Utilities

1.03 SUBMITTALS

A. See Related Work

1.04 REFERENCES

A. Arkansas Department of Transportation (ARDOT).

1. Standard Specifications for Highway Construction, Edition of 2014, hereafter referred to as “ARDOT Standard Specifications”.

PART 2 PRODUCTS

2.01 BASE COURSE MATERIALS

A. Crushed Stone: Class 7, meeting the requirements of Section 303 of the ARDOT Standard Specifications, or approved equal.

B. Prime Coat: Medium curing liquid asphalt, MC-30, or approved equal, meeting the requirements of Section 401 of the ARDOT Standard Specifications.

C. Tack Coat: Shall be applied as specified and meeting the requirements of Section 401 of the ARDOT Standard Specifications.

2.02 ASPHALT PAVEMENT MATERIALS

A. ACHM Surface Course:

1. PG 64-22 mix as described in Sections 407 and 409 of the ARDOT Standard Specifications.

2. The surface course shall be composed of a mixture of mineral aggregate and asphalt cement in the proportions by weight for the type mixture designated.

B. ACHM Binder Course:

1. PG 64-22 mix as described in Section 407 and 409 of the ARDOT Standard Specifications.

2. The binder course shall be composed of mixture of mineral aggregate and asphalt cement in the proportions by weight for the type mixture designated.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Ensure grading of the subgrade to the required elevation.

B. Scarify to a depth of six inches the subgrade where the base course is to be placed.

C. Water and thoroughly mix subgrade until optimum moisture content is obtained when deficiency of moisture content exists. When excess of moisture exists, rework and aerate subgrade until optimum moisture content is obtained.

D. Re-compact the subgrade to a minimum of 95% of the maximum dry density at or near the option moisture content as determined by ASTM D1557.

E. Before final rolling, shape the entire area to the required cross section, adding additional subsoil as required and compact the subgrade surface to the required density.

3.02 PLACEMENT OF BASE COURSE

A. Place the crushed stone base material over the prepared subgrade in accordance with the construction methods described in Section 303 of the ARDOT Standard Specifications.

B. Add water during compaction to bring the base course materials to optimum moisture content. When excess moisture exists, rework the base course materials until optimum moisture content is obtained.

C. Compact the base course to 100% of the maximum dry density as determined by ASTM D 1557.

3.03 PLACE PRIME AND TACK COAT

A. Apply the bituminous prime coat to the compacted base at the rate of 0.3 to 0.4 gallons per square yard. Apply the bituminous tack cost to the prepared base at the rate of 0.03 gallon to 0.10 gallon per square yard as designated by the Engineer.

B. Clean the base course surface and place the prime and tack coats in accordance with the requirements of Section 401 of the ARDOT Standard Specifications.

3.04 PLACING ACHM SURFACE COURSE

A. Construction Methods: Section 410, ARDOT Standard Specifications.

B. Temperature range mix.

1. When discharged from mixer: 285 degrees F to 325 degrees F.
2. When placed on base course: 275 degrees F. to 325 degrees F.

C. Temperature of air: Do not place ACHM when air temperature in the shade is below 40 degrees F.

D. Place asphalt pavement to compacted depth shown on Drawing.

E. Compact to required density, with approved rolling equipment. Start compaction as soon as pavement will bear equipment without checking or undue displacement.

F. Required density: 92% - 96% of maximum theoretical density.

G. Carry out compaction in three operations in pass sequence. Ensure each pass of roller overlaps previous passes to ensure smooth surface free of roller marks. Keep roller wheels sufficiently moist so as not to pick up material.

H. Perform hand tamping in areas not accessible to rolling equipment.

I. Ensure joints made during paving operations and at connection to existing pavement are straight, clean, vertical and free of broken or loose material. Construct joints to ensure a continuous bond between the courses and to obtain the required density. Provide all joints with the same texture as other sections of the course and meet the requirements for smoothness and grade.

J. Ensure surface of completed asphalt pavement is true to lines, profiles and elevations indicated, and is free from depressions exceeding ¼ inch when measured with a 10 foot straightedge.

K. Do not allow vehicular traffic on newly paved areas until surface has cooled to atmospheric temperature.

3.05 FIELD QUALITY CONTROL

A. Testing laboratory will make in-place tests of density and moisture content of the subgrade and the base course in accordance with ASTM D 6938.

B. Testing laboratory will make density tests of compacted asphalt paving in accordance with ASTM D 2950.

END OF SECTION – 32 12 00

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes the following:
   (1) Concrete Paving (Pedestrian)
   (2) Cast-in-place Concrete Slab base for Unit Paving

1.03 RELATED SECTIONS

A. Cast-in-place Concrete – Section 03 30 00

1.04 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.05 REFERENCE STANDARDS

A. Department of Transportation standard specifications for highway construction, latest edition
B. American Concrete Institute (ACI) latest edition
   (1) 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
   (2) 305R Hot Weather Concreting
   (3) 306R Cold Weather Concreting
   (4) 308 Standard Practice for Curing Concrete
   (5) 318 Building Code Requirements for Reinforced Concrete
   (6) 347 Recommended Practice for Concrete Formwork
C. ASTM International (ASTM) latest edition
   (1) A 185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
   (2) A 497 Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
   (3) A 615 Deformed and Plain Billet Steel for Concrete Reinforcement
   (4) C 31 Making and Curing Concrete Test Specimens in the Field
   (5) C 33 Concrete Aggregates
   (6) C 39 Compressive Strength of Cylindrical Concrete Specimens
   (7) C 42 Method of Obtaining and Testing Drilled Cores
   (8) C 94 Specification for Ready-Mixed Concrete
   (9) C 150 Portland Cement
   (10) C 260 Air Entraining Admixtures for Concrete
   (11) C 309 Liquid Membrane Forming Compounds for Curing Concrete
   (12) C 494 Chemical Admixtures for Concrete
   (13) D 1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
D. Federal Standard
   (1) FS TT C 800 – Curing Compound, Concrete, for New and Existing Surfaces
E. Concrete Reinforcing Steel Institute (CRSI) latest edition
   (1) CRSI-MSP Manual of Standard Practice
   (2) CRSI 63 Recommended Practice for Placing Reinforcing Bars
   (3) CRSI 65 Recommended Practice for Placing Bar Supports
F. American Association of State Highway and Transportation Officials (AASHTO) latest edition
   (1) M 213 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

1.06 ACTION SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.
B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
C. Material Certificates: Signed by manufacturers, materials producer and Contractor, certifying that each of the following materials complies with, or exceeds, requirements specified herein:
   (1) Cementitious materials and aggregates.
   (2) Steel reinforcement and reinforcement accessories.

(3) Admixtures.
(4) Curing compounds.
(5) Applied finish materials.
(6) Bonding agent or adhesive.
(7) Joint fillers.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
   (1) Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.
C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   (1) Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.
E. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.
F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.
G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination"

1.08 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.01 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

2.02 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel- type materials of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal while providing full-depth, continuous, straight, and smooth exposed surfaces.
   (1) Use flexible spring steel forms or uniformly curved laminated boards to form curves with a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.
B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.03 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A1064, fabricated from as-drawn steel wire into flat sheets.
B. Reinforcing Bars: Deformed steel bars, ASTM A 615/A 615M, Grade 60
C. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
D. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
E. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars; assembled with clips.
F. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
G. Joint Dowel Bars: A615/A615M, Grade 60, plain steel bars.
H. Plain Steel Wire: ASTM A 82
I. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice." Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.04 CONCRETE MATERIALS

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

(1) Cast-in-place Concrete Paving (Pedestrian),Cast-in-place Concrete Slab base for Unit Paving:

(a) Portland Cement conforming to ASTM C 150, Type 1 or 1A. Type III or IIIA (high early strength) may be used if specifically approved by Owner or Owner's Representative. Grey unless otherwise noted.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

(1) Maximum Coarse-Aggregate Size: 3/4 inch nominal.
(2) Minimum Coarse-Aggregate Size: No.4
(3) Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.
D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

(1) Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
(2) Retarding Admixture: ASTM C 494/C 494M, Type B.
(3) Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

E. Water: Potable and complying with ASTM C 94/C 94M.

2.05 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.
B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap- polyethylene sheet.
C. Water: Potable.
D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

(1) Manufacturers:

(a) BASF Corporation-Construction Systems
(b) Bon Tool Co.
(c) Brickform; a division of Solomon Colors
(d) ChemMasters, Inc
(e) Dayton Superior
(f) Euclid Chemical Company (The); an RPM company
(g) Kaufman Products, Inc
(h) L&M Construction Chemicals, Inc
(i) Lambert Corporation
(j) Metalcrete Industries
(k) Nox-Crete Products Group
(l) Sika Corporation
(m) SpecChem, LLC
(n) TK Products
(o) Vexcon Chemicals Inc.
(p) W. R. Meadows, Inc

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

(1) Manufacturers:

(a) Anti-Hydro International, Inc
(b) ChemMasters, Inc
(c) Dayton Superior
(d) Euclid Chemical Company (The); an RPM company
(e) Kaufman Products, Inc
(f) L&M Construction Chemicals, Inc
(g) Lambert Corporation
(h) Nox-Crete Products Group
(i) Right Pointe
(j) SpecChem, LLC
(k) TK Products
(l) Unitex by Dayton Superior
(m) Vexcon Chemicals Inc.
(n) W. R. Meadows, Inc

2.06 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
C. Epoxy-Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

(1) Types I and II, nonload bearing, Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.07 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
   (1) Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
   (2) When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   (1) Fly Ash or Pozzolan: 25 percent.
   (2) Slag Cement: 50 percent.
   (3) Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal- weight concrete at point of placement having an air content as follows:
   (1) Air Content: As noted in Section E, below, for each mix type.

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

E. Concrete Mixtures: Normal-weight concrete
   (1) Cast-in-place Concrete Paving (Pedestrian),Cast-in-place Concrete Slab base for Unit Paving:
      (a) Compressive Strength (28 Days): 4,000 psi, minimum
      (b) Maximum W/C Ratio at Point of Placement: 0.48
      (c) Slump Limit: 4 inches, plus or minus 1 inch (25 mm), for concrete placed by other than slipform
      (d) Air Entrainment: 6 percent plus or minus 1-1/2 percent for 3/4 inch nominal maximum aggregate size.

2.08 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.
   (1) When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
   (1) Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
   (2) Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
   (3) Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to the recommendation of the Geotechnical Engineer.

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

3.02 PREPARATION

A. Proof roll prepared base material surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving.

B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

C. Establish and maintain required lines, grades and elevations.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

A. Set forms to required lines, grades and elevations, rigidly braced and secured in accordance with ACI 347.

B. Install sufficient quantity of forms to allow continuance of work; forms to remain in place a minimum of 24 hours after concrete placement and finishing operations.

C. Check completed formwork for grade and alignment to following tolerances:
   (1) Top of forms not more than 1/8-inch in 10 feet

(2) Vertical face on longitudinal axis, not more than 1/4-inch in 10 feet

D. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage to concrete.

3.04 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.05 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
   (1) When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
   (1) Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
   (2) Provide tie bars at sides of paving strips where indicated.
   (3) Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   (4) Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
   (1) Locate expansion joints at intervals of 50 feet unless otherwise indicated.
   (2) Extend joint fillers full width and depth of joint.
   (3) Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
   (4) Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   (5) Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   (6) During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated, but not less than at intervals of 15 feet where not otherwise indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
   (1) Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
      (a) Tolerance: Ensure that sawed joints are within 3 inches (75 mm) either way from centers of dowels.
   (2) Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.06 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
   (1) Notify Landscape Architect at least 5 days prior to placement to schedule final inspection prior to placement. Placement shall not proceed without Landscape Architect’s approval. Notify other trades to permit installation of their work.
B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
C. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at required finish elevation and alignment.
D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place. If interrupted for more than 1/2 hour, place construction joint that corresponds to the established joint pattern.

G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

(1) Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

(1) Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

L. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

(1) When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
(2) Do not use frozen materials or materials containing ice or snow.
(3) Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

M. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:

(1) Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
(2) Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
(3) Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.07 CONCRETE FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Test surface for trueness with 10 foot straightedge Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

(1) Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
(2) Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

3.08 DETECTABLE WARNING INSTALLATION

A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 321726 "Tactile Warning Surfacing."

(1) Tolerance for Opening Size: Plus 1/4 inch

B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.

C. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.

(1) Before using stamp mats, verify that the vent holes are unobstructed.
(2) Apply liquid release agent to the concrete surface and the stamp mat.
(3) Stamping: While initially finished concrete is plastic after application and final floating of pigmented mineral dry-shake hardener, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
(4) Trimming: After 24 hours, cut off the tips of mortar formed by the vent holes.

(5) Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High- pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.09 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
B. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R-20 for hot-weather protection during curing.
C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:
   (1) Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      (a) Water.
      (b) Continuous water-fog spray.
      (c) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
   (2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture- retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
   (3) Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 CLEANING AND ADJUSTING

A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.
C. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner or Owner’s Representative.

3.11 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:
   (1) Elevation: 1/4 inch (19 mm).
   (2) Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
   (3) Surface: Gap below 10-feet- (3-m-) long; unleveled straightedge not to exceed 1/4 inch (13 mm).
   (4) Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
   (5) Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
   (6) Vertical Alignment of Dowels: 1/4 inch (6 mm).
   (7) Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
   (8) Joint Spacing: 3 inches (75 mm).
   (9) Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
   (10) Joint Width: Plus 1/8 inch (3 mm), no minus.
   (11) Vertical position of welded wire fabric: 1/2 inch.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
   (1) Testing Frequency: Obtain at least one composite sample for each 100 cu. yd., 5000 sq. ft. or fraction thereof of each concrete mixture placed each day.
      (a) When frequency of testing will provide fewer than five compressive- strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

(2) Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
(3) Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
(4) Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
(5) Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of five standard cylinder specimens for each composite sample.
(6) Compressive-Strength Tests: ASTM C 39/C 39M; one set for each day's pour of each concrete class exceeding 5 cubic yards, but less than 25 cubic yards, plus one set for each additional 50 cubic yards. Test one specimen at seven days and three specimens at twenty-eight days. One specimen to be broken at fourteen days or fifty-six days at the direction of the Landscape Architect or Owner's Representative.
(a) A compressive-strength test shall be the average compressive strength from three specimens obtained from same composite sample and tested at 28 days.
(7) Core pavement with the frequency and spacing as required by the Landscape Architect or Owner. Core shall be tested for thickness and quality of aggregate distribution. Patch core holes immediately with Portland cement concrete and finish to provide level surface as specified.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
D. Test results shall be reported in writing to Landscape Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Landscape Architect but will not be used as sole basis for approval or rejection of concrete.
F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Landscape Architect.
G. Concrete paving will be considered defective if it does not pass tests and inspections.
H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
I. Prepare test and inspection reports.

3.13 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Landscape Architect.
B. Drill test cores, where directed by Landscape Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 13 13 - CONCRETE PAVING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Prepare subgrade to receive base course materials for traffic bearing drive.

B. Place and compact base course materials for drive.

C. Concrete drive complete with reinforcement.

1.02 RELATED WORK

A. Section 32 1373 – Concrete Paving Joint Sealants

B. Section 31 2000 - Earth Moving

C. Section 32 1376 - Sidewalks

D. Section 32 1613 - Concrete Curb & Gutters

1.03 SUBMITTAL

A. See Related Work

1.04 REFERENCES

A. ASTM C150- Portland Cement.

B. ASTM C94 – Ready Mixed Concrete.

C. ASTM A185 – Welded Steel Wire Fabric for Concrete Reinforcement.

D. ASTM A615 – Deformed and Plain Billet – Steel Bar for Concrete Reinforcement.

E. ASTM D1751 – Preformed Expansion Joint Filler for concrete Paving and Structural construction.

1.05 INSPECTION AND TESTING

A. Inspection and testing of concrete will be performed by a firm approved by the owner and paid for by the Contractor, in accordance with Section 01 4529.

B. Three (3) concrete test cylinders will be taken during cold weather concreting, and be cured on job site under same conditions as concrete it represents.

C. One (1) slump test will be taken for each set of test cylinders taken.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Gravel Base: Angular crushed natural stone: free shale, clay and friable materials and debris.

2.02 CONCRETE MATERIALS

A. Portland Cement: ASTM C150; Normal –Type I. Materials for concrete paving shall conform to the requirements for Sections 32 0523–Concrete Work.

B. Fine and Coarse Aggregates: ASTM C33.

C. Water Clean and free from injurious amounts of oil, alkali, organic matter, or other deleterious material.

2.03 REINFORCEMENT

A. Reinforcing Steel: (60) yield strength; plain and deformed billet steel bars: ASTM A615; plain finish.

B. Welded Steel Wire Fabric: Plain type, ASTM, 6” x 6: W2.9x W2.9 size.

C. Tie Wire: Minimum 16 gage annealed type, or patented system acceptable to Architect/Engineer.

2.04 FORMWORK AND ACCESSORIES

A. Formwork: Matched, tight fitting and adequately stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of concrete.

B. Joint Filler: Minimum ½-inch thick asphaltic impregnated fiberboard ASTM D1751.

C. Concrete Curing Compound: Chlorinated rubber type: clear color; ASTM C309.

2.05 CONCRETE MIX

A. Mix and proportion to produce minimum 3500 psi concrete at 28 days with maximum slump of 3 inches and 4 to 6 percent air entrainment.

B. Use accelerating admixtures in cold weather only when acceptable to Architect/Engineer. Use of admixtures shall not relax cold weather placement requirements. Do not use calcium chloride.

C. Use set-retarding admixtures during hot weather only when acceptable to Architect/Engineer.

PART 3 EXECUTION

3.01 PREPARATION OF SUBGRADE

A. Ensure rough grading has brought subgrade to required elevations.

B. Fill soft spots and hollows with additional fill.

3.02 PLACEMENT OF GRAVEL FILL AND SAND CUSHION

A. Place and level gravel fill over prepared subgrade to a compacted depth indicated on drawings true to lines and levels.

B. During concrete placement, keep base sufficiently moist to prevent excessive absorption of water from freshly placed concrete.

3.03 FORMING

A. Form vertical surfaces to full depth and securely position to required lines and levels. Ensure form ties are not placed so as to pass through concrete.

B. Arrange and assemble formwork to permit easy dismantling and stripping, and to prevent damage to concrete during formwork removal.

3.04 PLACING REINFORCEMENT

A. Reinforce concrete drives: Allow for minimum 1 -1/2 inch concrete cover.

B. Do not extend wire mesh reinforcing through expansion and contraction joints. Provide dowelled joints through expansion and contraction joints, with one end of dowels fitted with capping sleeve to allow free movement.

3.05 GENERAL

A. Notify Architect/Engineer for inspection at least 24 hours before the planned time to pour concrete.

B. Inspection:

1. Ensure that excavation and formwork are completed and within the allowed tolerances.
2. Ensure that ice and excess water are removed, no frost is present, and that ground is not frozen.
3. Check that reinforcement is secured in place.
4. Verify that insulation, anchors, and other embedded items are secured in position.

C. Install concrete work in accordance with ACI 301-99 except as amended by this section.

3.06 FORMING EXPANSION AND CONTRACTION JOINTS

A. Install control expansion joints in accordance with ACI 301-99 Section 5

B. Place expansion and contraction joints shown on plans. Where joints are not illustrated, provide control joints for every 100 SF of surface area and expansion joints for every 400 SF of surface area. Where possible, make joints coincide with joints in adjacent concrete.

C. Fit joints with filler of required profiles, set drives perpendicular to longitudinal axis of drives. Recess ¼ inch below finished concrete surface.

3.07 PLACING CONCRETE

A. Place concrete, screed and wood float surfaces to a smooth and uniform finish, free of open texturing and exposed aggregate.

B. Avoid working mortar to surface.

C. Make ¼-inch wide dummy joints as indicated on Drawings.

D. Round all edges, including edges of dummy and expansion and contraction joints, with ¼-inch radius edging tool.

E. Where paved surfaces are adjacent to walks, make concrete curbs and gutters integral with walks. Make expansion and contraction joints of curbs coincide with walk joints. Provide dummy joint at line between walks and curbs.

F. All drives, sidewalks, ramps, and stairs are to have a broom finish applied to the surfaces, unless otherwise noted.

G. Ensure finished surfaces do not vary from true lines, levels or grade by more than 1/8 inch in 10 feet when measured with straightedge.

H. Apply curing compound on finished surfaces immediately after placement. Apply in accordance with manufacturer's recommendations.

I. All expansion joints must be sealed with an approved joint sealant.

END OF SECTION 32 13 13

SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.

B. Related Work:

1. Section 32 1313 - Concrete Paving
2. Section 32 1376 – Sidewalks
3. Section 32 1613 – Concrete Curb & Gutter

1.03 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufactures, for testing indicated below, Samples of material that will contact of affect joint sealants.

1. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit no fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will no be required if joint-sealant manufactures submit joint-preparation data that are based on previous testing, not older than 24 months, of sealant products for compatibility with and adhesion to joint substrates and other materials matching those submitted.

1.04 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each kind and color of joint sealant required, provide samples with joint sealants in ½ inch wide joints formed between two 6-inch long strips of materials matching the appearance of exposed surfaces adjacent to joint sealants.

C. Pavement-Joint Sealants Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

D. Qualification Data: For qualified Installer.

E. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.

G. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.

B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

C. Product Testing: Testing joint sealants using a qualified agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.06 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 PRODUCTS

2.01 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joints Sealants: As selected by Architect/Engineer from manufacturer's full range, and to be confirmed with submittal.

2.02 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work, include, but are not limited to, the following:
    a. Crafco Inc., and ERGON company; RoadSaver Silicone.
    b. Dow Corning Corporation; 888.
    c. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work, include, but are not limited to, the following:
    a. Crafco Inc., and ERGON company; RoadSaver Silicone SL.
    b. Dow Corning Corporation; 890-SL
    c. Pecora Corporation; 300 SL

C. Multicomponent, Pourable, Traffic-Grade, Erethane Joint Sealant for Concrete: ASTM C 920, Type M. Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    a. Pecora Corporation; Urespan NR-200.

2.03 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    a. Crafco Inc., an ERGON company; Superseal444/777.

B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    a. Meadows, W.R., Inc. Sealtight 3405.
    b. Right Pointe; D-3405 Hot Applied Sealant.

2.04 JOINT– SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer roads for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Roads for Cold-Applied Joint Sealant.

D. Backer Strips for Cold and Hot –Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.05 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of join-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint-sealant backings of kind indicated to support joint sealant during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place joint sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nosag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tools sealants according to the following requirements to form smooth, uniform beads of configuration indicated: to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.04 CLEANING

A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joints sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION 32 13 73

SECTION 32 13 76 - SIDEWALKS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Providing concrete sidewalk where shown on Drawings.

B. Providing concrete handicap ramps where shown on Drawings.

1.02 RELATED WORK

A. Section 31 2000 – Earth Moving.

B. Section 32 0523 – Cement and Concrete for Exterior Improvements.

C. Section 32 1373 – Concrete Paving Joint Sealants.

1.03 SUBMITTALS

A. See Related Work

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM):

1. ASTM D 1751, Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

PART 2 PRODUCTS

2.01 CONCRETE

A. General: Materials for use in sidewalk construction shall conform to the requirements for Section 32 0523, and shall be 3500 psi concrete.

2.02 WORK INCLUDED

A. The joint filler for all expansion joints shall be manufactured according to ASTM D 1751 and shall be elastic waterproof pre-molded compound that will not become soft and push out in hot weather, nor hard and brittle and chip out in cold weather. The strips shall be ½" in thickness except where shown otherwise on the Drawings; their width shall at least equal the full thickness of the slab; and their length shall at least equal the width of the slab at the joint.

2.03 FORMS

A. Forms shall be steel or 2" nominal thickness lumber true to proper dimensions, smooth, sufficiently braced to resist springing out of shape, and accurately set to proper lines and grades. Used forms shall be free of dirt and mortar. Cross forms shall be ¼" steel of the full width and depth of the concrete work and left in place until the wearing surface has been floated and has obtained its initial set.

2.04 CURING COMPOUND

A. Liquid membrane forming curing compound conforming to AASHTO M 148, Type 2, white pigmented (all-resin base).

2.05 SURFACE TREATMENT

A. Scofield Repello FPS surface treatment for water and stain repellency to concrete surfaces.

PART 3 EXECUTION

3.01 GRADING AND SUBGRADING

A. Prepare subgrade for walks by excavating or filling to a depth below the top of an intended pavement equal to the thickness of the finished walk and in exact conformity to the grade approved by the Engineer. Remove vegetative matter or material that will not compact properly and replace with suitable material. Place all fill required to bring the subgrade to the proper level in thin layers not exceeding 4 inches deep, and thoroughly ram, tamp or roll until it has been made compact and solid. Bring subgrade to true grade in a uniformly firm condition before placing the concrete. Do not place concrete on the subgrade until the Engineer has inspected and approved both grade and condition of subgrade.

3.02 GENERAL

A. Notify Architect/Engineer for inspection at least 24 hours before the planned time to pour concrete.

B. Inspection:

1. Ensure that excavation and formwork are completed and within the allowed tolerances.
2. Ensure that ice and excess water are removed, no frost is present, and that ground is not frozen.
3. Check that reinforcement is secured in place.
4. Verify that insulation, anchors, and other embedded items are secured in position.

C. Install concrete work in accordance with ACI 301-99 except as amended by this section.

3.03 SETTING FORMS

A. Stake forms and hold to the established lines and grades. Provide minimum 1/8" per foot fall away from structures or as shown on the drawings.

3.04 TREATMENT

A. Wet wood and coat metal forms with oil, soft soap, or whitewash before depositing any material against them. Remove all mortar and dirt from forms that have been previously used.

3.05 MARKINGS

A. Cut surface of concrete walks into flags by marking with an edging tool having a radius of ¼". Make flags not longer than 6 feet on any side nor longer than the width of the sidewalk. Round the slabs on all surface edges, including the cross markings between flags, to a radius of ¼".

3.06 JOINTS

A. Provide an expansion joint ½" in thickness, extending full depth of the concrete and with filler as herein specified, at intervals of not more than 15 feet, or as shown on plans. Provide a similar joint ½" in thickness in each walkway at intersection of walkways. Also provide an expansion joint ½" in thickness at each intersection of sidewalk and street curb and at such other points as may be designated by the Engineer. Separate sidewalk from abutting structures by ½" expansion joints. Place expansion joints ½" in thickness extending full depth of the concrete in a square outline around each object in sidewalks, such as fire hydrants, utility poles light standards, etc.

B. All expansion joints must be sealed with an approved joint sealant.

3.07 PLACING CONCRETE

A. Place concrete only on a moist subgrade and not adjacent to or around utility structures until such structures have been set to the proper grade.

B. Transport from the mixer and place by such a means as will not cause segregation of materials or loss of ingredients. Deposit successive batches in one layer by a continuous operation, completing individual sections to the required depth and width. Do not use concrete that has taken its initial set. Fill forms and bring the concrete to the established grade by means of a strike board or straight edge. Thoroughly tamp concrete until mortar is flushed to the surface sufficiently to finish and mark the surface.

C. Spade and/or vibrate the concrete so that it will flow together and completely fill all void spaces especially along forms (including cross forms of joints) to prevent honeycombing and shall be struck off and tamped in an approved manner, until dense surface is obtained, free from porous or rough spots and at the required sections and grade.

D. Use method of placing the various sections so as to produce a straight clean-out joint between them, in order to make each section and independent unit. Do not use any concrete in excess of that needed to complete a section at the stopping of work.

E. Do not pour concrete when temperature is below 35 degrees Fahrenheit, and do not place concrete on frozen subgrade. Take all necessary precautions to prevent damage to concrete in excess of that needed to complete a section at the stopping of work.

F. At all times during construction period, maintain proper drainage, by natural flow or pumping as required, so that water will drain away from excavated areas. Do not allow water to stand in any excavations, or elsewhere, to be covered by concrete. Provide and maintain in proper working order all necessary pumping and other equipment required to maintain drainage.

3.08 FINISH

A. After the concrete has been brought to the established grade by means of a strike board and tamped to bring the mortar to surface, float to a true even surface and finish with steel trowel. After the trowel finish has taken its initial set, brush surface lightly at right angles to center line of sidewalk with a soft bristle brush.

B. Do not apply heat to the concrete surface to hasten its hardening.

3.09 CURING AND PROTECTION:

A. As soon as the concrete has hardened sufficiently to prevent damage, apply specified liquid membrane-forming curing compound in accordance with manufacturer's written instructions.

B. Protect the freshly finished concrete from hot sun and drying winds until the curing compound is applied. Do not allow the concrete surface to be damaged or pitted by raindrops. Provide and use, when necessary, sufficient tarpaulins to completely cover all sections that have been placed within the proceeding twelve hours. Erect and maintain suitable barriers to protect the concrete. Repair any section damaged from traffic or other causes occurring prior to its official acceptance. Before the sidewalk is opened to traffic, remove and dispose of the covering.

C. Apply surface treatment to all concrete surfaces per manufacturer's requirements.

3.10 FREEZING TEMPERATURE

A. If at any time during the progress of the work, the temperature is predicted to drop below 35 degrees Fahrenheit within 24 hours after placement, heat the water and aggregates and take precautions to protect the work from freezing for at least five days.

END OF SECTION 32 13 76

SECTION 32 14 00 - UNIT PAVING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.02 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the unit paving as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

(1) Pedestrian asphalt unit pavers on sand setting bed over concrete sub-slab.
(2) Granite cobblestone pavers on mortar setting bed over concrete sub-slab.
(3) Detectable warning pavers.
(4) Sand setting bed over concrete sub-slab.
(5) Mortar setting bed.
(6) Metal edge restraints for unit pavers.

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.04 PREINSTALLATION TRAINING MEETINGS

A. Preinstallation Training Conference: Contractor and installer shall conduct Preinstallation training meeting with Laticrete.

1.05 ACTION SUBMITTALS

A. Product Data: For the following:

(1) Asphalt Pavers
(2) Granite cobblestone pavers.
(3) Detectable warning pavers.
(4) Mortar and grout materials.
(5) Setting bed materials.
(6) Polymeric sand for joints.
(7) Mortar joints.
(8) Metal edge restraints.

B. Samples for Initial Selection: For the following:

(1) Each type of unit paver indicated.
(2) Joint materials involving color selection.

C. Submittal Drawings:

(1) Show stone paving layout and patterns.
(2) Show special stone shapes.

D. Samples for Verification: Submit full size sample sets of paving units to indicate color and shape selections. Final Color selection will be made by the Landscape Architect and the Owner from manufacturers available colors. Include Samples of joint materials.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Sustainability Submittals: Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

(1) Solar Reflectance Index: Provide manufacturer's documentation / test report for the initial SR rating value complying with gray cement concrete of 0.26 and white cement concrete of 0.70.

1.06 INFORMATIONAL SUBMITTALS

A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed unit paver installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
B. Mockups: Build mockups of each type of unit paving in the location and of the size indicated or, if not indicated, build mockups where directed by Landscape Architect and not less than 10 by 10 feet. The mock-up shall illustrate various paver conditions and patterns on the design. Construction methods and materials shall be in accordance with these specifications Include each typical edge and perimeter condition.
C. This mock-up will serve to determine exact jointing at intersections, the surcharge of the bedding sand layer, edge restraint, paver cutting, dimensions, joint sizes, lines, laying pattern(s), color(s), and texture of the job. This area shall be the standard from which the work will be judged. Designated method for removal of cementitious residues and addition of sealers shall be executed on approximately ½ of the mock-up area prior to submittal of mock-up for acceptance.
    (1) Approved mockups may become part of the completed work if undisturbed at time of substantial completion.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect unit pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.
B. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.
C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
D. All grout, bonding agent, and mortar bedding layer materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be documented, reported to the manufacturer, and removed from site.
E. Store all grout, bonding agent, and mortar bedding layer materials off the ground and avoid excessive heat, rain, or freezing temperatures until ready for use.
F. Sand shall be covered with waterproof covering to prevent exposure to rainfall or removal by wind. The covering shall be secured in place.
G. Store liquids in tightly closed containers protected from freezing.
H. Protect the materials from deterioration during storage.
I. Stockpile aggregates to minimize segregation.

1.09 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
B. Weather Limitations for bedding and jointing of Sandstone pavers: Comply with the following requirements:
    (1) Temperature readings of the ambient and substrate temperature must be taken and recorded before and during application.
    (2) Do not apply if the surface below 41 deg F or over 86 deg F.
    (3) Product should not be applied in rain.

PART 2 - PRODUCTS

2.01 SUSTAINABILITY PERFORMANCE REQUIREMENTS

A. Solar Reflectance Index: Provide documentation for the initial SR rating value.

2.02 MANUFACTURERS

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
B. Subject to compliance with requirements, provide products by one of the following:

2.03 ASPHALT PAVERS

A. Asphalt-Block Pavers: Solid units made from asphalt cement complying with ASTM D312, Type III; inorganic stone dust or cement filler; and coarse aggregate, consisting of clean, hard, unweathered stone crushed into angular particles varying size.
B. Manufacturer: Hanover Architectural Products, 240 Bender Road, Hanover, PA 17331
http://www.hanoverpavers.com
    (1) Size: 5" x 12" commercial asphalt block.
    (2) Paver Thickness: 3" (pedestrian and vehicular).
    (3) Finish: Ground Finish.
    (4) Color: Matrix #10 – A80010 matrix.

2.04 GRANITE COBBLESTONE PAVERS

A. Cobblestone blocks shall be new or used granite. The blocks shall be sound and durable, reasonably uniform in quality and texture throughout, free from shale, excess mica, seams, scaling or evidence of disintegration. Match

Landscape Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects. The blocks shall be the following types, located as indicated on the plans:

(1) 4" x 4" x 4" cobblestone, Carbon grey/black, split face sides with split face finish top 1/ 2- 1/4 inch joint max. All blocks shall have one reasonably smooth split face with no projections or depression over 1/4". Cutting of blocks to meet the pattern requirements will be permitted subject to the approval of the Landscape Architect.

2.05 DETECTABLE WARNING PAVERS

A. For Straight Section:

(1) Manufacturer: Hanover; 12" x 12" detectable warning paver.
(2) Material: Concrete, ASTM C936, ASTM C67.
(3) Dimensions: 11.75 long x 11.75 wide x 3" thick.
(4) Finish: Tudor Finish.
(5) Color: Charcoal.

B. For Curved Section:

(1) Manufacturer: Pavestone; "Holland Stone" Series, 4" x 8" x 3" detectable warning paver.
(2) Material: Concrete, ASTM C936, ASTM C67.
(3) Dimensions: 3-7/8 wide x 7-13/16" long x 3" thick.
(4) Finish: Shotblast Finish.
(5) Color: Charcoal Black.

2.06 ACCESSORY MATERIALS

A. Materials for asphalt paver setting bed and joints:

(1) Sand for Leveling Course: Sound, sharp, washed, natural sand complying with gradation requirements in ASTM C 33 for fine aggregate. Do not use stone dust or mason sand for Leveling Course. Provide gradations as follows:

(a) Sieve Size Percent Passing:

(i) 3/8 in. (9.5 mm) 100.
(ii) No. 4 (4.75 mm) 95 to 100.
(iii) No. 8 (2.36 mm) 85 to 100.
(iv) No. 16 (1.18 mm) 50 to 85.
(v) No. 30 (0.600 mm) 25 to 60.
(vi) No. 50 (0.300 mm) 10 to 30.
(vii) No. 100 (0.150 mm) 2 to 10.
(viii) No. 200 (0.075 mm) 0 to 1.

(2) Sand for Joints: Polymeric Sand:

(a) Description: Dry mix, containing polymeric binding agent, activated with water.
(b) Manufacturer: Techniseal; www.techniseal.com
(c) Product: JS-2: Techniseal "HP" Polymeric Jointing Sand.
(d) Joint Sand Colors: As selected by Landscape Architect from manufacturer's full range.

B. Materials

(1) Portland Cement: ASTM C 150, Type 1; white.
(2) Hydrated Lime: ASTM C 207, Type S.
(3) Aggregate for Cement Setting Beds: Sand as recommended in ASTM C 398, uniformly graded from coarse to fine, with 100% passing the No. 4 sieve and not more than 5% passing the No. 100 sieve.
(4) Water: Potable, clear and free of deleterious materials which would impair the quality of the mortar.

C. Reinforced mesh where required shall be 2" x 2" x 16 ga. welded galvanized reinforcing mesh.
D. Sealant and related materials shall conform to the following:

(1) For joint filler provide closed cell extruded neoprene gasket conforming to ASTM C 509, grade 4, black.
(2) Sealant: Two (2) part self-leveling polyurethane sealant complying with ASTM C 920, Type M, Class 25, Grade P&NS, equal to Sikaflex-2c NS/SL made by Sika Chemical Co., or approved equal made by Tremco or Pecora. Color of sealant as selected by the Landscape Architect.
(3) Back-up rod shall be "Ethafoam" or approved equal.
(4) Prime joints using primer recommended by sealant manufacturer.

E. Stainless Steel for Lifting Plugs and Drains: AISI Type 302/304 non-magnetic, conforming to ASTM A 167.
F. Metal Edge Angle and Edge Restrains at Planting: See details on plans.

2.07 FABRICATION

A. All stonework shall be executed by masons skilled in the trade. All stone shall be well-cured and seasoned before cutting. Cut stone units with bed, unless otherwise approved by the Landscape Architect.
B. Stone shall be accurately cut to sizes, shapes, profiles and dimensions. There shall be no deviation from jointing.
C. Exposed surfaces and edges of stone units shall be free from cracks, broken corners, chipped edges, scratches, or other defects affecting appearance. Patching or filling not permitted.
D. The use of stone with chipped edges or faces shall not be permitted.

E. Cut stone units full and true on faces, reveals, beds, joint and top, to the full dimensions required by drawings. All edges shall be straight and true with sharp and true arises. All stone shall fit together accurately.
F. Make faces of stone units in same plane flush at joints. All finished surfaces shall be true in line and face.
G. Sawn surfaces and edges shall be cleaned of all rust stains and iron particles.
H. Cut stone to allow for uniform 1/4" wide joints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Sweep or clean substrates to remove dirt, dust, debris, and loose particles.
B. Proof-roll prepared subgrade according to requirements in Section 321313 "Concrete Paving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

3.03 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished work.
B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
D. Joint Pattern:
   (1) Asphalt Pavers: Running bond.
   (2) Granite Cobblestone Pavers: Running bond.
   (3) Detectable Warning Pavers: as indicated on drawings.
   (4) Fill gaps around utility boxes, vertical elements, edge restraints, etc. with paver units cut to fit. Make edge cuts without cracking or chipping the paver units. Provide a joint width of 1/16 inch to 1/8 inch between cut edges of paver and adjacent structure.
E. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
F. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
   (1) Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
   (2) For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge
G. Joint Sand:
   (1) Verify that pavers are completely dry.
   (2) Spread Polymeric sand and fill joints completely.
   (3) Sweep surface clean of sand prior to compaction to avoid staining.
   (4) Compact pavers and add more sand if necessary until joints are completely filled to a minimum depth of 1.25 inches.
   (5) Remove excess dust with leaf blower.
   (6) Polymeric Sand Wetting:
      (a) Perform wetting in three or more applications of water.
      (b) Do not flood pavement or generate runoff.
      (c) First application of water shall be in a fine mist; Do not displace sand. Wait 5 to 10 minutes.
      (d) Subsequent applications of water: Dampen surface in 5 to 10 minute intervals to gradually soak joints to a complete depth. Spot check joints by emptying sand to the bottom of a joint.
      (e) Allow joints to dry at least 24 hours before allowing traffic on pavers.
      (f) If there is a risk of rain within 24 hours, protect pavement with waterproof cover.

3.04 SAND SETTING-BED PAVER APPLICATIONS

A. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content re-mains constant and density is loose and constant until pavers are set and compacted.
B. Compact sand laying course using vibrating vehicular equipment until no densification is achieved with additional passes of the vibrating equipment.
C. Screed and level a final seating layer of the sand laying course over the compacted layer of sand laying course to achieve the thicknesses and grades specified on the Drawings after final compaction.

D. Do not disturb the sand laying course once it is compacted, screeded and leveled. If the sand laying course is disturbed due to exposure to construction traffic, foot traffic, the environment, or by other means, re-compact and reshape it until it meets the requirements of this Section.
E. Treat leveling base with soil sterilizer to inhibit growth of grass and weeds.
F. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
   (1) When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
G. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of 3500 to 5000-lbf com-paction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate, or other means as needed, to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
   (1) Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
   (2) Before ending each day's work, compact installed concrete pavers except for 36-inch width of un-compacted pavers adjacent to temporary edges (laying faces).
   (3) As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
   (4) Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not compacted and cover leveling course on which pavers have not been placed with non-staining plastic sheets to protect them from rain.
H. Spread dry polymeric sand evenly on surface of dry pavers and fill joints immediately with a push broom after vibrating pavers into leveling course. Fill joints completely, down to the full joint depth. Avoid sweeping over long distances to preserve the integrity of the sand. Do not install polymeric sand when pavers or joint conditions are wet or slightly damp as this will result in premature activation of the joint material.
   (1) Run a plate compactor over the entire surface to fully compact the joints. Repeat step H & H.1 until joints are completely full. Joints must be filled up to the bottom of the paver chamfer, or 1/8" be-low the top of the pavers.
   (2) Where a plate compactor cannot be used, proceed with a manual compaction: hammer vigorously each corner as well as the contour of each slab with a rubber mallet.
I. Remove all sand residue from the surface of paver field with a leaf blower, prior to wetting the surface. Keep the leaf blower at sufficient distance and power to maintain proper joint filling requirements. Ensure surface is completely free of sand, prior to wetting.
J. Activate the sand with water. Set spray nozzle to "shower" or "heavy mist" to avoid displacement of joint material. Start wetting from the bottom of the slope. Wet a 200 square foot section for approximately 30 seconds without displacing the sand. Wait a few seconds and wet the same section again for another 30 seconds or until joints are saturated. Do not allow joint to dry completely between initial and subsequent wetting. Avoid runoff and foaming.
   (1) Immediately move on to an adjacent 200 square foot sections and repeat process J until the entire paver field has been wetted. Avoid excess flooding on the surface, which could cause unwanted run-off.
   (2) On textured pavers, use the blower to blow excess water off the surface and into the joints.
K. Do not allow traffic on installed pavers until joint material has dried completely after initial wetting. It is recommended to keep all traffic off of installed pavers for 24-48 hours to ensure proper curing.

3.05 MORTAR SETTING BED APPLICATIONS
A. Application
   (1) Preparation of Subbase: Clean concrete subbase to remove dirt, dust, debris, film or curing compound, and loose particles. Saturate concrete subbase with clean water several hours before placing setting bed. About one hour prior to placing setting bed, remove surface water.
B. Setting
   (1) The prepared mortar shall be spread to the desired thickness. The mortar shall be rodded and compacted with a steel trowel.
   (2) Before placing the stone on a green or wet screed bed, a slurry coat shall be applied to the mortar bed using a flat trowel. Thickness of the bond coat shall be approximately 1/16". In addition, a skim coat shall be applied to the back of each stone, just prior to placing on the bed.
   (3) Stone shall be placed in the wet slurry coat before the surface dries. Uniform joints shall be maintained with a nominal width of 1/4".
   (4) After each piece is laid, it shall be beat in with a wooden block or rubber mallet to level the surface and embed the stone. Bearing shall be done before mortar takes initial set.
C. Mortar Joints: For paving, joints are 1/4" wide typically. After all stone units have been set and setting bed is thoroughly cured, brush all 1/4" wide joints clean. Thoroughly wet raked out portion of joints and then fill solid with joint mortar of approved color to match stone. Mortar shall be placed relatively dry and tooled in layers. Finished profile shall be slightly recessed. Grouting of joints as done in tile work is not permitted. Every effort must be made to keep mortar off stone face including applying masking tape to prevent staining of adjacent stone surfaces in continuous strips in alignment with joint edge. Remove tape immediately upon grout having achieved its finish set.
D. Joint Treatment for Joints to Receive Sealant

(1) All exterior control joints as noted on the drawings and all joints in base work shall receive back-up fillers and sealant as specified herein.
(2) General: Install all sealant in strict accordance with manufacturer's recommendations as approved by the Landscape Architect.
    (a) Apply sealant under pressure with a hand or power actuated gun or other appropriate means. Guns shall have nozzle of proper size and provide sufficient pressure to completely fill joints as detailed. Neatly point or tool all joints to provide the contour as indicated on the drawings.
    (b) For application of sealant when air temperature is below 40 deg. F., consult sealant manufacturer for recommendations.
(3) Preparation: Thoroughly clean all joints, removing all foreign matter such as dust, oil, grease, water, surface dirt and frost. Sealant must be applied to the base surface. Previously applied paint or film must be entirely removed.
(4) Application
    (a) Install back-up material and joint filler, of type and size specified, using a blunt instrument so as not to puncture the surface skin, at proper depth in joint to provide sealant dimensions as detailed. Provide back-up material of suitable size and shape so that, when compressed (25 to 50%) it will fit in joints as required. Sealant shall not be applied without back-up materials, and, if necessary, bond breaker strip. When using back-up of rod stock, roll the material into the joint to avoid lengthwise stretching. Rod stock shall not be twisted or braided.
    (b) Apply masking tape, where required, to prevent staining of adjacent stone surfaces, in continuous strips in alignment with joint edge. Remove tape immediately after joints have been sealed and tooled as directed.
    (c) Prime surfaces of all stone to receive sealant.
    (d) Apply, tool and finish sealant as required. When tooling light colored sealants, use dry tool or tooling solution recommended by sealant manufacturer.
    (e) Clean adjacent surfaces free of sealant or soiling resulting from this work as work progresses. Use solvent or cleaning agent as recommended by sealant manufacturer. All finished work shall be left in a neat, clean condition.
    (f) Sealants shall be applied in such a manner as to completely fill the joint.
    (g) All sealants shall be tooled to insure complete filling of the joint to eliminate air pockets and voids and to insure positive adhesion of the sealant with the bonding surfaces.
    (h) All joints shall be neatly finished.

3.06 REPAIR, POINTING, CLEANING AND PROTECTION

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units as intended. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
B. Cleaning: Remove excess grout and/or polymeric sand from exposed paver surfaces; wash and scrub clean per manufacturer recommendations.
C. Pointing: During tooling of joints, enlarge voids or holes and completely fill with mortar or grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

END OF SECTION 32 14 00

SECTION 32 15 42 - STONE FINES SURFACING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

(1) Exposed stone fines surfacing with stabilizer additive.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

(1) Review stone fines surfacing mix design and examine procedures for ensuring quality of materials, mixing and placement. Require representatives of each entity directly concerned with stone fines surfacing to attend, including the following:

(a) Contractor's superintendent.
(b) Stone fines surfacing Installer.

1.03 ACTION SUBMITTALS

A. Product Data: For each product specified. Include technical data and tested physical and performance properties.
B. Sieve Analyses: For stone fines materials, according to ASTM C 136.
C. Samples for Initial Selection: For stone fines materials, showing range of color and other appearance characteristics available for selection.
D. Samples for Verification: For the following:

(1) Surfacing Materials: 5 lb (2.5 kg) of each type of exposed surfacing material required, in sealed plastic bags labeled with gradation and source. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture, and size range of the material.

E. Sustainability Submittals: Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

(1) Solar Reflectance Index: Provide manufacturer's documentation / test report for the initial SR rating value complying with gray cement concrete of 0.26 and white cement concrete of 0.70.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
B. Material Certificates: For surfacing material. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of surfacing material.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from the same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

(1) Stone Fines Surfacing: 10 percent of quantity of stone fines materials installed, in the form of 50- lb. bags.
(2) Stabilizer Additive: 10 percent of quantity of binder material installed, but not less than four 5-gallon containers.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed stabilized stone fines surfacing similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance
B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

(1) Build mockups of each type of stone fines surfacing in the location and of the size indicated or, if not indicated, build mockups where directed by Landscape Architect and not less than 10 by 10 feet. Include base course and each typical edge and perimeter condition.
(2) Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
(3) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store stone fines materials where grading and other required characteristics can be maintained and contamination can be avoided.
B. Deliver stabilizer additive materials to mixing location in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
C. Store stabilizer additive materials in a clean, dry, protected location and within temperature range required by manufacturer. Protect stored materials from direct sunlight.
D. Protect and cover stone fines and related materials during storage and construction to prevent wetting by rain, snow or water and against contamination by earth and other materials or substances.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Apply materials only when substrate conditions and weather are within acceptable ranges as specified by the manufacturer.
B. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen base. Remove and reconstruct stone fines surfacing work damaged by frost or freezing.

PART 2 - PRODUCTS

2.01 SUSTAINABILITY PERFORMANCE REQUIREMENTS

A. Solar Reflectance Index: Provide documentation for the initial SR rating value.

2.02 STONE FINES SURFACING MATERIALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kafka Granite LLC, Mosinee WI (kafkagranite.com, 800-852-7415); Stabilized Pathway Aggregate.
   (1) Color: Midnight Blue
B. General: Use materials and gradations that have performed satisfactorily in previous installations.
C. Source Limitations: Obtain each type of surfacing material from single source that has resources to provide materials and products of consistent quality in appearance and physical properties.
D. Stone Fines Surface Course Materials: Crushed aggregate consisting of sound, angular, durable particles, with the following gradation according to ASTM C 136:

Sieve Designation	Range of Percent Passing
3/8 inch	100
No. 4	80-100
No. 8	65-90
No. 16	40-65
No. 30	25-55
No. 50	15-35
No. 100	10-20
No. 200	5-15

2.03 STABILIZATION MATERIALS

A. Stabilizer Binder: 1-component liquid rock dust stabilizer, designed to be applied to crushed aggregate fines to produce water-permeable, erosion-resistant stabilized stone fines surfacing for pedestrian traffic.

   (1) Basis-of-Design Product: Subject to compliance with requirements, provide Romex® D7000 Rock Dust Stabilizer. Romex North America (romexhardscapes.com, 1-844-722-3760).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that subgrade is in suitable condition for installation of stone fines and binder application.
B. Verify that compacted subbase material and base course are dry and ready to support stone fines surfacing and imposed loads.
C. Verify that gradients and elevations of base are correct, and that base course has been finished to a tolerance of 1/4 inch in 10 feet.
D. Notify Landscape Architect in writing of any unsatisfactory conditions. Do not begin stone fines surfacing installation until these conditions have been satisfactorily corrected.

3.02 PREPARATION, GENERAL

A. Protect adjacent surfaces, plants, and structures to prevent damage or contamination during placement and compaction of stone fines surfacing.
B. Coordinate installation of stone fines surfacing with adjacent construction including paving and site furnishings.
C. Immediately before placing stone fines materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive stone fines mixture.
   (1) Pre-soak base to assist in bonding of stone fines surfacing materials.

3.03 INSTALLATION, GENERAL

A. Mix stone fines surfacing materials from several containers or batches to produce uniform blend of colors and textures.
B. Provide crowns in areas of stone fines surfacing with slopes of 2 percent or less.
   (1) Slope surfaces not less than 1 percent to drain away from structures.
C. Coordinate application of stone fines surfacing with installation of edge restraints. Sequence the Work so stone fines surfacing materials are placed after installation of edge restraint assemblies has been completed.
D. Install stone fines surfacing so top surface is flush with adjacent material or edge restraints unless otherwise indicated.

3.04 SUBSTRATE PREPARATION

A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 1557 modified Proctor density.
B. Place aggregate base course as specified by tamping with plate vibrator, and screed to depth indicated.
   (1) Compact base course uniformly to at least 95 percent of ASTM D 1557 modified Proctor density.
   (2) Incorporate indicated crowns and cross-slopes into compacted base course, as applicable.

3.05 STONE FINES PLACEMENT

A. Surface Course Installation: After mixing to produce a uniform blend, spread approved stone fines mixture in a moist condition. Uniformly cover base course to a compacted depth indicated.
   (1) Use a paving machine, box Gannon™ or similarly equipped tractor/loader, or other method recommended by the manufacturer/supplier for placing stone fines in large areas. Spread the loose and uncompacted aggregate over the compacted base material.
   (2) Roll immediately after placement, using a double or singe static steel-wheel drum roller, or equivalent, weighing not more than 1 ton, and compact the surface course mixture to a density of 95 percent at optimum moisture content according to ASTM D 1557.
      (a) Do not use vibratory equipment for compacting stone fines surface course.
      (b) Hand roll areas not accessible with power roller to same density.
B. Stabilizer Application:
   (1) Pour the 1-component liquid rock dust stabilizer into a watering can with an inclined spray attachment and distribute evenly over the stone fines surface.
   (2) Allow 10-15 minutes for absorption. Then use a plate compactor or hand tamper to create a smooth surface.
   (3) Apply stabilizer at a rate of approximately 85 square feet per 5.2 gallon/20-litre container in two coats, apply approximately 60% of the liquid stabilizer on the first coat, compact then add the second coat in the following 1-2 hours after the first coat.
   (4) Protect the treated area from rain for 48 hours, ensuring air circulation under the rain protection.
   (5) After hardening lightly apply a third coat of liquid stabilizer using a sprayer, watering can, or roller for added strength of stabilized stone fines surfacing.
C. Finish Course Tolerance: Finish and measure surface so gap at any point between stone fines surface and an unleveled, freestanding, 10-foot-long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch.

3.06 ADJUSTING AND PROTECTION

A. Remove and replace stabilized stone fines surfacing that is damaged, defective or does not comply with specified requirements.
B. After final rolling, do not permit pedestrian or vehicular traffic on stone fines surfacing until it has fully cured, a minimum of 24-72 hours.
C. Erect barricades and warning signs as required to protect newly installed stone fines surfacing areas from traffic. Maintain barricades until time of Substantial Completion unless otherwise directed.

D. Ensure that a continuous grade is maintained along the stabilized stone fines surfacing, and that no areas form where water might collect or puddle. Correct deficiencies and maintain stone fines surfacing for remainder of construction period.

END OF SECTION 32 15 42

SECTION 32 16 13 - CONCRETE CURB AND GUTTER

PART 1 GENERAL

1.01 WORK INCLUDED

A. Construct cast-in-place combination curb and gutter.

1.02 RELATED WORK

A. Section 31 2000 – Earth Moving.

B. Section 32 1376 – Sidewalks.

C. Section 32 0523 – Cement & Concrete for exterior improvements.

D. Section 32 1373- Concrete Paving Joint Sealants.

1.03 SUBMITTALS

A. See Related Work

1.04 QUALITY ASSURANCE

A. Perform cast-in-place concrete in accordance with ACI 301 and Section 32 0523.

1. Standard Specifications for Highway construction, Edition of 2014, hereafter referred to as “AHTD Standard Specifications”.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ready Mixed concrete: ASTM C94 and Articles 2.01 through 2.06 of Section 32 0523.

B. Curing Compound: ASTM C309.

C. Pre-formed expansion joint fillers: ASTM D1751-18.

1. Thickness: ½ inch.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Grade subgrade and compact in same manner and to same density as specified in Section 31 2000 controlled fill.

3.02 GENERAL

A. Notify Architect/Engineer for inspection at least 24 hours before the planned time to pour concrete.

B. Inspection:

1. Ensure that excavation and formwork are completed and within the allowed tolerances.
2. Ensure that ice and excess water are removed, no frost is present, and that ground is not frozen.
3. Check that reinforcement is secured in place.
4. Verify that insulation, anchors, and other embedded items are secured in position.

C. Install concrete work in accordance with ACI 301-20 except as amended by this section.

3.03 INSTALLATION

A. Cast-in-place Concrete: Refer to Section 32 0523

1. See standard Detail Drawings for Curb and Gutter, and for Handicap Ramp.
2. Prepare subgrade in accordance with Section 31 2000.
3. Set forms to line and grade.
4. Install forms over full length of curb.
5. Form contraction joints at maximum 10 feet spacing using steel templates, division plates or sawcuts.
6. Remove templates or plates as soon as concrete has hardened sufficiently to retain its shape.
7. Install preformed expansion joint fillers at maximum 40 feet spacing, at curb returns, and behind curb at abutment to sidewalks and other structures.
8. Place top of expansion joint material ¼ inch below curb surface.
9. Place concrete in position without separation of concrete materials.
10. Consolidate concrete with mechanical vibrators.
11. Round face of curbs at top with finishing tool of correct radius.
12. Finish exposed surfaces with wood float followed by light brushing with broom.
13. Apply curing material and cure for seven days.

B. Repair of surface defects: Comply with requirements of Section 32 0523.
C. Field Quality Control: Comply with requirements of Section 32 0523.
D. Protection of Completed Work: Comply with requirements of Section 32 0523.

END OF SECTION 32 16 13

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Providing pavement markings as shown on Drawings.

1.02 REFERENCE STANDARDS

A. Federal Specifications (FS):

1. TT-P-115E Paint, Traffic, Highway, White and Yellow.
2. TT-P-1952B Paint, Traffic, and Airfield Marking, Water Emulsion Base.

B. Federal Standard (Fed. Std.)

1. No 141B Paint, Varnish, Lacquer, and related materials.

C. Arkansas Department of Transportation (ArDOT)

1. Standard Specifications for Highway Construction, 2014 Edition

1.03 SUBMITTALS

A. Submit a test report showing either that the proposed batch meets all specified requirements or that a previous batch manufactured using the same formulation as that used in manufacturing the proposed batch for the following properties required in the material specification: weight per gallon, viscosity, fineness of grind, drying time, and gradation. Testing procedures and reports shall be as specified in paragraph 5 of Method 1031.2 of Fed. Std.141.

1.04 DELIVERY, HANDLING AND STORAGE

A. Deliver material in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, formulation number and directions, all of which shall be plainly labeled at time of use.

B. Furnish paint in containers not larger than five gallons.

C. Store paint on project site. Store emulsion paints to prevent freezing.

1.05 SITE CONDITIONS

A. Unless other wise recommended by the paint manufacturer apply pavement markings material only when the ambient temperature is between 40 and 95 degrees F.

PART 2 PRODUCTS

2.01 MATERIALS

A. Parking:

1. Manufactured according to FS TT-P-115E, FS TT-P-1952B or ArDOT Standards Specification Section 718,719, or 720.
2. Symbol Color: White.
3. Handicapped Access Aisles on Asphalt Paving: Color, White
4. Handicapped Access Aisles on Concrete Paving: Color, ADA Blue
5. Paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of six months.
6. Note: Verify colors with owner prior to painting.

B. Roadway:

1. Manufactured according to ArDOT Standard Specifications Section 719 or 720.
2. Color:
    a. Separating traffic traveling in opposite directions: Yellow
    b. Left edge of roadways: Yellow
    c. Separating two-way left turn lanes and reversible lanes from other lanes: Yellow
    d. All other applications: White
    e. Pre-molded striping and symbols as shown and called for on plans.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 30 days before application of markings materials.

B. Thoroughly clean all surfaces to be marked before application of paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required.

C. Completely remove rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed.

D. Where oil or grease are present on old pavements to be marked, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application. After cleaning, seal, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

3.02 EQUIPMENT

A. General: Use only approved machines, tools, and equipment. Maintain equipment in satisfactory operating condition. Han-operated push type machines of a type commonly used for application of paint to pavement surfaces will be acceptable for marking small street and parking areas. Use applicator machine equipped with the necessary paint tanks and spraying nozzles. Equipment shall be capable of applying paint uniformly at coverage specified. Provide sandblasting equipment as required for cleaning surfaces to be painted. Use hand-operated spray guns for use in areas where push-type machines cannot be used.

B. Sandblasting Equipment: Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 c.f.m of air at a pressure of not less than 90 psi at the nozzle for each nozzle used.

C. During concrete placement, keep base sufficiently moist to prevent excessive absorption of water from freshly placed concrete.

3.03 APPLICATION

A. Rate of Application: Apply two (2) coats of paint at manufacturer's recommended rate with total maximum of 320 lineal feet per gallon per coat with 4" wide stripe. Apply with mechanical equipment to produce uniform straight edges. At sidewalk curbs, use a straightedge to ensure a uniform, clean, and straight stripe.

B. Paint: Apply paint in stripes of specified width to clean, dry surfaces, unless otherwise approved, only when air and pavement temperature is above 40 F and less than 95 F. Maintain paint temperature within these limits. Apply paint pneumatically with approved equipment at rate of coverage specified herein. Provide guide lines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Sharply outline all edges of markings. Maintain the maximum drying time requirements of the paint specifications to prevent undue softening of bitument, and pickup, displacement, or discoloration by tires of traffic. If there is a deficiency in drying of the markings, discontinue painting operations until cause of the slow drying is determined and corrected.

3.04 PROTECTION

A. Prevent damage to newly painted surfaces by either placing small markers along newly painted lines or controlling traffic to keep vehicles away from area of newly painted lines.

END OF SECTION 32 17 23

SECTION 32 33 00 - SITE FURNISHINGS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.02 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the site furnishings as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

(1) Trash and recycling receptacles.
(2) Bicycle racks.
(3) Tables and chairs.
(4) Adirondack chairs.
(5) Pedestrian pole lights.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed installation of site furnishings similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Submit Manufacturer's standard catalog data sheets and standard product details as required for installation and integration with other work.
B. Sample for Initial Selection: For units with factory-applied finishes.
C. Shop Drawings: Submit shop drawings to show component parts, fabrication, installation, and dimensions for all items in this section, including manufacturer's instructions for footings and anchorages.
D. Manufacturer's recommended installation procedures.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
B. Trash Receptacle Inner Containers: Five full-size units for each size indicated, but no fewer than two units.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling.
B. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

PART 2 - PRODUCTS

2.01 TRASH RECEPTACLES

A. Trash Receptacles with polyethylene liner complying with University of Arkansas Campus Standards.

(1) Manufacturer: Landscape Forms, 431 Lawndale Avenue, Kalamazoo, MI 49048; http://www.landscapeforms.com
(2) Product: Petosky Litter Receptacle.
(3) Material: Cold-rolled Steel body / Spun Steel lid.
(4) Capacity: 30 gallons.
(5) Color: Stone (Panguard II polyester powder coat).

2.02 RECYCLING RECEPTACLES

A. Recycling Receptacles with polyethylene liner with 5" dia. opening complying with University of Arkansas Campus Standards.

(1) Manufacturer: Landscape Forms, 431 Lawndale Avenue, Kalamazoo, MI 49048; http://www.landscapeforms.com
(2) Product: Petosky Litter Receptacle.
(3) Material: Cold-rolled Steel body / Spun Steel lid.
(4) Capacity: 30 gallons.
(5) Color: Ivy (Panguard II polyester powder coat).

(6) Graphic/Sign: Sign 09 recycling logo for aluminum cans and plastic bottles.

2.03 BICYCLE RACKS

A. Bicycle Racks made of CorTen steel mounted below grade complying with University of Arkansas Campus Standards.

(1) Manufacturer: STREETLIFE America LLC, Philadelphia, PA, US Tel 1-215-247-0148; usa@streetlife.com
(2) Product: Strip Bicycle Rack BP-70-IGM (in ground mount) & BP-70-CT (surface mount).
(3) Dimension: As shown on the drawings. Custom mounting requirements described in drawings.
(4) Material: untreated CorTen steel, ca. 1 cm thick weathered pre-delivery.
(5) Including horizontal black synthetic (PE/PP) protection strip fitted at the top.
(6) Delivery: Assembled.
(7) Installation: below grade/surface mount as concrete ready.

2.04 TABLES AND CHAIRS

A. Movable tables complying with University of Arkansas Campus Standards.

(1) Table Manufacturer: Fermob USA, 1610 Redi Rd. Cumming, GA 30040 https://www.fermobusa.com/
(2) Product: Luxembourg 32x32” Table (4 Legs), freestanding.
(3) Material: Aluminum
(4) Color: Titanium (Panguard II polyester powder coat).Rosemary

B. Movable chairs complying with University of Arkansas Campus Standards.

(1) Manufacturer: Fermob USA, 1610 Redi Rd. Cumming, GA 30040 https://www.fermobusa.com/
(2) Product: Luxembourg Armchair; freestanding.
(3) Material: Aluminum
(4) Color: Rosemary

C. Adirondack chairs complying with University of Arkansas Campus Standards.

(1) Manufacturer: Rejuvenation, Williams-Sanoma https://www.rejuvenation.com
(2) Product: Vaughn Teak Outdoor Adirondack Chair
(3) Material: Teak
(4) Color: Natural Teak

2.05 LIGHTS

A. Pedestrian pole light complying with University of Arkansas Campus ‘Contemporary’ Standards.

(1) Manufacturer: BEGA, 1000 BEGA Way, Carpinteria, CA 93013 https://www.bega-us.com/
(2) Product: 3"-5" OD tapered aluminum pole with round hinged base model 1308HR.
(3) Height: 13'-8".
(4) Base: 12-5/8" diameter.
(5) Material: Aluminum.
(6) Color: Old BEGA Black.
(7) Luminaire: 77120LED.
(8) Material: Aluminum.
(9) Color: Old BEGA Black.
(10) LED Color Temperature: 2700K.

B. Crosswalk pole lights complying with University of Arkansas Campus Standards.

(1) Manufacturer: BEGA, 1000 BEGA Way, Carpinteria, CA 93013 https://www.bega-us.com/
(2) Product: 3"-5" OD tapered aluminum pole with round hinged base model 1908HR.
(3) Height: 19'-8".
(4) Base: 12-5/8" diameter.
(5) Material: Aluminum.
(6) Color: Old BEGA Black.
(7) Luminaire: B84249 Crosswalk Service BEGA Twin Head.
(8) Material: Aluminum.
(9) Color: Old BEGA Black.
(10) LED Color Temperature: 2700K.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine the areas and conditions where site furnishings are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.
B. Prepare surface as needed to perform installation per manufacturer's recommendation.

3.03 INSTALLATION, GENERAL

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
C. Install site furnishings level, plumb, true, and securely anchored or positioned at locations indicated on Drawings.

3.04 INSTALLATION

A. Bicycle Racks: Bolt base plates to concrete slab or footing on stable compacted surface using two (2) 5/8" x 6" stainless steel anchor bolts. Bolt heads shall be flush with surface of the plate.
B. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
C. Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, pertinent requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures.

END OF SECTION 32 33 00

SECTION 32 57 30 - SITE DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes the following:

(1) Custom painted galvanized handrail.

1.03 PERFORMANCE STANDARDS FOR RAILINGS (UNLESS GREATER REQUIRED BY CODE)

A. Railing assemblies shall be designed and installed to resist the simultaneous application of a lateral force of 50 PLF and a vertical load of 100 PLF, both applied to the top of the railing. Railings shall resist a total lateral force and total vertical load of at least 200 lbs. each.

B. Submit calculations and drawings signed and sealed by a Professional Engineer licensed in the State of Arkansas indicating that railing system can meet these performance criteria.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's, fabricator's and finisher's specifications and installation instructions for products used in ornamental metal work, including finishing materials and methods.

B. Samples: For each type of exposed finish required, prepared on 12" x 12" samples of metal of same thickness and material indicated for the Work.

C. Shop Drawings: Submit for all items of work of this Section, as enumerated under paragraph 1.02, showing locations, layouts, materials, thicknesses, finishes, dimensions, construction, relation to adjoining construction, erection details, profiles, jointing and all other details to fully illustrate the work of this Section.

D. Contractor Licensed Engineer Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Mockups: Provide mockup of railings as directed by the Landscape Architect.

F. Sustainability Submittals: Complete provided Product Data Reporting Form in spec section 01 81 13 and provide the following:

G. Recycled Content: Provide recycled content information. Highlight post-consumer and pre-consumer quantities. Provide material costs excluding labor itemized.

1.05 QUALITY ASSURANCE

A. General: Work of this section shall be fabricated and installed by an experienced fabricator or manufacturer who has been engaged in work of equivalent scope and fabrication standards for at least five (5) years. Materials, methods of fabrication, fitting, assembly, bracing, supporting, fastening, operating devices, and erection shall be in accordance with drawings, specifications, and approved shop drawings, and be of highest quality practices of the industry, using new and clean materials as specified, having structural properties sufficient to safely sustain or withstand stresses and strains to which materials and assembled work will be subjected. All work shall be accurately and neatly fabricated, assembled, and erected.

B. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. However, do not delay job progress; allow for adjustments and fitting where taking of field measurements before fabrication might delay the work.

C. Shop Assembly: Insofar as practicable, fitting and assembly of work shall be done in shop. Work that cannot be permanently shop assembled, shall be completely assembled, marked and disassembled in shop before shipment to insure proper assembly in field. Shop assemble work in largest practical sizes to minimize field work. It is the responsibility of the Contractor for this work to assure himself that the shop fabricated items will properly fit the field condition. In the event that shop fabricated items do not fit the field condition, the item shall be returned to the shop for correction.

PART 2 - PRODUCTS

2.01 SUSTAINABILITY PERFORMANCE REQUIREMENTS

A. Recycled Content: Provide materials with a minimum of 25% recycled or reused content.

2.02 MANUFACTURER

A. Handrail - Contemporary: Galvanized steel.

(1) Refer to Drawing L620.

2.03 MATERIALS

A. Provide materials that have been selected for their surface flatness, smoothness, and freedom from surface blemishes where exposed to view in the finished unit. Surfaces exposed to view that exhibit pitting, seam marks, roller marks, oil-canning, stains, discolorations, or other imperfections on the finished units will not be acceptable.

B. Steel and Iron: Provide steel and iron in the form indicated, complying with the following requirements:

(1) Tubing: Cold-formed, ASTM A 500; or hot-rolled, ASTM A 501.
(2) Steel Plates, Shapes and Bars: ASTM A 36.
(3) Gray Iron Castings: ASTM A 48, Class 30.
(4) Malleable Iron Castings: ASTM A 47, grade as recommended by fabricator for type of use indicated.
(5) Steel Rods: ASTM A 108.
(6) Steel (Carbon) for Concealed Supports Only

(a) Structural Shapes: ASTM A 36.
(b) Plates (for forming or bending cold): ASTM A 283, Grade C.
(c) Steel Sheets: ASTM A 366, Grade 1.

(7) Shop prime with rust inhibitive primer equal to Series 88 Azeron made by Tnemec, or approved equal made by Benjamin Moore or Sherwin Williams.

C. Welding Electrodes and Filler Metal: Type and alloy of filler metal and electrodes as recommended by producer of the metal to be welded, and as required for color match, strength and compatibility in the fabricated items.

D. Fasteners: Furnish basic metal and alloy, matching finished color and texture as the metal being fastened, unless otherwise indicated. Provide Phillips flat-head screws for exposed fasteners, unless otherwise indicated.

E. Anchors and Inserts: Either furnish inserts to be set in concrete or masonry work, or provide other anchoring devices as required for the installation of ornamental metal items. Provide toothed steel or lead shield expansion bolt devices for drilled-in-place anchors. Provide galvanized or cadmium-coated anchors and inserts for exterior installations.

(1) Provide units with exposed surfaces matching the texture and finish of the metal item anchored.

F. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

G. Cast-in-Place and Preinstalled Anchors: Anchors fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete.

H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

(1) Provide at base to avoid water collection and rusting.

2.04 FABRICATION

A. Cutting: Cut metal by sawing, shearing or blanking. Flame cutting will be permitted only if cut edges are ground back to clean, smooth edges. Make cuts accurate, clean, sharp, square and free of burrs, without deforming adjacent surfaces or metals.

B. Holes: Drill or cleanly punch holes (do not burn), so that holes will be accurate, clean, neat and sharp without deforming adjacent surfaces or metals.

C. Connections

(1) Make connections with tight joints, capable of developing full strength of member, flush unless indicated otherwise, formed to exclude water where exposed to water. Locate joints where indicated on drawings. Provide connections to allow for thermal movement of metal at locations and by methods approved by Landscape Architect. For work exposed to view, use concealed fasteners (unless welded or other connections indicated) with joints accurately fitted, flush and rigidly secured with hairline contacts.
(2) Welding: Welding shall be in accordance with recommendations of the American Welding Society and shall be done with electrodes and/or methods recommended by the manufacturers of the metals being welded. Welds shall be continuous, except where spot welding is specifically permitted. Welds exposed to view shall be ground flush and dressed smooth with and to match finish of adjoining surfaces so that joint will not be visible; undercut metal edges where welds are required to be ground flush and dressed smooth. All welds on or behind surfaces which will be exposed to view shall be done so that finished surface will be free of imperfections such as pits, runs, splatter, cracks, warping, dimpling, depressions or other forms of distortion or discoloration. Remove weld splatter and welding oxides from all welded surfaces.

D. Built-In Work: Furnish anchor bolts, inserts, plates and any other anchorage devices, and all other items for architectural metal work to be built into concrete, masonry, or work of other trades, with necessary templates and instructions, and in ample time to facilitate proper placing and installation.

E. Supplementary Parts: Provide as necessary to complete each item of work, even though such supplementary parts are not shown or specified.

F. Coordination: Accurately cut, fit, drill and tap work of this Section to accommodate and fit work of other trades. Furnish or obtain, as applicable, templates and drawings to or from applicable trades for proper coordination of this work.

G. Exposed Work: In addition to requirements specified herein or shown on drawings, all surfaces exposed to view shall be clean, and free from dirt, stains, grease, scratches, distortions, waves, dents, buckles, tool marks, burrs and other defects which mar appearance of finished work. Ornamental metal work exposed to view shall be straight and true to line or curve, smooth arises and angles as sharp as practicable, miters formed in true alignment, profiles accurately intersecting, and with joints carefully matched to produce continuity of line and design. Exposed

fastenings, where permitted, shall be of the same material, color and finish as the metal to which applied, unless otherwise indicated, and shall be of the smallest practicable size.

H. Materials used shall be of such strength, thickness and alloy that they are capable of meeting all standards and descriptions specified herein and as detailed on drawings.

2.05 SHOP FINISHING

A. General

(1) Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated.
(2) Provide colors or color matches as indicated on selected samples.
(3) Protect mechanical finishes on exposed surfaces from damage by application of strippable temporary protective covering prior to shipment.
(4) Corrosion Protection: Coat concealed surfaces which will be in contact with concrete, masonry, wood or dissimilar metals, in exterior work and work to be built into exterior and below grade walls and decks, with a heavy coat of bituminous paint. Do not extend coating onto exposed surfaces.

B. Steel and Iron Finishes

(1) Painted Hot-Dip Galvanized Finish

(a) Hot-Dip Galvanizing: For steel exposed to the elements, weather or corrosive environments and other steel indicated to be galvanized, provide coating for iron and steel fabrications applied by the hot-dip process. Galvanizing bath shall contain special high-grade zinc.

(i) Basis of design: Duragalv®
(ii) Comply with ASTM A 123 for fabricated products and ASTM A 153 for hardware.
(iii) If required, plug vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes after galvanizing and grind smooth.
(iv) Galvanized surface shall be prepared per SSPC SP2 or SP3 to provide a smooth surface removing all runs, drips, or sags.
(v) Galvanizing shall exhibit a rugosity (smoothness) of 16-25 microns or less when measured by a profilometer. This pertains to those elements that are less than 24 pounds per running foot.
(vi) Galvanized surfaces, that are to receive coatings, must be blasted per SSPC SP 16. The use of iron, steel shot, and aluminum oxide grit as a blast medium, and power wire brushes are not permitted.
(vii) For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

(b) Factory-Applied Primer over Galvanized Steel: Provide factory-applied polyamide epoxy prime coat over hot-dipped galvanized steel.

(i) Basis of design: Primergalv®.
(ii) Primer shall be certified OTC/VOC compliant at less than 2.8 lbs./gal. and conform to EPA and local requirements.
(iii) Apply the primer at the galvanizer's facility within 12 hours after galvanizing. Application must be in a controlled environment meeting applicable conditions as required by the coating manufacturer. Primer shall have a one-year re-coat window for application of finish coat.
(iv) Primer shall be applied at 2-6 mils DFT and meet or exceed the following performance criteria as stipulated by the coating manufacturer:

1. Abrasion Resistance: ASTM D 4060 (CS17 Wheel, 1,000 grams load) 1 kg load, 200 mg loss.
2. Adhesion: ASTM D 4541, 1050 psi.
3. Corrosion Weathering: ASTM D 5894, 13 cycles, 4,368 hours, 10 per ASTM D 714 for blistering; 7 per ASTM D 610 for rusting.
4. Direct Impact Resistance: ASTM D 2794, 160 in. lbs.
5. Flexibility: ASTM D 522, 180 degrees bend, 1 inch mandrel, Passes.
6. Pencil Hardness: ASTM D 3363, 3H.
7. Moisture Condensation Resistance: ASTM D 4585, 100 degrees F, 2000 hours, Passes no cracking or delamination.
8. Dry Heat Resistance: ASTM D 2485, 250 degrees F.
9. Accelerated Weathering: QUV- ASTM D 4587 QUV A 5000 Hours, Passes.
10. Salt Fog Resistance: ASTM B 117, 5,600 hours No cracking or delamination.

(c) Topcoat: Provide factory-applied high-performance 2nd generation aliphatic acrylic urethane coating in specified color and gloss range matching approved samples.

(i) Basis of design: Colorgalv® 10. Topcoat shall be certified OTC/VOC compliant and conform to EPA and local requirements.

1. Color: Sherwin Williams "UofA Advanced Bronzetone" or as approved by Landscape Architect.

2. Custom formula:

Custom: Advance Bronzetone

CCE* Color Cast	OZ	32	64	128
W1 White	-	42	-	1
B1 Black	6	36	-	1
R2 Maroon	-	26	-	1
Y3 Deep Gold	2	14	1	-

Custom Manual Match
BRONZETONE

(ii) Topcoat shall be applied over the primer at the galvanizer's facility. Topcoat shall be applied in a controlled environment meeting applicable conditions and recoat times as required by the coating manufacturer.

(iii) Topcoat will be applied at 2-3 mils DFT and must meet or exceed the criteria for the following categories as stipulated by the coating's manufacturer:

1. Abrasion Resistance: ASTM D 4060, CS17 Wheel, 1,000 cycles 1kg load; 154 mg loss.
2. Adhesion: ASTM D 4541; 1,766 psi.
3. Direct Impact Resistance: ASTM D 2794; 176 in. pounds.
4. Dry Heat Resistance: ASTM D 2485; 250 degrees F (121 C).
5. Salt Fog Resistance: ASTM B 117 9,000 hours; Rating 10 per ASTM D714 for blistering, Rating 10 per ASTM D 610 for Rusting.
6. Flexibility: ASTM D 522, 180 degrees bend, 1/8-inch mandrel; Passes.
7. Pencil Hardness: ASTM D 3363; HB.
8. Moisture Condensation Resistance: ASTM D 4585, 100 degrees F 38 C, 4000 hours; No rusting, blistering, or delaminating.
9. Corrosion Weathering: ASTM D 5894, 33 Cycles, 12,531 Hours; Rating 10 Per ASTM D 714 for blistering. Rating 10 Per ASTM D 610 for Rusting.
10. Thermal Cycling: ASTM D 2246, 10 cycles; Excellent.

(d) Warranty:

(i) Provide galvanizer's warranty that materials will be free from 10 percent or more visible rust for 20 years.

(ii) Gloss and color warranty shall be 10 years in accordance with the following performance specifications:

1. Fade: Defined as a loss of gloss not to exceed 35 units of gloss, which shall be measured in accordance with ASTM D 523-89 with 60 degrees geometry.
2. Color shift: Not to exceed 15 DE CIE LAB units for whites and light colors. Dark colors not to exceed 25 DE CIE LAB units measured by ASTM D 2244 (yellows, oranges, and reds are excluded).

2.06 PROTECTION

A. Provide necessary protection to all exposed surfaces of architectural metal work, so as to prevent damage, staining, discoloration, abrasion, etc., to these surfaces from time of shipment from factory to acceptance of work of this project. Protection shall be provided by wrappings, strippable coatings, or other means. After installation, remove protective paper or strippable coating and clean exposed surfaces, and then provide additional temporary protection to protect architectural metal work from damage during subsequent construction activities. Surfaces which are damaged, stained, discolored, abraded etc., shall be rejected and replaced with new materials, at no cost to the Owner.

2.07 STEEL FRAMING, BRACING, SUPPORTS AND REINFORCEMENTS

A. Steel framing, plate reinforcing, supplementary steel framing or reinforcing, bracket assemblies, and the like required for the support, framing, reinforcing, bracing, etc., of work of this Section shall be of such sizes and shapes as indicated on the drawings, or as required to suit the conditions, and shall be provided with all necessary supports and accessory items such as inserts, hangers, braces, struts, clip angles, anchors, bolts, nuts, welds, etc., as required to properly and rigidly fasten, anchor or attach work of this Section in place and to the concrete, masonry and other connecting and adjoining work.

2.08 DECORATIVE HANDRAILS AND RAILINGS

A. Welded Connections: Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:

(1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
(2) Obtain fusion without undercut or overlap.
(3) Remove flux immediately.

(4) At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
(5) Form changes in direction of railing members by radius bends.
(6) Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces of handrail and railing components.
(7) Provide wall returns at ends of wall-mounted handrails, close ends of returns.
(8) Close exposed ends of handrail and railing members with prefabricated end fittings.
(9) Brackets, Flanges, Fittings, and Anchors: Provide brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.
    (a) Furnish inserts and other anchorage devices for connecting handrails and railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.
    (b) For railing posts set in concrete, provide preset sleeves of steel, not less than 6 inches long and inside dimensions not less than 1/2 inch greater than outside dimensions of post, with steel plate forming bottom closure.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install work of this Section square, plumb, straight, true to line or radius, accurately fitted and located, with flush, tight hairline joints (except as otherwise indicated or to allow for thermal movement), with provisions for other trades, with provisions to allow for thermal movement, and with attachment devices as required for secure and rigid installation. It is the responsibility of the Contractor to assure himself that shop fabricated architectural metal items will properly fit the field condition. In cases where the shop fabricated architectural metal items do not fit the field condition, the item shall be returned to the shop for correction.
B. Attachments
    (1) Unless otherwise indicated, work to be built into concrete or masonry shall be anchored with shop welded on galvanized steel strap anchors; work to be attached to concrete or masonry shall be anchored by bolts into embedded inserts or expansion shields; work attached to structural steel shall be anchored by welds or bolts; work attached to metals other than structural steel shall be anchored by bolts or screws. Power actuated fasteners not permitted unless approved by Landscape Architect. Provide all supplementary parts necessary to complete each item of work of this Section.
    (2) All attachment devices shall be of type, size and spacing to suit condition and as approved by Landscape Architect. Provide shims, slotted holes, or other means necessary for leveling, plumbing and other required adjustments. Attachment devices for work exposed to view shall be concealed, unless indicated otherwise. Where bolts or screws are permitted in work exposed to view, they shall be oval head and counter sunk, unless otherwise noted, with projecting end cut off flush with nuts or adjacent material, and shall match adjacent surfaces.
    (3) Do all necessary drilling, tapping, cutting or other preparations of surrounding construction in the field accurately, neatly, and as necessary for the attachment and support of work of this Section, but obtain Landscape Architect's approval prior to such preparation to work of others.
C. Tolerances: All work of this Section shall be plumb, square, level, true to radius and correctly aligned within the following limitations:
    (1) Offset from true horizontal, vertical and design location shall not exceed 1/16" per ten (10) feet of length for any component, not cumulative.
    (2) Maximum offset from true alignment between abutting components shall not exceed 1/32".
D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units at Contractor's option.
E. Restore protective coverings which have been damaged during shipment or installation of the work. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at the same location.
F. Retain protective coverings intact and remove simultaneously from similarly finished items to preclude non-uniform oxidation and discoloration.
G. Field Welding: Comply with AWS Code for the procedures of manual shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting welding work.

3.02 CLEANING

A. Clean steel by washing thoroughly with clean water and soap and rinsing with clean water.

3.03 PROTECTION

A. Protect finishes of ornamental metal from damage during construction period with temporary protective coverings approved by ornamental metal fabricator. Remove protective covering at the time of Substantial Completion.
B. Restore finishes damaged during construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

3.04 APPLICATION OF FACTORY APPLIED HOT-DIPPED GALVANIZED COATINGS

A. Galvanizing Application: Galvanize materials in accordance with specified standards and this specification. The dry kettle process shall be used to eliminate any flux inclusions on the surface of the galvanized material. The use of the wet kettle process is prohibited.

B. Prior to Galvanizing: The steel shall be immersed in a flux solution (zinc ammonium chloride). The flux tank must be 12 to 14 Baumé density and contain less than 0.4 percent iron.

(1) To provide the galvanized surface required, the following procedures shall be implemented:

(a) A monitoring recorder shall be utilized and inspected regularly to observe any variances in the galvanizing bath temperature.

(b) The pickling tanks shall contain hydrochloric acid with an iron content less than 12 percent and zinc content less than 3 percent. Titrations shall be taken weekly at a minimum.

(c) All chemicals and zinc shall be tested at least once a week to determine compliance with ASTM standards. All testing shall be done using atomic absorption spectrometry or x-ray fluorescence (XRF) equipment at a lab in the galvanizing facility.

C. Installation: Comply with fabricator's and galvanizer's requirements for installation of materials and fabrications, including use of nylon slings or padded cables for handling factory-coated materials.

D. Touch-Up and Repair: For damaged and field-welded metal coated surfaces, clean welds, bolted connections, and abraded areas the following procedures must be used.

(1) For galvanized surfaces, apply organic zinc repair paint complying with requirements of ASTM A 780, modified to 95 percent zinc in dry film. Galvanizing repair paint shall have 95 percent zinc by weight. Basis of design is ZIRP by Duncan Galvanizing. Thickness of applied galvanizing repair paint shall be not less than coating thickness required by ASTM A 123 or A 153 as applicable.

(2) For factory-applied finish coatings, field-touch-up shall be performed by qualified applicators with experience in the application of high-performance industrial coatings. All coating manufacturer’s requirements for mixing, application and environmental conditions must be followed. Touch-up shall be performed so that the repair is not visible from a distance of 6 feet. A touch-up repair kit and repair procedures shall be provided to the Owner for each type of factory-applied finish upon request.

END OF SECTION 32 57 30

SECTION 32 91 13 - SOIL PREPARATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.02 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the soil preparation as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

(1) Planting soils specified by composition of the mixes.

1.03 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.
B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
C. CEC: Cation exchange capacity.
D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
F. Finish Grade: Elevation of finished surface of planting soil.
G. Imported Soil: Soil that is transported to Project site for use.
H. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
I. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
J. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
K. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
L. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
M. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
N. SSSA: Soil Science Society of America.
O. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
P. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
Q. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
R. USCC: U.S. Composting Council.

1.04 SUBMITTALS

A. Product Data

(1) Include recommendations for application and use.
(2) Include test data substantiating that products comply with requirements.
(3) Include sieve analyses for aggregate materials.
(4) Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:

B. Samples: For each bulk-supplied material, 1 quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.
C. Qualification Data: For each testing agency.
D. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
E. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.06 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.
   (1) Notify Landscape Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
   (1) Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.
   (2) Qualified Testing Agency: Wallace Laboratories, 365 Coral Circle, El Segundo, CA 80245; Tel 310-615-0116, Attn: Mr. Garn Wallace, Ph D.

1.07 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.
B. Sample Collection and Labeling: Have samples taken and labeled by soil scientist (CPSS) certified by SSSA, soil classifier (CPSC) certified by SSSA, soil scientist (RPSS) registered by the National Society of Consulting Soil Scientists or state-certified, -licensed, or -registered soil scientist under the direction of the testing agency.
C. Number and Location of Samples: Minimum of eight representative soil samples from varied locations, where directed by Landscape Architect for each soil to be used or amended for landscaping purposes.
D. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
E. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
F. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.08 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.
B. Physical Testing:
   (1) Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
      (a) Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
      (b) Hydrometer Method: Report percentages of sand, silt, and clay.
   (2) Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
   (3) Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
   (4) Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).
C. Chemical Testing:
   (1) CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
   (2) Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
   (3) Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NEC-67, including the following:
   (1) Percentage of organic matter.
   (2) CEC, calcium percent of CEC, and magnesium percent of CEC.
   (3) Soil reaction (acidity/alkalinity pH value).
   (4) Buffered acidity or alkalinity.
   (5) Nitrogen ppm.
   (6) Phosphorous ppm.
   (7) Potassium ppm.
   (8) Manganese ppm.
   (9) Manganese-availability ppm.
   (10) Zinc ppm.
   (11) Zinc availability ppm.
   (12) Copper ppm.
   (13) Sodium ppm and sodium absorption ratio.
   (14) Soluble-salts ppm.

(15) Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
(16) Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

(1) Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
(2) Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

1.09 DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
B. Bulk Materials

(1) Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
(2) Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
(3) Do not move or handle materials when they are wet or frozen.
(4) Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.01 TOPSOIL

A. Provide screened topsoil which is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay, lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 1/2” inches in any dimension and other extraneous or toxic matter harmful to plant growth.

(1) Obtain topsoil from local sources or from areas having similar soil characteristics to that found at project site. Obtain topsoil only from naturally, well-drained sites where topsoil occurs in a depth of not less than 4 inches; do not obtain from bogs or marshes.

2.02 SOIL AMENDMENTS

A. "Back to Earth" Cotton Burr Blend Premium Compost complying with University of Arkansas Campus Standard.
B. Lime: Natural dolomitic limestone containing not less than 85% of total carbonates with a minimum of 30% magnesium carbonates, ground so that not less than 90% passes a 10-mesh sieve and not less than 50% passes a 100-mesh sieve.
C. Aluminum Sulfate: Commercial grade.
D. Peat Humus: FS-Q-P-166 decomposed peat with no identifiable fibers and with pH range suitable for intended use.
E. Bonemeal: Commercial, raw, finely ground; 4% nitrogen and 20% phosphoric acid.
F. Superphosphate: Soluble mixture of treated minerals: 20% available phosphoric acid.
G. Sand: Clean, washed sand, free of toxic materials.
H. Perlite: Conforming to National Bureau of Standards PS 23.
I. Vermiculite: Horticultural grade, free of toxic substances.
J. Sawdust: Rotted sawdust, free of chips, stones, sticks, soil or toxic substances and with 7.5 lbs. nitrogen uniformly mixed into each cubic yard of sawdust.
K. Manure: Well-rotted, unbleached stable or cattle manure containing not more than 25% by volume of straw, sawdust or other bedding materials and containing no chemicals or ingredients harmful to plants.
L. Commercial Fertilizer: Complete fertilizer and neutral character, with some elements derived from organic sources and containing following percentages of available plant nutrients:

(1) For trees and shrubs, provide fertilizer with not less than 5% total nitrogen, 10% available phosphoric acid and 5% suitable potash.
(2) For lawns, provide fertilizer with percentage of nitrogen required to provide not less than 1 pound of actual nitrogen per 1000 square feet of lawn area and not less than 4% phosphoric acid and 2% potassium. Provide nitrogen in a form that will be available to lawn during initial period of growth; at least 50% of nitrogen to be organic form.

PART 3 - EXECUTION

3.01 GENERAL

A. Place planting soil and fertilizers according to requirements in Section 329300 "Plants."
B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.02 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
B. Subgrade Preparation: Till subgrade to a minimum depth indicated on the drawings. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   (1) Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
C. Mixing: Spread unamended soil to total depth indicated on the drawings, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
   (1) Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
      (a) Mix lime and sulfur with dry soil before mixing fertilizer.
      (b) Mix fertilizer with planting soil no more than seven days before planting.
D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is indicated on Drawings.
E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.03 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 4 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
C. Mixing: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
   (1) Mix lime and sulfur with dry soil before mixing fertilizer.
   (2) Mix fertilizer with planting soil no more than seven days before planting.
D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698.
E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.04 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform the following test:
   (1) Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.
C. Soil will be considered defective if it does not pass tests.
D. Prepare test reports.
E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.06 PROTECTION

A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
   (1) Storage of construction materials, debris, or excavated material.
   (2) Parking vehicles or equipment.
   (3) Vehicle traffic.
   (4) Foot traffic.
   (5) Erection of sheds or structures.

(6) Impoundment of water.
(7) Excavation or other digging unless otherwise indicated.

B. If planting soil or subgrade is over compacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.07 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
   (1) Dispose of excess subsoil and unsuitable materials as directed by Owner.

END OF SECTION 32 91 13

SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.02 SECTION INCLUDES

A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the turf and grasses as shown on the drawings and/or specified herein, including but not necessarily limited to the following:
   (1) Sodding of lawn areas.
   (2) Protecting and maintaining all sodded areas until Substantial Completion.

1.03 RELATED SECTIONS

A. Plants - Section 329300, for trees, shrubs, ground covers, and other plants.

1.04 INFORMATION SUBMITTALS

A. Certification: Submit certificates of inspection as required by governmental authorities and manufacturer's or vendor's certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.
B. Qualification Data: For landscape Installer.
C. Product Certificates: For fertilizers, from manufacturer.
D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Instructions: Submit typewritten instructions recommending procedures to be established by Owner for maintenance of turf during a calendar year. Submit prior to expiration of required maintenance period(s).

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
   (1) Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
   (2) Experience: Five years' experience in turf installation, in addition to requirements in Section 01400 "Quality Control."
   (3) Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   (4) Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
      (a) Landscape Industry Certified Technician - Exterior.
      (b) Landscape Industry Certified Lawn Care Manager.
      (c) Landscape Industry Certified Lawn Care Technician.
   (5) Pesticide Applicator: State licensed, commercial.
B. Topsoil: Before delivery of topsoil, furnish Landscape Architect with written statement giving location of properties from which topsoil is to be obtained.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
C. Bulk Materials
   (1) Do not dump or store bulk materials near structures, utilities, walkways, and pavements, or on existing turf areas or plants.
   (2) Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   (3) Accompany each delivery of bulk materials with appropriate certificates.

1.08 PROJECT CONDITIONS

A. Proceed with and complete landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.
B. Utilities: Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.
C. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, correct conditions before planting.
D. Coordination with Lawns: Plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to Landscape Architect. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.09 WARRANTY

A. Special Warranty: Installer agrees to repair or replace turf and grass and accessories that fail in materials, workmanship, or growth within specified warranty period.
   (1) Failures include, but are not limited to, the following:
      (a) Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
      (b) Structural failures.
   (2) Warranty Periods: From date of Substantial Completion.
      (a) Turf and Grasses: 12 months.
   (3) Include the following remedial actions as a minimum:
      (a) Immediately remove dead turf and grass and replace unless required to plant in the succeeding planting season.
      (b) Provide extended warranty for period equal to original warranty period, for replaced turf and grass material.

PART 2 - PRODUCTS

2.01 WATER

A. Water: Potable, clean, fresh and free from harmful materials. Water shall be furnished by Contractor. All hoses and other irrigation equipment required for the Work shall be furnished by the Contractor.

2.02 SOD

A. Sod, type as indicated on plans, composed of either field grown grass or approved nursery grown grass; a densely rooted growth of grass substantially free from noxious weeds and undesirable grasses.
B. Sufficiently thick to secure a dense stand of live grass. Live, fresh, uninjured at the time of placing, with a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling.
C. Cut in uniform strips using approved cutting devices. Unless otherwise indicated on the Drawings, sod strips shall be 1 foot or 2 foot in width.
D. Sod shall be free from noxious weeds, annual grasses, moss, large stones, tree roots, or other materials harmful to growth, or that will interfere with future mowing or other maintenance of the sodded areas.
E. Sod shall be thick, well developed, machine cut strips 3/4-inch thick, from an approved sod farm. Individual sod pieces shall be cut to a uniform size with square corners. Standard sections shall be strong enough to support their own weight when held vertically. Each piece shall be uniformly moist, and not excessively dry or wet.

2.03 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   (1) Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   (1) Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
C. Pesticides
   (1) General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
   (2) Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
   (3) Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.04 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a natural fiber mesh. Include manufacturer's recommended steel wire staples.

2.05 PROTECTIVE FENCING

A. All newly sodded areas shall be continuously protected from being disturbed. Where such areas will be subject to pedestrian, animal or vehicular traffic, erect and maintain the following fence: standard construction protection fencing. Sod protection fencing to be maintained until successful establishment of full lawn area.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
   (1) Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   (2) Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   (3) Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.02 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.
   (1) Reduce elevation of planting soil to allow for soil thickness of sod.
      (a) Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
      (b) Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.05 SODDING

A. Lay sod within 24 hours of harvesting unless a suitable preservation method is accepted by Landscape Architect prior to delivery time. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   (1) Lay sod across slopes exceeding 1:3.
   (2) Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

3.06 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
C. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
D. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
E. Watering: Install and maintain permanent piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (100 mm) per the contract documents.
   (1) Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
F. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.
G. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.

3.07 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Landscape Architect:
B. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
C. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.08 CLEAN-UP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
D. Remove nondegradable erosion-control measures after grass establishment period.

3.09 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
   (1) Sodded Turf: 12 months from date of Substantial Completion.

3.10 INSPECTION AND ACCEPTANCE

A. When landscape work is completed, including maintenance, Landscape Architect will, upon request, make an inspection to determine acceptability.
   (1) Landscape work may be inspected for acceptance in parts agreeable to Landscape Architect, provided work offered for inspection is complete, including maintenance.
B. Where inspected landscape work does not comply with requirements, replace rejected work and continue specified maintenance until reinspected by Landscape Architect and found to be acceptable. Remove rejected plants and materials promptly from project site.

END OF SECTION 32 92 00

SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:

(1) Plants.
(2) Tree-watering devices.

1.03 RELATED SECTIONS

A. Soil Preparation - Section 329113.
B. Turf and Grasses - Section 329200.

1.04 REFERENCES

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

(1) ANLA: American Nursery & Landscape Association (americanhort.org).
(2) ANSI - American National Standards Institute (ansi.org).
(3) AOAC: AOAC International (aoac.org).
(4) ASTM - ASTM International (astm.org).

B. Industry Standards and Publications: Comply with the following standards and documents, based on the publication date in effect as of date of the Contract Documents unless otherwise indicated, including amendments:

(1) ANSI A300, American National Standards for Tree Care Operations.
(2) ANSI Z60.1, American Standard for Nursery Stock.
(3) ANLA Horticultural Standards.
(4) Hortus Third, The Staff of the L.H. Bailey Hortorium. 1976, MacMillan Publishing Co., New York.
(5) Standardized Plant Names, American Joint Committee on Horticultural Nomenclature,1942 edition.
(6) International Society of Arboriculture.

1.05 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required and sufficient to encompass the fibrous root feeding system necessary for the healthy development of the plant; wrapped with untreated biodegradable 8-oz. burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
C. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.
D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well- established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
E. Finish Grade: Elevation of finished surface of planting soil.
F. Organic Matter: the fraction of soil that consists of plant or animal tissue in various states of decomposition.
G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
H. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
I. Planting Area: Areas to be planted.
J. Planting Soil: See Section 329113.
K. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
L. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
M. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

N. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.06 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
B. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.07 ACTION SUBMITTALS

A. Product Data: For each type of product.
   (1) Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
      (a) Submit in the form of a plant list indicating proposed nursery source for each type of plant.
   (2) Plant Photographs: Include color photographs for each type of container-grown stock in digital 3- by format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of 3 photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
   (3) Slow-Release, Tree-Watering Device.
   (4) Edging Materials and Accessories: to verify color selected.
B. Samples for Initial Selection: For each of the following:
   (1) Organic Mulch: 1-pint (0.5-L) volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
C. Soil Test Report: See Section 329113.
D. Although the report(s) may contain the laboratory's comments or recommendations to the Landscape Architect regarding amendment requirements or procedures, the report shall not be interpreted to prescribe or dictate procedures or quantities of soil materials for the work of this Contract.
E. Soil Supplier: See Section 329113.

1.08 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of at least three similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
   (1) Manufacturer's certified analysis of standard products.
   (2) Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
D. Sample Warranty: For special warranty.

1.09 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
   (1) Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
   (2) Experience: Five years' experience in landscape installation in addition to requirements in Section 014500 "Quality Requirements."
   (3) Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   (4) Personnel Certifications: Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network:
      (a) Landscape Industry Certified Technician - Exterior.
      (b) Landscape Industry Certified Interior.
      (c) Landscape Industry Certified Horticultural Technician.
B. Soil-Testing Laboratory Qualifications: See Section 329113.
C. Topsoil Analysis: See Section 329113.
D. Pesticide Applicator: State licensed, commercial.

E. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
F. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
   (1) Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
G. Plant Material Observation: Landscape Architect will tag plant material at place of growth before plants are prepared for transplanting. All trees selected for use in the Project will be tagged, and representative shrubs and ground covers will be tagged. Retain tags placed on plants by Landscape Architect until the Work has been completed and accepted.
   (1) Landscape Architect may also observe plants further for condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected plants immediately from Project site.
   (2) Notify Landscape Architect in writing not less than 28 days in advance of delivery of plant materials to site, and request inspection of plants at the nursery.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
B. Bulk Materials:
   (1) Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   (2) Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   (3) Accompany each delivery of bulk materials with appropriate certificates.
C. Deliver bare-root stock plants within 36 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
E. Handle planting stock by root ball.
F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
   (1) If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation, including wind-drying and desiccation of branches, leaves and buds.
H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
   (1) Set balled stock upright and plumb on firm ground and cover ball with soil, sawdust, fibrous moisture-retention medium or other acceptable material.
   (2) Do not remove container-grown stock from containers before time of planting.
   (3) Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.
   (4) During the growing season, water stored plant material and keep root balls moist with an automatic drip irrigation system to prevent drying out. Do not move trees if root balls are saturated. Mist plants several times a day as necessary to reduce transpiration in sunny or windy locations.
   (5) During the dormant season and cold weather, insulate root balls and protect against damage caused by freezing, wind, and ice.
   (6) During the storage period, inspect plants for pests and diseases and have them evaluated and treated by an arborist certified in the state where the project is located.
   (7) Perform inspection and maintenance of plants for entire duration of storage period.
   (8) Do not store plants more than 28 days without written acceptance from Landscape Architect.

1.12 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
B. Planting Restrictions: Plant during one of the following periods for types of plants indicated. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

(1) Deciduous Plants, Container-Grown: March 15 through June 15 for Spring planting season; September 15 through November 15 for Fall planting season.
(2) Deciduous Plants, Balled and Burlapped: March 15 through June 15 for Spring planting season; October 1 through November 30 for Fall planting season.
(3) Evergreen Plants: March 30 through June 1 for Spring planting season; October 1 through November 30 for Fall planting season.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.13 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
(1) Failures include, but are not limited to, the following:
(a) Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
(b) Structural failures including plantings falling or blowing over.
(c) Faulty performance of tree stabilization, edgings and tree grates.
(d) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
(2) Warranty Periods: From date of Substantial Completion.
(a) Trees, Shrubs, and Ornamental Grasses: 12 months.
(b) Ground Covers Perennials, and Other Plants: 12 months.
(3) Include the following remedial actions as a minimum:
(a) Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
(b) Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
(c) A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
(d) Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.01 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
(1) Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.
(2) Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
(a) Provide trees of height not less than size designated, measured from the crown of the roots to the tip of the top branch.
(b) Provide trees with a single trunk, except where multi-stem trees are indicated, growing from a single, unmutilated crown of roots. Trees with double-leaders or twin heads are unacceptable.
(c) Tree trunks with any part that is conspicuously crooked compared with normal trees of the same variety are unacceptable.
(d) Provide trees with trunks free from sunscald, frost cracks, and wounds resulting from abrasions, fire or other causes; and without evidence of fresh scars or damage from handling. Pruning wounds are acceptable only when they show vigorous bark on all edges.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
D. Labeling: Label each tree and shrub of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
F. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
(1) Provide balled and burlapped trees.

(2) Branching Height: One-half of tree height.

G. Deciduous Shrubs: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.
   (1) Shrub sizes indicated are sizes after pruning.
   (2) Provide balled and burlapped or container-grown shrubs.

H. Broadleaf Evergreens: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.
   (1) Provide balled and burlapped or container-grown shrubs.

I. Ground Cover: Provide ground cover of species indicated, in pots or similar containers, with well- established root systems reaching to sides of container to maintain a firm ball, but without excessive root growth encircling the container; and complying with ANSI Z60.1 in sizes and species as shown on Drawings.

J. Ornamental Grasses: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container.

2.02 INORGANIC SOIL AMENDMENTS

A. See Section 329113.

2.03 ORGANIC SOIL AMENDMENTS

A. See Section 329113.

2.04 PLANTING SOIL MIX

A. See Section 329113.

2.05 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
   (1) Size: 5-gram tablets.
   (2) Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   (1) Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.06 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
   (1) Type: Triple shredded hardwood.
   (2) Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
   (3) Color: Natural.

2.07 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.08 TREE-WATERING DEVICES

A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over two to three weeks; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

B. Color: As selected by Landscape Architect from manufacturer's full range

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

(1) Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
(2) Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
(3) Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
(4) Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
C. Plant Installation Observation: Landscape Architect will schedule visits to Project site to coincide with installation of plant materials, for the purpose of overseeing placement and arrangement of approximately 10 percent of specimen trees and of other plants to the extent determined by Landscape Architect.

(1) Notify Landscape Architect in writing not less than 7 days in advance of starting installation of plant materials at Project site.
(2) Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
(3) Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.03 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.

(1) Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

(1) Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
(2) Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
(3) Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
(4) If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
(5) Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
(6) Maintain supervision of excavations during working hours.
(7) Keep excavations covered or otherwise protected when unattended by Installer's personnel.

B. Backfill Soil: See Section 329113.
C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

(1) Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.

D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

3.05 TREE AND SHRUB PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top- most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
C. Balled and Burlapped Stock: Move plant stock with root systems as solid units with root balls intact during entire operation and firmly wrapped with burlap. Set each plant plumb and in center of planting pit or trench with root flare in relationship to adjacent finish grades as indicated on Drawings.
    (1) Backfill: Planting soil as specified in Section 329113.
    (2) After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
    (3) Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
    (4) Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
        (a) Quantity: As directed by Landscape Architect and complying with manufacturer's recommendations.
    (5) Continue backfilling process. Water again after placing and tamping final layer of soil.
D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare in relationship to adjacent finish grades as indicated on Drawings.
    (1) Backfill: Planting soil as specified.
    (2) Carefully remove root ball from container without damaging root ball or plant.
    (3) Backfill around root ball as indicated on Drawings.
    (4) Place planting tablets equally distributed around each planting pit when pit is approximately one- half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
        (a) Quantity: As directed by Landscape Architect and complying with manufacturer's recommendations.
    (5) Continue backfilling process. Water again after placing and tamping final layer of soil.

3.06 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape. Consult Landscape Architect before proceeding with pruning.
B. Do not apply pruning paint to wounds.

3.07 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
B. Use specified planting soil for backfill.
C. Dig holes large enough to allow spreading of roots.
D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.08 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.
B. Organic Mulch in Planting Areas: Apply 2-inch (50-mm) average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

3.09 PLANT MAINTENANCE

A. Maintain plantings beginning immediately after plants are installed by performing, without limitation, pruning, cultivating, watering, weeding, removing fallen leaves, fertilizing, mulching, restoring planting saucers and mulch, keeping mulch beds weed-free, adjusting and repairing tree-stabilization devices including tightening and adjusting guy wires, stakes, and deadmen to keep trees in vertical position, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings and to promote and maintain healthy plant growth.
B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
C. Watering: Flood plants during the construction and maintenance periods at least twice each week. If present and operational, coordinate programming of irrigation system to meet watering needs. If irrigation system is not operational, provide hand watering as needed to maintain healthy growth. At each watering, thoroughly saturate the soil around each tree and shrub. If sufficient moisture is retained in the soil as determined by the Owner, the required watering may be reduced. Provide not less than 20 gallons of water for each watering of each tree.

(1) Install and maintain temporary piping, hoses, and plant-watering equipment to convey water from sources and to provide adequate watering of plants. Provide water tank trucks or similar portable water supply if water service is insufficient.

D. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.10 PESTICIDE APPLICATION

A. Do not apply pesticides without prior approval from Landscape Architect for treatment of pest infestation.
B. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
C. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
D. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already- germinated weeds and according to manufacturer's written recommendations.

3.11 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Landscape Architect.
   (1) Submit details of proposed pruning and repairs.
   (2) Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
   (3) Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.
B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.
   (1) Provide new trees of same size as those being replaced.
   (2) Species of Replacement Trees: Same species being replaced, or species selected by Landscape Architect.

3.12 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.13 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
   (1) Maintenance Period: 12 months from date of Substantial Completion.
B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
   (1) Maintenance Period: 12 months from date of Substantial Completion.

END OF SECTION 32 93 00

SECTION 32 94 13 - METAL EDGING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Metal edging for the following:

(1) Edge restraints for stone fines surfacing areas, with stakes for embedding in grade.
(2) Edge restraints for unit paving areas, continuous angle or flat anchored to slab.
(3) Edge restraints for planting areas, with stakes for embedding in grade.
(4) Edge restraints for river cobble at planting areas, with stakes for embedding in grade.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Samples for Verification: For edging materials and accessories, as follows:

(1) Metal Edging: Full-size edge restraint, not less than 24 inches (610 mm) long.
(2) Anchoring Devices: Full-size unit of each type.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer whose work has resulted in successful installations of metal edging of the types and applications specified for this Project.
B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

(1) Build mockups for metal edging as part of paving mockups specified in Section 321400 "Unit Paving." and Section 321542 "Stone Fines Surfacing."
(2) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
(3) Preinstallation Conference: Conduct conference at Project site

PART 2 - PRODUCTS

2.01 METAL EDGINGS

A. Anchored Steel Edging for Unit Paving: A36 hot dipped galvanized angle steel.

(1) Asphalt Paver Edging Size: 3”x5”x1/4” thick unequal angle steel.
(2) Linear Cobblestone Paver Edging Size: 3”x5”x1/4” thick unequal angle steel.
(3) Radial Cobblestone Paver Edging Size: 8”x3/16” thick flat steel.
(4) Anchors: 3/8” diameter x 2-1/4” hot dipped galvanized expansion anchor.

B. Staked Steel Edging: Standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

(1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(a) Border Concepts, Inc.
(b) Collier Metal Specialties, Inc.
(c) Russell, J. D. Company (The).
(d) Sure-Loc Edging Corporation.

(2) Edging Size: 3/16 inch (6.35 mm) wide by 4 inches (127 mm) deep.
(3) Stakes: Tapered steel, a minimum of 15 inches (380 mm) long.
(4) Accessories: Standard tapered ends, corners, and splicers.
(5) Finish: Standard paint.
(6) Paint Color: Black.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive metal edging for compliance with requirements and conditions affecting installation and performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EDGING INSTALLATION

A. Provide edge restraints as indicated. Install edge restraints before placing unit pavers, stone fines surfacing, river cobbles, planting soil or mulch in planting areas.

(1) Install edge restraints to comply with manufacturer's written instructions. Install stakes or bolts as indicated, at intervals required to hold edge restraints in place during and after installation.

B. Staked Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches (760 mm) apart, but not fewer than three stakes per section, driven below top elevation of edging.

C. Anchored Steel Edging: Install steel edging where indicated according to details and anchor manufacturer’s recommendations.

D. Radius Bends: Formed on site to radiuses indicated.

END OF SECTION 32 94 13

DIVISION 33 – UTILITIES

SECTION 33 40 01 – STORM DRAINAGE UTILITIES (WITH CMP)

SECTION 33 4000 - STORM DRAINAGE UTILITIES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Pipe culverts.

B. Concrete curb inlet structures and junction boxes.

C. Connection to existing concrete drainage structures.

D. Pipe material noted on plans may not be substituted by any other material.

1.02 RELATED WORK

A. Section 31 2000 – Earth Moving

B. Section 32 0523 – Cement and Concrete for Exterior Improvements.

C. Section 32 1613 – Concrete Curb and Gutters.

D. Section 33 0516 – Manhole and Structures.

1.03 SUBMITTALS

A. See Related Work

PART 2 PRODUCTS

2.01 PIPE CULVERTS

A. Reinforced Concrete Pipe (RCP): ASTM C76-78, Class III.
   1. Material: Concrete and reinforcing steel.
   2. Shape: Circular.
   3. Sizes: As shown on Drawings.

B. Joint Material:
   1. Cold-applied preformed plastic gasket type sealant conforming to Federal Specification SS-5-00210.
   2. Primer: As specified by the manufacturer.

C. Polymer Coated Corrugated smooth interior Steel Pipe (CMP): AASHTO M36 and AASHTO M218:
   1. Material: Steel (polymeric pre-coated galvanized type B 10mil both sides).
   2. Type: Corrugated w / ¾" x ¾" x 7½ " external ribs in accordance w/ ASTM A760.
   3. Sizes: As shown on Drawings.

D. Corrugated Polyethylene Pipe (CPEP): AASHTO M 294 or ASTM F 2648 for LEED Projects.
   1. Material: Virgin Polyethylene compounds, uniformly pigmented, with no cracks or creases. The pipe shall have a minimum pipe stiffness at five percent deflection as follows when tested in accordance with M 294 or F 2648:

Diameter (in)	Pipe Stiffness (psi)
12	45
15	42
18	40
24	34
30	28
36	22

   2. Type: "S" – Full circular cross-section with an outer corrugated wall and a smooth inner wall.
   3. Sizes: As shown on drawings.

E. Couplings for CPEP
   1. Couplings shall be corrugated to match the pipe corrugations and shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Couplings shall be bell and spigot, split collar, or screw–on collar.

2.02 CURB INLET STRUCTURE AND JUNCTION BOX

A. Concrete and reinforcing steel:
   1. Refer to Standard Detail.
   2. Refer to Section 32 0523 and ACI 301.

B. Manhole rings and covers: ASTM A48, Class 30A, Type II Traffic safe.
   1. Material: Cast Iron, solid cover.
   2. Size 24-inch diameter with ring depth equal to concrete thickness.

2.03 BEDDING AND BACKFILL MATERIALS

A. Select Backfill Materials: soil excavated from trench or sub-soil from site that is free of rocks larger than 1-1 ½ inches in greatest dimension, and free from frozen soil, large clumps of soil, muddy soil, organic matter and foreign materials.

B. Class I Bedding Material: Angular, graded stone, ¼ inch to 1½ inch size.

PART 3 EXECUTION

3.01 CONCRETE PIPE CULVERT INSTALLATION

A. Excavate and backfill the trench in accordance with the provision of Section 33 05 16

B. Grade the bottom of the trench to provide a firm bedding surface of uniform density along the entire length of the pipe.
C. Shape the bottom of the trench to conform to the bottom one quarter of the outside diameter of the circular pipe.
D. Lay the pipe beginning at the downstream end with the groove end of the pipe placed facing upstream.
E. Join pipe using specified cold applied preformed plastic joint sealant. Clean the pipe joint surface and prime, if recommended by the manufacture, brush on and allow to dry. Remove protective wrapping from one side of the rope. Lay rope strip side up on the surface of the pipe joint and press the strip firmly to surface of pipe joint end-to-end continuing around the entire circumference of the joint. Remove the remaining protective wrapping and force pipe into connection until material fills the joint space.
F. To insure an even and well-filled joint, accomplish the final joining of the pipe by either pushing or pulling by mechanical means each joint of the pipe as it is laid.
G. In cold weather, either warm the joint material in a hot water bath, or by other approved methods, to the extent required to keep the material pliable for placement without breaking or cracking, or use butyl rubber type joint sealant.
H. In areas not under pavement of structure “Slice-in” the bedding material under the haunches of the pipe with and then hand tamp or mechanical tamp the backfill up to the horizontal centerline of the pipe.
I. Under pavement and structures, compact the backfill on the sides of the pipe to the required densities specified in Section 31 2000 using mechanical tamps with the top 12 inches of subgrade compacted to 95% of the soils Modified Proctor maximum dry density at or near the optimum moisture content.

3.02 CORRUGATED POLYETHLENE PIPE CULVERT INSTALLATION

A. Excavate subsoil to depth and grade line as required for proper installation of the culvert pipe. Keep trench as narrow as possible but sufficiently wide to permit tamping under the haunches and installation of connecting band when sections are joined. Keep sidewalls as vertical as possible, at least to an elevation above the top of the pipe.
B. Grade bottom of trench to provide a firm bedding surface of uniform density along the entire length of the pipe. Remove rock or soft, unstable material encountered at the excavated grade line to a minimum depth of 6 inches and replace with Class I bedding material.
C. Shape bottom of trench to conform to bottom one quarter of the outside diameter of the circular pipe and up to the widest part of arch pipe, allowing a uniform blanket of loose material to cover the shaped bedding to a depth sufficient to allow the corrugations to be filled with the material.
D. Place corrugated metal pipe on bedding with longitudinal laps or seems, if any, at the sides. To assemble sections of pipe, place corrugated connecting band around or under the first pipe, then lay the second pipe section with the corrugations matching and the adjacent ends butting together. Keep dirt and gravel out of joint so that corrugations fit snugly. Fasten bolts on band tightly and uniformly.
E. Place backfill material in 4 inch layer haunches alternately on both sides of pipe, using Class I bedding material. Slice-in with a shovel under the haunches to eliminate voids. Using select backfill material, place material in 6 inch lifts alternately on each side of pipe up to widest part at arch pipe, and using hand tamps or mechanical tampers, compact each lift to a minimum of 90% of optimum density for the material as determined by Modified Proctor procedures, ASTM D-1557. If Class I bedding material is used, place the material in such manner as to eliminate voids and consolidate and interlock the material to form a stable side support for the pipe.
F. In locations not in traffic areas, hand place select backfill to a level 12 inches above the top of the pipe in such manner as to minimize voids, unless otherwise noted on the plans. Backfill up to surrounding ground surface or finished subgrade with subsoil containing no rocks or boulders large thank 6 inches in greatest dimension within 12 inches of the subgrade. Leave top of backfill slightly mounded to allow for settlement.
G. Under traffic areas, backfill trench from horizontal centerline of pipe up to top of subgrade using either select backfill material or Class I bedding material. If select backfill material is used, place material in 6 inch lifts and compact with mechanical tamps. Compact each layer to within 24 inches of subgrade to 90% of optimum density for the material as determined by Modified Proctor procedures, ASTM D-1557. Compact the remaining 24 inches to subgrade to 95% of optimum density using the same procedures. If Class I bedding material is used, place the material in such manner as to minimize voids and interlock the material to form a stable fill that will support the pavement structure and subsequent traffic loads.
H. Patch cut edges and surface-damaged areas with specified patching material to restore protection to metal surface originally provided by polymer coating.

3.03 CONCRETE STRUCTURES INSTALLATION

A. Forming concrete, placing reinforcing steel and placing and curing concrete: Refer to Section 32 05 23 and ACI 301.
B. Excavation and Backfill: Refer to Section 33 0516.

3.04 EXISTING STRUCTURE MODIFICATION

A. Remove top and throat of existing curb inlet.
B. Remove loose and damaged concrete material.
C. Dispose of removed material including cast iron ring and cover.
D. Cut and tie reinforcing steel to new steel as detailed on Drawings.
E. Form new top and provide new cast iron ring and cover.
F. Place steel as detailed on Drawings and place concrete to modify structure into a junction box.
G. Patch inside face of wall to achieve smooth surface.

END OF SECTION 33 40 00

GEOTECHNICAL REPORT

McCLELLAND CONSULTING ENGINEERS
DESIGNED TO SERVE
an ESP COMPANY

1580 E. Stearns Street
Fayetteville, Arkansas 72703
(479) 443.2377
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July 17, 2026

UNIVERSITY OF ARKANSAS

521 South Razorback Road
Fayetteville, Arkansas 72701

CERTIFICATE OF AUTHORIZATION
McCLELLAND CONSULTING ENGINEERS, INC.
No. 24
ARKANSAS-ENGINEER

ATTN: Ms. Kristen Knight
Senior Director of Construction, Planning, and Design

RE: Geotechnical Investigation Report for
Mandy and Bill Dillard II Hall
University of Arkansas
Fayetteville, Arkansas
MCE Project Number: 26-3843

Dear Ms. Knight:

We are submitting herewith the report for the Geotechnical Investigation on the above-referenced project. We appreciate the opportunity to provide this service to you. If there are any questions regarding the Geotechnical Investigation, please contact us.

Sincerely yours,

McCLELLAND CONSULTING ENGINEERS
an ESP COMPANY

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No.23825
WILLIAM M. HOPKINS
07.17.2026

William M. Hopkins, P.E.
Associate | Geotechnical Engineer

Jose C. Reyes
Geotechnical Specialist

Enclosure: Geotechnical Report

McCLELLAND CONSULTING ENGINEERS
DESIGNED TO SERVE
an ESP COMPANY

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GEOTECHNICAL INVESTIGATION

UNIVERSITY OF ARKANSAS

Mandy and Bill Dillard II Hall
University of Arkansas

Project No. 26-3843
July, 2026

Prepared For:
Ms. Kristen Knight
Mr. Andrew Watkins
University of Arkansas - Facilities Management
521 South Razorback Road
Fayetteville, Arkansas 72701

GEOTECHNICAL REPORT

University of Arkansas

Dillard Hall

MCE Project Number: 26-3843

Fayetteville, Arkansas

FOR

University of Arkansas – Facilities Management
521 S. Razorback Road
Fayetteville, Arkansas 72701

Executive Summary

This is a report of findings of the Geotechnical Investigation for the Dillard Hall development to be located on the campus of the University of Arkansas in Fayetteville, Arkansas. This report includes detailed information on subsurface conditions and existing surface materials in addition to providing recommendations for the site development, structure foundations, and project pavements. The significant findings listed below should not be used separately from the further discussion provided in the body of this report.

- MCE conducted a Geotechnical Investigation consisting of 11 project borings.
    - Materials resulting in auger refusal were encountered within all of the project borings, excluding B-10, at depths ranging from approximately 10.0 to 25.0 feet below the existing surface elevations.
    - Perched groundwater was encountered by project borings B-01 and B-06 at a depth of approximately 14.0 feet below the existing surface elevations.
- Surface materials (Stratum I) encountered during this investigation consisted of topsoil, asphalt underlain by aggregate, and concrete pavement materials
- The materials that make up Stratum II consist of Sandy Lean Clay (CL).
- The materials that make up Stratum III consist of Clayey Sand with Gravel (SC), Clayey Gravel with Sand (GC), and Silty Gravel with Sand (GM).
- The materials that make up Stratum IV consist of weathered sandstone materials.
- The materials that make up Stratum V consist of highly weathered to weathered shale materials.
- The materials that make up Stratum VI consist of competent sandstone and shale materials.
- It is recommended that all existing organics, pavements, and otherwise deleterious materials be removed from the site prior to construction. MCE recommends that the Contractor anticipates a minimum of 12 inches of initial stripping to be necessary across the site in order to fully remove the existing Stratum I materials.
- It is expected that up to 16 feet of fill will be required to achieve the planned finished grades on the west side of Dillard Hall, near the Level 2 walkout. The Design Team should be aware of the potential settlement that may occur due to this quantity of fill.
    - Properly placed, moisture-conditioned select fill placed in accordance with the recommendations outlined in *Section 10.10* may undergo long-term consolidation of up to one (1) percent of the overall fill height.
    - Methods such as preloading/surcharging the placed select fill may be utilized to accelerate the settlement within the deep fill areas. These should be coordinated between MCE and the Contractor prior to the start of construction to ensure that the appropriate parameters are utilized, if desired.

- Based on the provided information and the encountered subsurface conditions, it is recommended that the Design Team consider the use of a shallow foundation system composed of continuous and spread footings for the support of the academic building.
    - These shallow foundation elements are recommended to bear directly on native Stratum IV weathered sandstone materials. Should site grades not allow for the direct bearing on these sandstone materials, then either CLSM, otherwise referred to as “flowable fill”, or an aggregate base course material be utilized between the Stratum IV materials and the bottom of foundation elevations.
    - It is recommended that the foundation elements bearing on suitable in-situ Stratum IV materials or imported aggregate/CLSM materials placed on suitable in-situ Stratum IV materials may utilize a safe net allowable bearing capacity of 3,800 psf for continuous footings and 4,000 psf for spread footings.
- It is recommended that a shallow foundation system consisting of spread footings will be suitable for the support of the Pergola/Canopy area.
    - The shallow foundations are recommended to bear directly on suitable Stratum III materials or on a minimum of one (1) foot of properly-placed select fill.
    - It is recommended that spread footings bearing on properly placed select fill or “suitable” native subgrade may utilize a safe net allowable bearing capacity of 2,300 psf.
- It is recommended that a shallow foundation system consisting of continuous footings will be suitable for the support of the trash tunnel.
    - The shallow foundations are recommended to either bear on suitable Stratum II/III/IV materials or on imported select fill placed on suitable in-situ materials.
    - Where the existing utility tunnel is present, it may be necessary to utilize No. 57 stone (or an approved alternative), wrapped in a separation geotextile between the ceiling of the utility tunnel and the floor of the trash tunnel.
- As an alternative to the shallow foundation system, it is recommended that the Design Team consider the use of a drilled pier foundation system for the support of the Dillard Hall academic building.
    - If utilized, this drilled pier foundation system shall be designed for end-bearing and must be founded into the encountered competent shale materials (Stratum VI).
    - The drilled piers should be founded a minimum of one (1) pier diameter (1L:1D), or a minimum of five (5) feet, into the competent shale material, whichever is greater. The exact length of the rock sockets may be lengthened based on the final loading conditions. Adequate end-bearing material should be encountered prior to beginning the recommended rock socket length.
    - The competent shale materials may utilize a safe allowable end bearing capacity of 50 kips per square foot (ksf) for design purposes.
- Slab-on-grade construction may be utilized for the academic building, the pergola, and the trash tunnel structures, provided a minimum of four (4)-inch cushion of sand, crushed stone, or gravel is placed below the slab areas with a vapor barrier directly below the concrete.
- It is expected that the planned access drive will primarily be utilized for heavy truck traffic, such as garbage trucks. As such, it is recommended that the Contractor budget for the placement of a minimum of two (2) feet of imported select fill below the project pavement dimensions.
- **Construction materials testing and special inspection services are to be provided by MCE to provide consistency with the recommendations in this report and the documentation of those recommendations being implemented during construction.**

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1.0 Introduction

McClelland Consulting Engineers, LLC, an ESP Company (MCE) conducted a Geotechnical Investigation for the planned Mandy and Bill Dillard II Hall (Dillard Hall) building project located in Fayetteville, Arkansas. The investigation was requested by Mr. Andrew Watkins, Construction Project Manager, and authorized by Ms. Kristen Knight, Senior Director of Construction, Planning, and Design, both with the University of Arkansas – Facilities Management, with the intention of exploring the subsurface soil conditions within the planned structure dimensions to provide recommendations for the site development and structure foundations.

2.0 Existing Site Description

The project site is located on the south side of the University of Arkansas campus, in the northwest quadrant of the intersection of Harmon Avenue and W. Fairview Street. The site encompasses approximately two (2) acres of the following Washington County Parcels: 765-11631-000, 765-11632-000, 765-11633-000, 765-10790-000, 765-10789-000, and 765-11630-000, all of which are owned by the University of Arkansas.

The project site primarily exists as a greenspace, with an existing motor-bike parking lot and access drive along the western boundary. Sidewalks are present along the north, eastern, and southern boundaries. Based on historical imagery from Google Earth, the site was previously utilized as a student and faculty parking lot and was later used as a laydown yard during the construction of the adjacent campus buildings. Topographically, the project site exhibits a downward slope from the west to east, with maximum grade differentials estimated to be on the order of 29 feet.

Site conditions at the time of this investigation may be referenced in Figure 1 below.

Figure 1: Existing Site Conditions
Left: From Project Boring B-05; Oriented Southwest
Middle: From Project Boring B-05; Oriented Northeast
Right: Towards Project Boring B-07; Oriented Northeast

3.0 Project Scope

The Dillard Hall academic building is planned to be a four (4) – story structure with a mezzanine between Levels 1 and 2. The structure is expected to have a footprint of approximately 26,000 square feet (SF).

Based on discussions with the Design Team, the maximum anticipated column dead load for the project is 600 kips, and the maximum anticipated column dead plus live load is 925 kips. The building is anticipated to be constructed primarily of steel HSS and wide-flange beam and column framing with steel braced frames supporting four (4) slab-on-metal-deck floors and a slab-on-metal-deck roof. A slab-on-grade is planned to be constructed at the ground level.

Additionally, it is understood that a trash tunnel will connect the mezzanine to Willard J. Walker Hall; this tunnel is planned to be constructed of reinforced concrete slabs and walls. A pergola/canopy is also planned to be constructed under this scope of work directly north of the Donald W. Reynolds Center for Enterprise Development building. This lightly-loaded pergola/canopy is anticipated to be timber-framed with a slab-on-grade. Although final loading conditions were not provided as of the issuance of this report, maximum column loads for the canopy are expected to not exceed 25 kips.

Civil site and pavement improvements are expected to include new pedestrian walkways, a new access drive east of Dillard Hall, drainage features, and general utility infrastructure. Final site grades are planned to range from near existing to as much as 11 feet of fill in areas surrounding the structure.

4.0 Field Investigation

Based on the understood project scope, MCE conducted a Geotechnical Investigation consisting of 11 project borings. Boring Layouts are provided for reference in Appendix A on Plates 1 and 2.

4.1 Project Borings and Field Investigation

The project borings were conducted using a CME-45B truck-mounted and Diedrich D-50 Turbo track-mounted drill rigs utilizing 4.5-inch diameter solid-stem augers and 6.5-inch hollow-stem augers, respectively. Soil samples were obtained at the depths indicated on the boring logs with the use of a two (2) inch diameter split-spoon sampler. The split-spoon sampler was driven by blows from a 140-pound automatic hammer dropped from a fixed height of 30 inches. The number of blows required to drive the split-spoon sampler the final 12 inches of an 18-inch drive, or portion thereof, is referred to as the Standard Penetration value, N, and is recorded on the boring logs in units of blows-per-foot.

Water-based rock coring techniques were utilized to advance into the underlying rock formation once auger-drilling techniques were no longer feasible or reasonable, given the subsurface conditions. Rock core samples were collected utilized NQ2-size tooling with a diamond-impregnated bit.

Final drilled depths are shown as the depths achieved by the split-spoon sampler or rock core tooling, whichever is relevant to the boring location.

In addition to Standard Penetration Testing (SPT), the field tests performed included visual soil/rock classifications groundwater observations, and percent recovery (REC) and rock quality designation (RQD) values of the recovered rock samples.

The project boring locations were strategically laid out in an effort to target the planned project features while providing the subsurface data necessary for the Geotechnical recommendations. Project borings B-01 through B-09 were all conducted within the understood building footprint, with a planned target depth of 50.0 feet below the existing surface elevation or advancing a minimum of 10 feet into the underlying rock formation; whichever occurred first. Project borings B-10 and B-11 were conducted within the planned pergola/canopy and Level 1 entry, respectively, with target depths of 10.0 feet below the existing surface elevations, or until auger refusal materials were encountered; whichever occurred first.

The visual soil and rock classifications are given on the boring logs, which can be referenced in Appendix B on Plates 3 through 20; a key to the terms and symbols on the boring logs is provided on Plate 21. Table 1 on the following page provides details of the project borings.

Table 1: Project Boring Locations & Field Investigation Details

Boring ID	Targeted Development Feature	Existing Surface Elevations (feet)	Target Depth (feet)	Auger Refusal Depth (feet)	Total Depth Investigated (feet)	End of Boring Elevation (feet)
B-01	Dillard Hall Academic Building	1,419.41	50.0	15.0	25.0	1,394.41
B-02	Dillard Hall Academic Building	1,418.17	50.0	15.0	25.0	1,393.17
B-03	Dillard Hall Academic Building	1,419.92	50.0	10.0	25.0	1,394.92
B-04	Dillard Hall Academic Building	1,418.06	50.0	15.0	25.0	1,393.06
B-05	Dillard Hall Academic Building	1,414.04	50.0	10.0	20.0	1,394.04
B-06	Dillard Hall Academic Building	1,420.20	50.0	15.0	25.0	1,395.20
B-07	Dillard Hall Academic Building	1,422.04	50.0	15.0	25.0	1,397.04
B-08	Dillard Hall Academic Building	1,422.22	50.0	25.0	34.0	1,388.22
B-09	Dillard Hall Academic Building	1,418.58	50.0	10.0	20.0	1,398.58
B-10	Pergola/Canopy Area	1,432.58	10.0	N/A	10.0	1,422.58
B-11	Level 1 Entry Area	1,406.08	10.0	5.0	5.0	1,401.08

NOTES: The existing surface elevations shown in Table 1 are based on topographic survey data obtained by MCE personnel.
The corresponding end of boring elevations are based on this data, as well as measurements taken at the time of the investigation.

4.2 Encountered Groundwater Conditions

At the time of the investigation, perched groundwater was encountered by project borings B-01 and B-06 at depths of approximately 14.0 feet below the existing surface elevations (perched groundwater encountered at elevations of approximately 1,405.41 feet and 1,406.20 feet, respectively). Installation and periodic measurement of monitoring wells may be required to establish seasonal piezometric surfaces below the project site.

Although this perched water was only encountered in two (2) project boring locations, the presence of relatively shallow shale and sandstone (rock) materials presents the possibility of encountering perched water throughout the project dimensions. As a result of the low permeability created by these subsurface materials, groundwater has the potential to collect “perched” condition during and after precipitation events. Any groundwater or perched water must be removed prior to the placement of fill or construction materials, if encountered during construction.

To help reduce the potential for issues related to groundwater, it is recommended that earthwork operations take place during typically dry portions of the calendar year (June through September). However, earthwork operations should expect typical dewatering measures to be required to maintain a desirable construction schedule.

Due to the site location in relation to the surround topography, as well as the conditions encountered during this investigation, it is recommended that a perimeter drainage system be implemented to properly remove any subsurface water from the structure dimensions. Project grading should be designed to properly discharge any surface water that may develop following precipitation events.

4.3 Encountered Auger Refusal Materials

Auger refusal is generally defined as the point at which a boring encounters material through which it can no longer be advanced using traditional auger drilling techniques. Refusal is somewhat subjective and is dependent on the type of drilling equipment used and the down pressures exerted by the drill rig.

At the time of this investigation, materials resulting in auger refusal were encountered within project borings B-01 through B-09 and B-11 at depths ranging from approximately 10.0 to 25.0 feet below the existing surface elevations (auger refusal encountered at elevations ranging from approximately 1,397.22 feet to 1,409.92 feet).

In addition to these auger refusal materials, hard weathered sandstone and shale materials were encountered beginning at depths ranging from approximately 0.33 to 8.5 feet below the existing surface elevations (elevations ranging from approximately 1,405.75 feet to 1,418.54 feet). Based on the provided site grading information, it is expected that these materials will be encountered during the initial building footprint excavation. Where encountered, the Contractor should budget for the use of rock-removal techniques, as further described in *Section 10.2.1.* The consistency of these weathered sandstone materials may vary considerably across the project site.

Subsurface (fence) diagrams have been provided in Appendix D outlining the encountered subsurface strata in relation to the expected first floor finished-floor elevation (FFE).

Additional information pertaining to the local geology and how it affects the project site can be found in the *Local Geology of the Project Site* section of this report (*Section 7.0*).

5.0 Laboratory Analysis

Laboratory tests were performed on the soil and rock samples recovered from the borings. The laboratory tests were conducted to determine the engineering properties of the project subsurface strata. The tests performed on the samples collected from the borings included moisture content, Atterberg Limits, sieve analyses, and unconfined compression tests. The results of laboratory testing for the project borings are provided on the boring logs and in the Laboratory Testing Results in Appendix C.

Table 2 below shows the relevant test method specifications utilized on the project.

Table 2: Laboratory Test Method Specifications

Test Designation	Test Method
ASTM D2488	Standard Practice for Description and Identification of Soils (Visual)
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purpose (USCS)
ASTM D2216	Standard Test Method for Lab Determination of Water Content of Soil
ASTM D6913	Standard Test Method for Particle-Size Distribution of Soils Using Sieve Analysis
ASTM D4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D7012	Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperature

6.0 On-Site Soil Conditions

The following sections provide information regarding on-site conditions at the project location. This information includes descriptions of the existing soil types, imagery showing the approximate location of the existing soil types, and details about the local geology.

6.1 United States Department of Agriculture (USDA) Soil Types and Map

The following soil types exist in the project area according to current USDA soil maps, with the description from the Natural Resources Conservation Service (NRCS). The project site is located in Washington County in Northwest Arkansas. The soil types that exist in the project area according to current USDA soil maps are briefly detailed in Table 3 on the following page.

Table 3: USDA Local Soil Types

USDA Soil Type	USDA Symbol	USDA Descriptions
Enders-Leesburg Complex	ErF	A soil complex is a mapping unit containing two (2) or more distinct soil types that are so intricately mixed geographically that they cannot be separated at standard mapping scales. The Enders series consists of deep, well-drained, very slowly permeable soils that formed in loamy and clayey residuum from shale, or interbedded shale and sandstone. These soils are on nearly level to moderately steep upland mountaintops and ridges and gently sloping to very steep mountain side slopes and foot slopes. Slopes range from one (1) to 65 percent. The Leesburg series consists of very deep, well-drained, moderately permeable soils that formed in loamy alluvium or colluvium underlain by sandstone, shale, or limestone. These soils are on nearly level to very steep side slopes, toe slopes, or terraces.
Fayetteville Fine Sandy Loam	FaC2	The Fayetteville series consists of deep, well-drained, moderately permeable soils that formed in residuum or colluvium from slightly calcareous sandstone. These nearly level to steep soils are on uplands of the Boston Mountains. Slopes range from three (3) to 40 percent.

Figure 2 below provides imagery of the approximate site location and how it relates to the existing soil types.

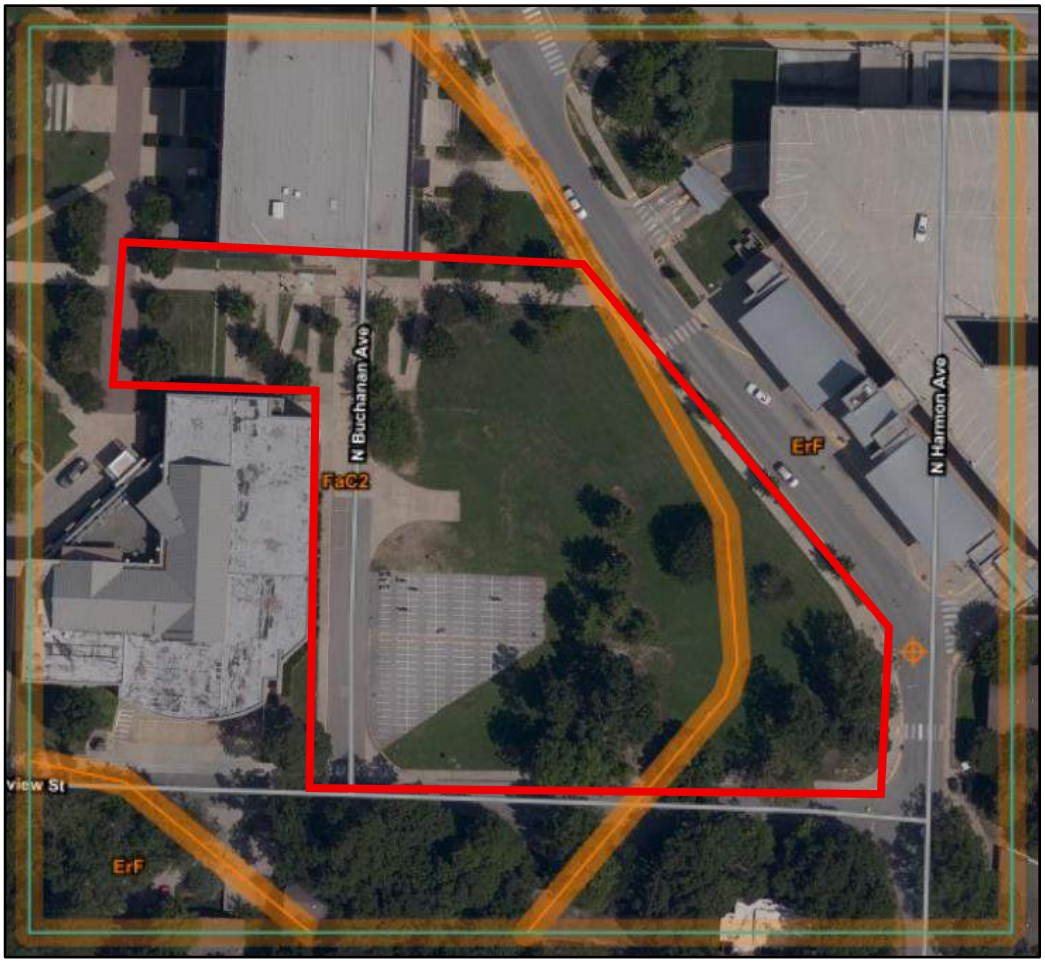

Figure 2: USDA Soil Survey Report Image
The image was produced by the United States Department of Agriculture.
The red outline represents the approximate project extent.

7.0 Local Geology of the Project Site

According to maps and literature published by the United States Geological Survey (USGS) and the Arkansas Geological Survey (AGS), the project site is underlain by the Early Pennsylvanian Age Cane Hill Member of the Hale Formation, as well as the Middle Pennsylvanian Age Prairie Grove Member of the Hale Formation and the Bloyd Shale. It should be noted that a fault line is currently mapped as spanning from the southwest to the northeast, approximately 0.10 miles southeast of the project site. Additional information about this fault system is provided in *Section 7.4.*

Brief descriptions from the *Stratigraphic Summary of Arkansas – Information Circular 36 (IC-36)* of the local geologic formations and conditions are provided below and on the following page.

7.1 Cane Hill Member of the Hale Formation

The Hale Formation is made up of two (2) members: a lower Cane Hill Member and an upper Prairie Grove Member. The Cane Hill Member is typically composed of dark gray silty shale interbedded with siltstone and thin-bedded fine-grained sandstone. Some lithologies are locally calcareous. Isolated thick to massively bedded sandstones sometimes occur in the section. Fossils are principally found associated with the calcareous units and include various mollusks, brachiopods, and other groups. The lower contact of the Cane Hill marks the Mississippian-Pennsylvanian boundary in north Arkansas.

7.2 Prairie Grove Member of the Hale Formation

The Prairie Grove Member is composed of thin to massive, often crossbedded, frequently pitted (“honeycomb weathering”), light gray to dark brown, limy sandstone or variously sandy limestone with lenses of relatively pure, crinoidal, highly fossiliferous limestone and oolitic limestone. Prairie Grove outcrops frequently have a mottled appearance when fresh. Fossils are common but generally fragmental. The fossil fauna includes crinoids, bryozoans, brachiopods, algae, corals, trilobites, mollusks, and microfossils. The lower contact of the Prairie Grove is considered unconformable. The Hale (Cane Hill) rests with pronounced unconformity upon older strata. The reported thickness of the Hale ranges from a few feet to more than 300 feet.

7.3 Bloyd Shale Formation

The Bloyd Formation consists of (in ascending order): the Brentwood Limestone Member, the Woolsey Member, Dye Shale Member, Kessler Limestone Member, and the Trace Creek Shale Member (considered a part of the Atoka Formation by many modern workers).

The Brentwood is a sequence of limestones separated by thick intervals of dark shale. The normal sequence usually has two (2) to four (4) limestone intervals; however, east of the type region, the unit becomes more sandy.

The Woolsey is composed of terrestrial sediments comprised of dark gray, fissile shale often interbedded with thin siltstones. A thin coal bed, called the Baldwin Coal, occurs at or near the top of the Woolsey. To the east of Washington County, the Woolsey is replaced by a thick, fine- to medium-grained, cross-bedded sandstone facies commonly referred to as the Middle Bloyd Sandstone. This unit frequently contains quartz granules and is a common bluff-former.

The Middle Bloyd Sandstone is normally mapped as part of the Dye Shale. The marine deposited Dye Shale Member is predominantly a dark-gray shale with scattered calcareous concretions. Where underlain by the Woolsey, the Dye frequently has a bed of calcareous sandstone with scattered clay pebbles and quartz granules, called the caprock, at its base.

The Kessler Limestone Member is either a single unit of limestone or a sequence of limestone and shale interbedded. The limestones are bioclastic and oolitic and contain abundant oncoliths, traces of clay-pebble conglomerate, and minor amounts of calcareous sandstone. The Kessler seems to be absent east of central Madison County.

The Trace Creek Shale Member is composed of dark-gray shales with some thin beds of sandstone. The sandstone beds become thicker and more common toward the top of the unit. Fossils of most common invertebrate phyla are known mostly from the limestones and calcareous sandstones of the Bloyd. The base of the Bloyd is considered conformable, but unconformities are recognized at the base of the Dye and at the base of the Trace Creek. Typical thicknesses reported for the Bloyd range between 175 and 200 feet.

7.4 Structural Geology of the Project Site

It should be noted that the project site is in close proximity to a known fault or fault zone; the Fayetteville Fault. The Fayetteville Fault is a known “normal fault” with its downthrown side on the southeast. This fault or fault system trends from the southwest to the northeast. Modern literature indicates that the Fayetteville Fault is not currently active.

Figure 3 below provides a visual of the local geologic formations in relation to the project site. The heavier black lines trending southwest to northeast represent the Fayetteville Fault.

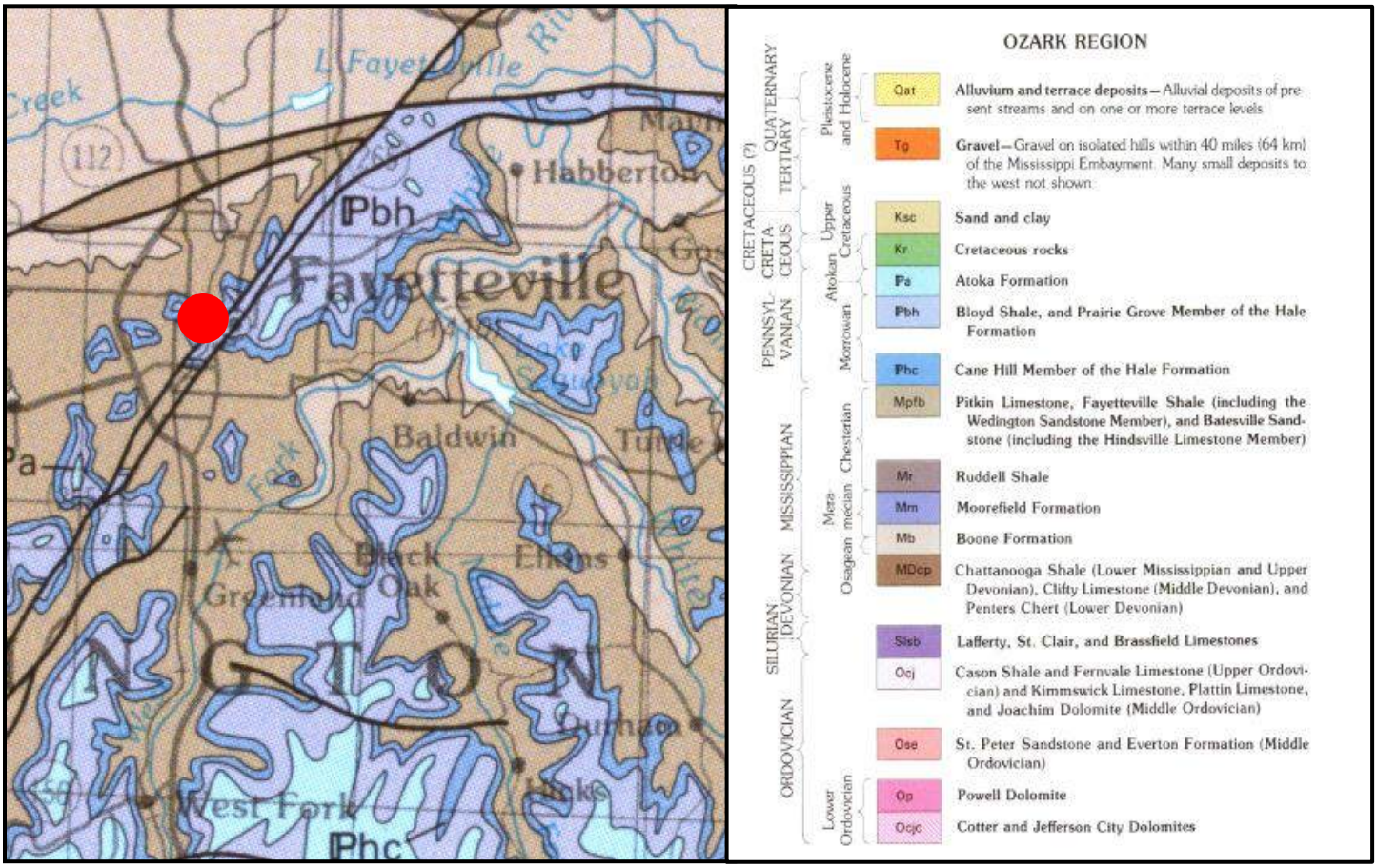

Figure 3: Image from the Geologic Map of Arkansas
The red dot represents the approximate location of the project site

8.0 Seismic Site Classification & Liquefaction Considerations

The project site is recommended to be assigned as a Risk Category III according to Table 1604.5 of the 2021 International Building Code (IBC). The site seismic classification determination may utilize the values in Table 4 on the following page, with reference to Section 1613 of the 2021 IBC and the American Society of Civil Engineers (ASCE) Standard 7-16, based on a Site Class C for the soil profile within the project area.

Table 4: ASCE Seismic Design Values

Seismic Values					
S_s	0.16	S_{DS}	0.139	I_e	1.25
S_1	0.091	S_{D1}	0.091	C_V	0.7
F_a	1.3	T_L	12	Seismic Design Category	
F_v	1.5	PGA	0.076	B	
S_{MS}	0.208	PGA_M	0.099		
S_{M1}	0.136	F_{PGA}	1.3		

9.0 On-Site Soil Stratum Summary

This summary is based on a collection of field notes and field-testing values recorded during the on-site investigation, notes recorded during the laboratory analysis, and results from the laboratory testing. The encountered subsurface soil conditions are summarized below and on the following page.

9.1 Stratum I – Surface Materials

The materials that make up Stratum I consisted of topsoil materials across a majority of the project site (B-01 through B-05, B-09 through B-11), with thicknesses ranging from approximately four (4) to six (6) inches. Flexible asphalt pavements underlain by aggregate base materials were encountered in the existing motorbike parking lot (B-06 and B-07). The asphalt was observed to have thicknesses ranging from approximately four (4) to five (5) inches, while the underlying aggregate had a thickness of approximately two (2) inches. Concrete pavement was encountered in an existing access drive (B-08) with a thickness of approximately six (6) inches.

These thicknesses are only valid for the project boring locations and could fluctuate in the unexplored portions of the project site.

9.2 Stratum II – Fine-Grained Subgrade Materials

The materials that make up Stratum II consist of Sandy Lean Clay (CL). These materials were encountered in various shades of reddish-brown and brown.

Table 5 below organizes the consistency, moisture content, and plasticity properties of the Stratum II soils.

Table 5: Stratum II Materials – Classification Data

Property	Stratum II – CL Materials
Consistency Values	Medium Stiff to Hard
N-Values	Five (5) to 25
Natural Soil Moisture Content (%)	12 to 16
Liquid Limit (LL)	23
Plasticity Index (PI)	Eight (8)
Plasticity Characteristics	Low
Fine Fraction of Total Mass (%)	52
Volumetric Change Potential	Low to Moderate Due to Moisture Content Variation

9.3 Stratum III – Coarse-Grained Subgrade Materials

The materials that make up Stratum III consist of Clayey Sand with Gravel (SC), Clayey Gravel with Sand (GC), and Silty Gravel with Sand (GM). These materials were encountered in various shades of reddish-brown and brown and contained varying amounts and gradations of gravel, sand, and fines.

Table 6 below organizes the consistency, moisture content, and plasticity properties of the Stratum III soils.

Table 6: Stratum III Materials – Classification Data

Property	Stratum III – SC Materials	Stratum III – GC Materials	Stratum III – GM Materials
Consistency Values	Medium Dense to Very Dense	Loose to Very Dense	Loose
N-Values	12 to Greater than 50	Eight (8) to Greater than 50	Seven (7)
Natural Soil Moisture Content (%)	Five (5) to 22	10 to 22	Four (4)
Liquid Limit (LL)	27 to 29	26 to 41	VC*
Plasticity Index (PI)	11 to 15	14 to 20	VC*
Plasticity Characteristics	Low to Moderate	Low to Moderate	Negligible
Fine Fraction of Total Mass (%)	18 to 41	26 to 29	VC*
Volumetric Change Potential	Low to Moderate Due to Moisture Content Variation	Low Due to Moisture Content Variation	Negligible

*VC Indicates that a Visual Classification was Performed; As such, the Material Property was not Measured.

9.4 Stratum IV – Weathered Sandstone

The materials that make up Stratum IV consist of Weathered Sandstone materials. Through both visual and laboratory analyses, these materials were observed to generally classify as a Silty Sand (SM), Silty Sand with Gravel (SM), and Silty Gravel with Sand (GM) in accordance with the Unified Soil Classification System (USCS). These materials were generally encountered as light brown in color. These weathered sandstone materials are expected to result in difficult excavation conditions during construction.

Table 7 below organizes the consistency, moisture content, and plasticity properties of the Stratum IV materials.

Table 7: Stratum IV Materials – Classification Data

Property	Stratum IV – Weathered Sandstone Materials
Consistency Values	Moderately Hard to Hard
N-Values	23 to Greater than 50
Natural Soil Moisture Content (%)	Six (6) to 17
Liquid Limit (LL)	CND*
Plasticity Index (PI)	NP
Plasticity Characteristics	Negligible
Fine Fraction of Total Mass (%)	14
Volumetric Change Potential	Negligible Due to Moisture Content Variation

*CND Indicates that the Material Property Could not be Determined due to a Lack of Soil Plasticity

9.5 Stratum V – Highly Weathered to Weathered Shale Materials

Stratum V materials consisted of highly weathered and weathered shale materials. Through both visual and laboratory analysis, these materials were observed to generally classify as Lean Clay with Sand (CL) in accordance with the USCS. These materials were generally observed to increase in consistency in correlation to depth within the boreholes. The highly weathered and weathered shale materials were encountered in various shades of brown and gray and contained varying quantities and gradations of sand and gravel.

Table 8: Stratum V Materials – Classification Data

Property	Stratum IV – Highly Weathered to Weathered Shale Materials
Consistency Values	Soft to Hard
N-Values	46 to Greater than 50
Natural Soil Moisture Content (%)	11 to 14
Liquid Limit (LL)	36 to 37
Plasticity Index (PI)	17 to 19
Plasticity Characteristics	Low
Fine Fraction of Total Mass (%)	75 to 86
Volumetric Change Potential	Moderate Due to Moisture Content Variation

9.6 Stratum VI – Competent Rock Materials

The materials that make up Stratum VI consist of competent rock materials, identified during this investigation as competent sandstone and shale materials, indicative of the underlying the Early Pennsylvanian Age Cane Hill Member of the Hale Formation, as well as the Middle Pennsylvanian Age Prairie Grove Member of the Hale Formation and the Bloyd Shale. The consistency of these materials was determined to range from moderately hard to hard.

As previously discussed, rock core samples were collected using a two (2) inch diameter NQ2-size core barrel within the planned footprint of Dillard Hall.

The rock core samples collected were measured in the field to determine the percent recovery (REC) and percent of rock quality designation (RQD); these samples were subjected to further laboratory testing to determine the unit weight, and ultimate compressive strength. The results of these analyses are provided in Table 9 on the following page.

Table 9: Rock Core Data

Boring ID	Core Run	Depth (feet)	Description of Material	Recovery (%)	RQD (%)	Recorded Specimen ID and Depth Taken (feet)	Unit Weight (pcf)	Ultimate Compressive Strength (tsf)
B-01	1	15.0 to 20.0	Sandstone to Weathered Shale	94	44	C1 - 16.0	145.3	404.6
	2	20.0 to 25.0	Weathered Shale to Shale	100	70	-	-	-
B-02	1	15.0 to 20.0	Sandstone to Weathered Shale	98	45	-	-	-
	2	20.0 to 25.0	Shale	97	70	C2 - 24.0	158.6	57.7
B-03	1	10.0 to 15.0	Sandstone	60	41	C3 - 10.0	137.2	101.8
	2	15.0 to 20.0	Sandstone to Weathered Shale	75	35	-	-	-
	3	20.0 to 25.0	Weathered Shale to Shale	98	62	-	-	-
B-04	1	15.0 to 20.0	Weathered Shale to Shale	93	19	-	-	-
	2	20.0 to 25.0	Shale	85	35	C4 - 24.0	158.2	106.8
B-05	1	10.0 to 15.0	Weathered Shale to Shale	100	62	-	-	-
	2	15.0 to 20.0	Shale	98	42	C5 - 19.0	157.9	97.9
B-06	1	15.0 to 20.0	Weathered Shale to Shale	82	23	-	-	-
	2	20.0 to 25.0	Shale	90	48	-	-	-
B-07	1	15.0 to 20.0	Weathered Shale to Shale	97	41	C6 - 16.0	153.7	53.8
	2	20.0 to 25.0	Shale	98	67	C7 - 24.0	159.4	62.8
B-08	1	25.0 to 29.0	Shale	100	65	C8 - 25.0	156.7	66.6
	2	29.0 to 34.0	Shale	87	36	-	-	-
	3	34.0 to 35.0	Shale	25	25	-	-	-
B-09	1	10.0 to 15.0	Sandstone to Weathered Shale	77	47	C9 - 13.0	151.4	325.2
	2	15.0 to 20.0	Weathered Shale to Shale	93	71	C10 -19.0	162.3	92.8

10.0 Engineer's Analysis and Recommendations

As previously described, Dillard Hall is planned to be a four (4) story structure with a mezzanine between Levels 1 and 2 and a footprint of approximately 26,000 SF. The ground level is planned to feature a slab-on-grade, while the subsequent levels and roof are each planned to be slab-on-metal-deck. Maximum column loads for the structure are expected to be on the order of 925 kips. Structure framing is planned to primarily feature steel HSS and wide-flange beam and columns, with steel braced frames.

A trash tunnel is planned to connect the mezzanine level with Willard J. Walker Hall in the north; this tunnel is expected to be located near the existing surface elevations of the site and will be constructed of reinforced concrete slabs and walls.

Included in this project scope is a pergola/canopy structure that is to be constructed directly north of the Donald W. Reynolds Center for Enterprise Development building. This pergola is expected to feature a concrete slab-on-grade. Final loading conditions for this structure are not expected to exceed 25 kips.

Additional site improvements are anticipated to include new pedestrian walkways, a new access drive east of Dillard Hall, drainage features, and general utility infrastructure. Final site grades are planned to range from near existing to as much as 11 feet of fill in areas surrounding the structure.

The purpose of this investigation was to obtain sufficient subsurface information from which to provide the necessary geotechnical recommendations and considerations for the planned project structure. Additional considerations for project pavements and tunnel have been included within this report at the request of the Design Team. Those recommendations and considerations are presented in the following sub-sections of this report.

10.1 Initial Site Preparation

As described in *Section 9.1,* topsoil materials were encountered at the surface across a majority of the project site, with thicknesses ranging from approximately four (4) to six (6) inches. Flexible asphalt pavements underlain by aggregate base materials were encountered in the existing motorbike parking lot, with total pavement section thicknesses ranging from approximately six (6) to seven (7) inches. Concrete pavement was encountered in an existing access drive with a thickness of approximately six (6) inches.

Additionally, it should be noted that asphalt and concrete pavements are present within the eastern-boundary access drive and the pedestrian walkways on the north side of the Dillard Hall footprint. The thicknesses of these pavements are not known; as they were not encountered within any of the project borings. However, it is expected that the overall thicknesses of these sections will be less than 12 inches.

It is recommended that all existing organics, pavements, and otherwise deleterious materials be removed from the site prior to construction. **MCE recommends that the Contractor anticipates a minimum of 12 inches of initial stripping to be necessary across the site in order to fully remove the existing surface materials.**

10.2 Site Grading Considerations

Based on the provided documentation, it is anticipated that cuts on the order of nine (9) feet and fills on the order of 16 feet will be required to achieve the finished site elevations associated with the academic building structure and surrounding pavement areas. It is understood that the structure has a planned FFE of 1,413 feet for the lower level (first-floor), with a walkout towards Harmon Avenue, and a planned FFE of 1,433 feet for the second floor, with a walkout towards the Donald W. Reynolds Center for Enterprise Development.

Based on the findings of this investigation, subgrade materials considered suitable for the placement of shallow foundations within the academic building consist of the referenced moderately hard to hard Stratum IV Weathered Sandstone. The subgrade materials considered suitable for the placement of shallow foundations within the pergola/canopy and for the civil site improvements generally consist of the referenced Stratum II and III materials.

A brief summary of expected depths of suitable subgrade materials is provided on the following page:

- Within the footprint dimensions of the Dillard Hall Academic Building and its features, it is expected that suitable subgrade materials will generally be present at or above the planned FFE of the lower level.
    - Due to the existing site grades, the use of imported fill materials is expected to be required below the structural elements. Conventional select fill is not recommended for use in this scenario; rather, the use of either aggregate base or controlled low-strength material (CLSM) should be considered. This is further outlined in *Section 10.5* for the consideration of the Project Team.
    - Difficult excavation conditions are expected to be present within the structure footprint as a result of the encountered Stratum IV materials. These are further described in *Section 10.2.1.*
- Within the pergola/canopy and civil site improvements, it is expected that subgrade materials in suitable condition for the placement of imported select fill or the direct placement of shallow foundations associated with the canopy will be present immediately following initial site stripping and grading.

The suitability of the in-situ materials should be evaluated by the Geotechnical Engineer or his/her designated representative at the time of construction to ensure that the recommendations contained herein remain consistent with the site conditions.

Specific care should be taken by the Contractor to prevent excessive saturation of subgrade materials exposed during site stripping and excavations as the in-situ soils and underlying shale materials are susceptible to reduced shear strengths when exposed to increased moisture and/or freezing conditions. This can be achieved by providing positive drainage during construction and covering with select fill or otherwise specified material soon after exposure, where applicable.

As previously noted, it is expected that up to 16 feet of fill will be required to achieve the planned finished grades on the west side of Dillard Hall, near the Level 2 walkout. The trash tunnel is largely expected to be constructed within this fill material, at or above existing surface elevations. The Design Team should be aware of the potential settlement that may occur due to this quantity of fill. Properly placed, moisture-conditioned select fill placed in accordance with the recommendations outlined in *Section 10.10* may undergo long-term consolidation of up to one (1) percent of the overall fill height. With a planned quantity of 16 vertical feet of fill, this would result in a potential of up to 1.92 inches of settlement.

Methods such as preloading/surcharging the placed select fill may be utilized to accelerate the settlement within the deep fill areas. These should be coordinated between MCE and the Contractor prior to the start of construction to ensure that the appropriate parameters are utilized, if desired.

10.2.1 Rock Construction Considerations

For the purposes of this project, "Rock Excavation" is defined as any material that cannot be excavated or removed using the following equipment performance benchmarks:

- Mass Grading
  Materials that cannot be effectively loosened or displaced by a Caterpillar D-8 dozer (or industry equivalent) equipped with a single-shank ripper in good working condition.
- Trenching/Confined Areas
  Materials that cannot be removed by a Caterpillar 330B tracked excavator (or equivalent) equipped with specialized rock teeth.

Based on the materials encountered during this subsurface investigation, materials necessitating specialized rock removal techniques, such as pneumatic breaking or heavy ripping, are expected to impact the planned construction operations. In particular, these are expected to be required within the structure footprint to excavate the required quantity of Stratum IV Weathered Sandstone materials.

As a conservative measure, it is recommended that the Contractor budget for rock excavation to be required to remove these materials beginning at first-encounter. However, it is expected that much of these materials may be removed in a mass-grading setting utilizing the equipment described above. Blasting is not expected to be required to remove the Stratum IV materials from the project site.

A geophysical rippability study was considered in order to provide more definite parameters and expectations for the removal of these materials. However, based on previous experience with similar sandstone materials, these studies may not provide an accurate representation of the true "rippability" of these materials.

The Contractor should expect the consistency of these Stratum IV materials to vary considerably across the site, with some requiring hammer-hoe attachments to fully remove, and others being removed through the use of conventional rock teeth on a Caterpillar 330B or equivalent.

10.2.2 Temporary Slopes During Construction

Excavations should be performed in accordance with the requirements outlined by the *Occupational Safety and Health Administration (OSHA) 1926 – Subpart P – Appendix B*. Excavated slopes during construction with depths less than 20 feet should be benched or sloped to provide the minimum horizontal-to-vertical (H:V) ratios as noted in Table 10 below.

Table 10: Temporary Slopes During Construction

On-site Soil Stratum	Material Description	OSHA Soil Type	Maximum Allowable Slopes (H:V)
Stratum II	Fine-Grained Subgrade Materials	Type B Soils	1:1 (45˚)
Stratum III	Coarse-Grained Subgrade Materials	Type C Soils	$1^1/_2$:1 (34˚)
Stratum IV	Weathered Sandstone Materials	Type B Soils	1:1 (45˚)
Stratum V	Highly/Weathered Shale Materials	Type B Soils	1:1 (45˚)
Stratum VI	Competent Sandstone/Shale Materials	Stable Rock	Vertical (90˚)

Note: OSHA Soil Type assignments should be considered preliminary and should be verified at the time of construction, if applicable, by an OSHA-competent person.
Prolonged exposure of any encountered materials to the environment and/or increased moisture conditions may require additional shoring measures. Stratum IV and V materials should not be considered Stable Rock due to their weathered nature and potential for deterioration upon exposure to moisture.

Sloping or benching of excavations greater than 20 feet deep shall be designed by a licensed Professional Engineer (PE) prior to excavation. Construction slopes steeper than recommended may be unstable, particularly when introduced to moisture increases during precipitation events.

If excavation efforts require deep vertical trenching (deeper than five (5) feet), and the minimum allowable slope ratio is not achievable, then the Contractor must establish a comprehensive Shoring Plan. That Shoring Plan should be reviewed and stamped by a license PE prior to excavation. As noted above, **these OSHA Soil Type assignments should be considered preliminary and should be verified at the time of construction by an OSHA competent person, when applicable.**

10.3 Subgrade Verification Method

Following stripping and initial excavation/grading, the subgrade materials across the development area should be initially evaluated by the Geotechnical Engineer or his/her designated representative. All subgrade materials should be proof-rolled with a tandem-axle fully-loaded dump truck weighing approximately 60,000 pounds, or equivalent construction equipment. The proof-rolling should be observed by the Geotechnical Engineer or his/her designated representative to verify and document stable subgrade conditions. Alternate means of subgrade verification may be conducted should proof-rolling not be feasible within excavation or undercut dimensions. The implemented means of verification should be under the direction of the Geotechnical Engineer. Any soft and/or yielding subgrade areas encountered should be repaired by undercutting and backfilling with select fill material. These materials should then be subsequently evaluated by the Geotechnical Engineer or his/her representative for approval. **It is highly recommended that the structure footprint be evaluated immediately preceding any additional site grading to reduce unnecessary undercut.**

10.4 General Foundation Recommendations

All foundations associated with the planned academic building development should be sized to meet three (3) conditions:

- Bearing Capacity (Ultimate & Allowable)
  The maximum stresses imposed on the foundation strata should not exceed the allowable bearing pressures as determined by the shear strength properties of the in-situ soils. The allowable bearing pressures outlined in this report incorporate an appropriate factor of safety against general shear failure.
- Settlement & Serviceability Limits
  The design of the foundation system must limit both total and differential settlement to magnitudes that will neither damage nor impair the use of the structure.
- Lateral Stability & Seismic Resilience
  The foundation system must provide sufficient resistance to lateral and overturning forces under the most critical load conditions, including earthquake loadings.

These geotechnical performance factors, alongside local construction considerations such as the encountered subsurface materials and the potential for perched water tables, have served as the technical basis for the recommendations detailed in this report.

It should be noted that considerations and recommendations for the use of both shallow foundations and deep foundations (drilled piers) have been provided for the support of Dillard Hall. It is recommended that the structure bear on one (1) foundation type, as opposed to a combination of the two (2), to reduce the potential for differential settlement beyond the values outlined in this report.

10.5 Shallow Foundation Recommendations

Based on the provided information, current project scope, and encountered subgrade materials, considerations for the use of shallow foundation systems have been provided for the consideration of the Design Team, as it relates to the academic building, the planned pergola/canopy, and the trash tunnel walls. Those recommendations and considerations are provided in the following subsections.

10.5.1 Dillard Hall

Based on the provided information and the encountered subsurface conditions, it is recommended that the Design Team consider the use of a shallow foundation system composed of continuous and individual (spread) footings for the support of the Dillard Hall academic building. If utilized, these shallow foundation elements are recommended to bear directly on native Stratum IV weathered sandstone materials. Should site grades not allow for the direct bearing on these sandstone materials, then either CLSM, otherwise referred to as “flowable fill”, or an aggregate base course material be utilized between the Stratum IV materials and the bottom of foundation elevations.

For the purposes of this report, the aggregate base course is expected to be an ARDOT Class 7 material, compacted to a minimum of 98% of the modified proctor value (ASTM D1557), within two (2) percent of the optimum moisture. Any material utilized for this purpose, CLSM or aggregate base, should be submitted to the Geotechnical Engineer for review and approval prior to use.

It is expected that excavations for these shallow foundation elements may require the use of hammer hoe attachments. Depending on the condition of the bottom of footing excavations, CLSM may need to be placed to ensure a smooth, level surface from which the foundations may be constructed. Further coordination is encouraged between MCE and the Contractor on these items prior to construction.

It is recommended that the foundation elements bearing on suitable in-situ Stratum IV materials or imported aggregate/CLSM materials placed on suitable in-situ Stratum IV materials, as described above, may utilize a safe net allowable bearing capacity of 3,800 pounds per square foot (psf) for continuous footings and 4,000 psf for spread footings.

The allowable bearing capacities provide a minimum factor of safety of three (3) and were calculated using a minimum footing width of three (3) feet, a minimum footing thickness of two (2) feet, and a minimum footing depth of two (2) feet below exterior ground elevations, which is adequate to protect against frost heave in the project area.

The total long-term foundation settlement for footings bearing on suitable conditions, as described in this section with the assumed dimensions and loading is anticipated to be less than ¾-inch. The maximum differential settlement between footings is anticipated to be on the order of ½-inch between individual footings or along a 40-foot span for continuous footings.

10.5.2 Pergola/Canopy

It is recommended that a shallow foundation system consisting of individual (spread) footings will be suitable for the support of the Pergola/Canopy area. The shallow foundations are recommended to bear directly on suitable Stratum III materials or on a minimum of one (1) foot of newly placed, properly compacted, and moisture-conditioned select fill material meeting the criteria outlined in the Select Fill Material section (*Section 10.10*). Suitable native materials are expected to be present immediately following initial site stripping and grading.

MCE recommends that the Contract ran allowance for the placement of a minimum of one (1) foot of select fill beneath the pergola footings, to be utilized in the event that the exposed subgrade conditions at the time of construction vary from those encountered during this investigation.

It is recommended that spread footings bearing on properly placed select fill or “suitable” native subgrade may utilize a safe net allowable bearing capacity of 2,300 psf. Suitable in-situ subgrade materials should be exposed prior to the placement of any select fill material beneath structure foundation elements.

The total long-term foundation settlement for footings bearing on properly placed select fill material or on suitable in-situ materials with the assumed dimensions and loading is anticipated to be approximately ¾-inch. The maximum differential settlement between footings is anticipated to be on the order of ½-inch between individual footings.

10.5.3 Trash Tunnel

It should be noted that the original investigation was not targeted at providing recommendations for the planned trash tunnel extending from Dillard Hall to Willard J. Walker Hall. As such, the recommendations contained herein are based on the project boring locations conducted near the understood tunnel alignment.

Based on the information provided by the Design Team, it is understood that the trash tunnel is planned to be constructed of a eight (8) – foot tall concrete walls, a slab-on-grade floor, and an elevated structural slab for the roof. Loading conditions for each wall are expected to range from approximately 3.1 kips per linear foot (klf) to approximately 4.7 klf (Dead Load plus Live Load), based on information provided by the Structural Design Team.

The provided grading information indicates that the tunnel is planned to bear near the surface of the existing site grades and will follow above the alignment of a portion of an existing utility tunnel .

It is recommended that a shallow foundation system consisting of continuous footings will be suitable for the support of the trash tunnel. The shallow foundations are recommended to either bear on suitable Stratum II/III/IV materials or on imported select fill placed on suitable in-situ materials.

Where the existing utility tunnel is present, it may be prudent to utilize No. 57 stone (or an approved alternative), wrapped in a separation geotextile between the ceiling of the utility tunnel and the floor of the trash tunnel. The use of a material such as No. 57 stone or similar will limit the necessary compaction effort above the utility tunnel in an effort to reduce the potential for damage to this element. Further coordination should occur between MCE and the Contractor to ensure the appropriate materials are implemented under this scope item. MCE is not responsible for ensuring that any loads placed on the existing utility tunnel will not damage or otherwise create issues related to this feature.

As the tunnel alignment was not directly targeted under this scope of work, the net allowable bearing capacity recommended herein for design must be confirmed at the time of construction by the Geotechnical Engineer or his/her representative. It is recommended that the foundation elements bearing on properly placed select fill or on suitable native subgrade may utilize a safe net allowable bearing capacity of 2,000 psf for continuous footings.

Suitable in-situ subgrade materials should be exposed prior to the placement of any select fill material beneath structure foundation elements.

The total long-term foundation settlement for footings bearing on properly placed select fill material or on suitable in-situ materials with the assumed dimensions and loading is anticipated to be approximately ¾-inch. The maximum differential settlement between footings is anticipated to be on the order of ½-inch between individual footings.

10.6 Foundation Recommendations – Drilled Piers

As an alternative to the initially-recommended shallow foundation system, it is recommended that the Design Team consider the use of a drilled pier foundation system for the support of the Dillard Hall academic building. If utilized, this **drilled pier foundation system shall be designed for end-bearing must be founded into the encountered competent shale materials (Stratum VI).** The sandstone materials encountered during this investigation are not expected to be of an adequate thickness to allow for the appropriate bearing of the drilled piers.

The drilled piers should be founded a minimum of one (1) pier diameter (1L:1D), or a minimum of five (5) feet, into the competent shale material, whichever is greater. The exact length of the rock sockets may be lengthened based on the final loading conditions. Adequate end-bearing material should be encountered prior to beginning the recommended rock socket length.

This material, herein referred to as 'competent,' may utilize a safe allowable end bearing capacity of 50 kips per square foot (ksf) for design purposes. The anticipated depth of competent shale materials may be referenced in Table 11 below.

Table 11: Estimated Depth to Competent Rock

Boring ID	Existing Surface Elevations (ft)	Est. Depth to Competent Rock (ft)	Est. Elevation of Competent Rock (ft)
B-01	1,419.41	21.0	1,398.41
B-02	1,418.17	20.0	1,398.17
B-03	1,419.92	22.0	1,397.92
B-04	1,418.06	24.0	1,394.06
B-05	1,414.04	16.0	1,398.04
B-06	1,420.20	18.0	1,402.20
B-07	1,422.04	22.0	1,400.04
B-08	1,422.22	25.0	1,397.22
B-09	1,418.58	16.0	1,402.58

NOTES: The existing surface elevations shown in Table 11 are based on topographic survey data obtained by MCE personnel. The corresponding estimated depth to competent rock and relevant elevations are based on this data, as well as measurements taken at the time of the investigation.

The use of surface casing and drilling slurries is not recommended as the primary means of maintaining drilled shaft integrity. Based on the anticipated lower-level FFE, it is expected that drilled piers will largely be constructed beginning within the Stratum IV weathered sandstone and extending through the Stratum V, into Stratum VI, materials. As such, the use of casing is not expected to be necessary to maintain the integrity of the drilled shaft. However, temporary casing may be necessary, should shaft construction occur during or immediately following precipitation events.

Should any perched water be encountered during drilling operations, this groundwater will have the potential to undermine the integrity of the drilled shafts.

The drilled piers should be designed for end-bearing support. As previously noted, the final drilled pier design may utilize a net allowable end-bearing capacity of 50 ksf for the competent shale material, based on the data recorded during this investigation and the known characteristics of the rock formation in the project area. The provided allowable end-bearing pressure provides a minimum factor of safety of 2.0 with regard to the encountered rock material.

Drilled piers should have a minimum length-to-diameter ratio of 3L:1D. A short-term increase in allowable loadings during seismic and wind events is not recommended at this time.

The recommended bearing stratum should be verified by the inspection of probe holes drilled beyond bottom-of-pier elevations. The recommendation for verification through probing is based on the project scope and loading. The probe holes should be drilled beyond the bottom of the foundations (rock socket) to an additional depth of twice the individual pier diameter (2L:1D) or an additional five (5) feet into the competent rock, whichever is greater. The ultimate foundation depth should be sure to include the full rock socket length below any encountered voids, fractured, weathered, or dissolution zones (low-consistency rock). Probing verification would then need to be performed below the extended drilled pier bearing elevation, as previously described. The actual number of probe holes conducted may vary at the discretion of MCE based on the on-site results of probing operations.

Prior to the placement of concrete at each pier location, the Contractor should make a reasonable effort to remove all water and other deleterious materials from the drilled pier excavation. In addition to potentially reducing the provided bearing capacities of the referenced shale material, the increased water-to-cement ratio (W/C) may reduce the compressive strength of the concrete as well as the overall strength of the pier foundation. In the event that groundwater cannot be adequately removed using conventional pumping methods, alternative means such as the tremie method should be utilized to displace the existing groundwater during concrete placement.

Concrete should be placed directly down the center of the drilled pier under pressure provided by a pump truck or other means, uninterrupted by reinforcing bars or tie wires.

Drilled piers should not be positioned within one (1) pier diameter of each other end-to-end. For piers within three (3) pier diameters end-to-end, it is recommended that a minimum of three (3) days of concrete curing occur prior to rock coring. Alternatively, piers within this condition may be constructed consecutively, provided that measures such as shoring are available if required. Further, when installing multiple piers within this proximity, it is recommended that these piers have similar bearing depths, regardless of size or loading conditions; further coordination is recommended on a case-by-case basis and may be directed by the results of the performed probing operations.

Drilled piers in an uplift condition may utilize an allowable uplift skin friction value of 500 pounds per square foot (psf) for the overburden soils (Stratum II and Stratum III), 1,500 psf for weathered sandstone and shale (Stratum IV and Stratum V), and 3,000 psf for the competent shale materials (Stratum VI). ***Skin friction calculations should negate the top two (2) feet of the drilled pier length, regardless of the subgrade material at this depth*.** It is recommended that drilled piers be designed to derive their downward compressive capacity from end bearing only. Skin friction should not be utilized in determining the allowable downward compressive capacity due. To provide consistent foundation performance, all drilled piers should bear in competent shale at a consistent end-bearing elevation or stratum.

Total and/or differential foundation settlement under the structure supported by a drilled pier foundation system can be anticipated to be negligible to one-eighth ($^1/_8$) – inch, based on the provided loading conditions.

The shale formation does have the potential for a significant loss in shear strength if it is left exposed to the elements. **For these reasons, drilled pier dimensions should not be left unsupported for extended periods of time prior to concrete placement, including overnight. Drilled piers shall be poured the same day they are drilled.**

It is recommended that the Contractor expect rock drilling to be necessary to install the drilled piers. In particular, this may be required to advance through the weathered sandstone and sandstone materials.

A table with the requested inputs for L-Pile analysis has been provided for reference in Appendix F.

10.7 Structure Slab-on-Grade

Slab-on-grade (SOG) construction may be utilized for the academic building, the pergola, and the trash tunnel structures, provided a minimum of four (4)-inch cushion of sand, crushed stone, or gravel is placed below the slab areas with a vapor barrier directly below the concrete.

Within each structure, it is recommended that a minimum of one (1) foot of newly placed, properly compacted, and moisture-conditioned select fill or aggregate base material is placed below the planned slab-on-grade in order to provide consistent, suitable under-slab conditions.

As discussed in *Section 10.5.3,* this use of select fill may be revised to include crushed stone (No. 57 or No. 67 stone) below the trash tunnel slab-on-grade in order to limit the compaction effort applied immediately above the existing utility tunnel.

Suitable materials shall be exposed beneath the structure footprints prior to the placement of select fill or aggregate base. These materials should then be placed and compacted in standard lifts until the finished subgrade elevation is achieved. As previously noted, the entireties of the slab subgrade areas are recommended to be verified for stability during construction through proof-rolling operations.

10.8 Lateral Earth Pressures

Based on the understood scope of work, multiple below-grade site retaining elements will be implemented as part of the scope of work. These elements are expected to include basement walls within Dillard Hall, the sidewalls of the trash tunnel, and typical site retaining walls.

The earth-retaining wall elements should be designed to resist the minimum equivalent fluid weights provided in Table 12 below. The recommended minimum factor of safety against sliding and overturning is 1.5 and 2.0, respectively.

Table 12 assumes a drained-condition to be present for each retaining structure. To achieve a drained condition, the retaining structure should be backfilled using a perimeter drainage system or a gravity trench drain system graded to daylight for the release of any hydrostatic pressure that may develop. Alternative means of drainage may be required if daylighting is not an option, those alternate means would need to be discussed and approved by the Design Team.

The values provided in Table 12 for No. 57 or No. 67 crushed stone gravel assume a 1H:1V maximum backfill slope from the heel of the retaining wall foundation. If a vertical “chimney drained” is provided by the No. 57 or No. 67 stone, then the values for on-site soils should be used based on proximity and relevancy to the material behind the gravel.

Table 12: Estimated Lateral Earth Pressures – Drained Condition

Soil/Backfill Type	Moist Unit Weight (lbs/ft^3)	Friction Angle φ (^{0})	Equivalent Fluid Pressure (lbs/ft^3)		
			Active	Passive	At-Rest
On-site Stratum II Materials	110	22	50	242	69
On-site Stratum III Materials	125	28	45	346	66
Select Fill Material (GC or GM)	120	28	43	332	64
No. 57 or No. 67 Stone	95	35	26	351	41

A coefficient of friction of 0.40 may be used provided the retaining structure is supported on a minimum of four (4) inches of placed and compacted Class 7 Base Course material. A friction value of 0.35 may be used provided the retaining structures are supported directly on select fill material or on-site soils.

10.9 Project Pavement Recommendations

As with the trash tunnel, this investigation did not originally target the project pavement improvements. As such, the recommendations contained herein are based on nearby project borings but were not necessarily conducted in the alignment of the planned access drive. Site grading for the project pavements should initially consist of stripping all Stratum I surface materials, followed by proof-rolling as previously described. Subgrade preparation and proof rolling should follow the same procedure as described in the *Subgrade Verification* section of this report. Based on the data obtained from this investigation, suitable subgrade materials are generally anticipated to be encountered within the upper one (1) foot below the existing surface elevations.

It is expected that the planned access drive will primarily be utilized for heavy truck traffic, such as garbage trucks. As such, it is recommended that the Contractor budget for the placement of a minimum of two (2) feet of imported select fill below the project pavement dimensions. The placement of this select fill and undercut necessary within the access drive should be directed by the Geotechnical Engineer or his/her representative at the time of construction.

Thickened lifts or "bridging" lifts may be utilized to establish stable subgrade conditions within the pavement areas, should unstable subsurface conditions be encountered during construction. Bridging lifts should only be implemented under the direction of the Geotechnical Engineer. The top eight (8) inches of any thickened lift should be compacted and tested per project specifications. A minimum of one (1) standard lift should be placed above any thickened lift utilized beneath pavement areas. **Bridging lifts should not be utilized within the structure(s) footprint or beneath any structure-related elements.**

10.9.1 Minimum Pavement Section Recommendations

The pavement recommendations provided in this section are based on stable in-situ materials or properly-placed, moisture-conditioned select fill materials placed above in-situ materials, verified for stability through proof-rolling. The minimum pavement sections are recommended to be as shown in Tables 13 and 14 below.

For the recommendations provided in Tables 13 and 14, light-duty pavements are considered to be those pavements with low-volume traffic areas such as pedestrian sidewalks, parking, and staging areas for passenger cars.

The standard-duty pavements are recommended as performing similarly to a typical city street pavement section with a residential classification. Heavy-duty pavement recommendations are intended to apply to areas subjected to heavy-truck traffic.

Table 13: Minimum Project Pavement Sections – Asphalt

Pavement Type	Pavement Materials	Light Duty	Standard Duty	Heavy Duty
Asphalt Pavement	ACHM Surface Course (1/2")	3"	3"	2"
	ACHM Binder Course (1")	N/A	N/A	3"
	Class 7 Base Course (95% MPD)	6"	8"	12"

Table 14: Minimum Project Pavement Sections – Concrete

Pavement Type	Pavement Materials	Light Duty	Standard Duty	Heavy Duty
Concrete Pavement	Portland Cement Concrete	5"	6"	8"
	Class 7 Base Course (95% MPD)	6"	8"	8"

The pavement sections provided in Tables 13 and 14 should be viewed as minimums and can be increased through the design process by the project Civil Engineer if warranted.

For the purposes of this report, the concrete pavements are assumed to be jointed plain concrete pavements (JPCP), i.e. unreinforced concrete, with a minimum compressive strength of 4,000 pounds per square inch (psi).

10.10 Select Fill Material

Select fill material utilized on this project should consist of locally available silty or clayey chert gravel and must be free of organics. Approved materials must conform to the USCS as a GM or GC material and meet the following physical criteria:

- Plasticity Index (PI): 35 or less
- Liquid Limit (LL): 45 or less
- Gradation: Minimum of 40% retained on the ¾-inch sieve; maximum of 30% passing the No. 200 sieve.

Any material utilized as select fill in the deep fill areas (greater than five (5) feet) should have a maximum dry density of at least 92.0 pounds per cubic foot (pcf), based on the Standard Proctor Test (ASTM D698). ***Variations to these criteria may be evaluated on a case-by-case basis. Any material proposed for use as select fill on the project must be reviewed and approved by the Geotechnical Engineer prior to placement.***

All fill and backfill should be placed in horizontal lifts not exceeding eight (8) inches compacted. When placing fill next to existing slopes, the slope face should be stripped of all vegetation and the face "benched" to allow the placement of the horizontal lifts and bonding to the slope face. Table 15 below provides the recommended compaction parameters for select fill and Class 7 base course to be used on the project.

MCE anticipates that due to the mass excavator requirements within the project site that on-site material may be processed for re-use as select fill on the project. Bulk samples of any material planned to be utilized as select fill material should be submitted to the Geotechnical Engineer for further analysis and approval.

Table 15: Compaction Requirements

Material Type	Test Standard	Minimum Dry Density (%)	Optimum Moisture Range (%)
Select Fill (Typ.)	ASTM D698 / AASHTO T99	98	-2% to +2%
Select Fill (Aggregate in Building Pad)	ASTM D1557 / AASHTO T180	98	-2% to +2%
Base Course	ASTM D1557 / AASHTO T180	95	Near Optimum

11.0 Construction Materials Testing and Special Inspections

Construction materials testing and special inspection services are to be provided by MCE to provide consistency with the recommendations in this report and the documentation of those recommendations being implemented during construction.

Testing of the earthwork, concrete, structure, and other phases should be conducted and documented during construction to assure the Owner and Engineer that the construction complies with the specifications. Field verification of earthwork operations will be required to confirm the recommendations contained herein.

Additionally, all trenching and excavations should be conducted following the current Arkansas State Law and Occupational Safety and Health Administration (OSHA) guidelines and requirements.

12.0 Limitations and Reserved Rights

The recommendations and conclusions made in this report are based on the assumption that the subsoil conditions do not deviate appreciably from those disclosed in the subsurface exploration. Should significant subsoil variations or undesirable conditions be encountered during construction operations that are not described herein, the Geotechnical Engineer reserves the right to inspect these conditions to reevaluate this report. A review of the final construction plans and specifications by this office is encouraged to ensure compliance with the intent of these recommendations.

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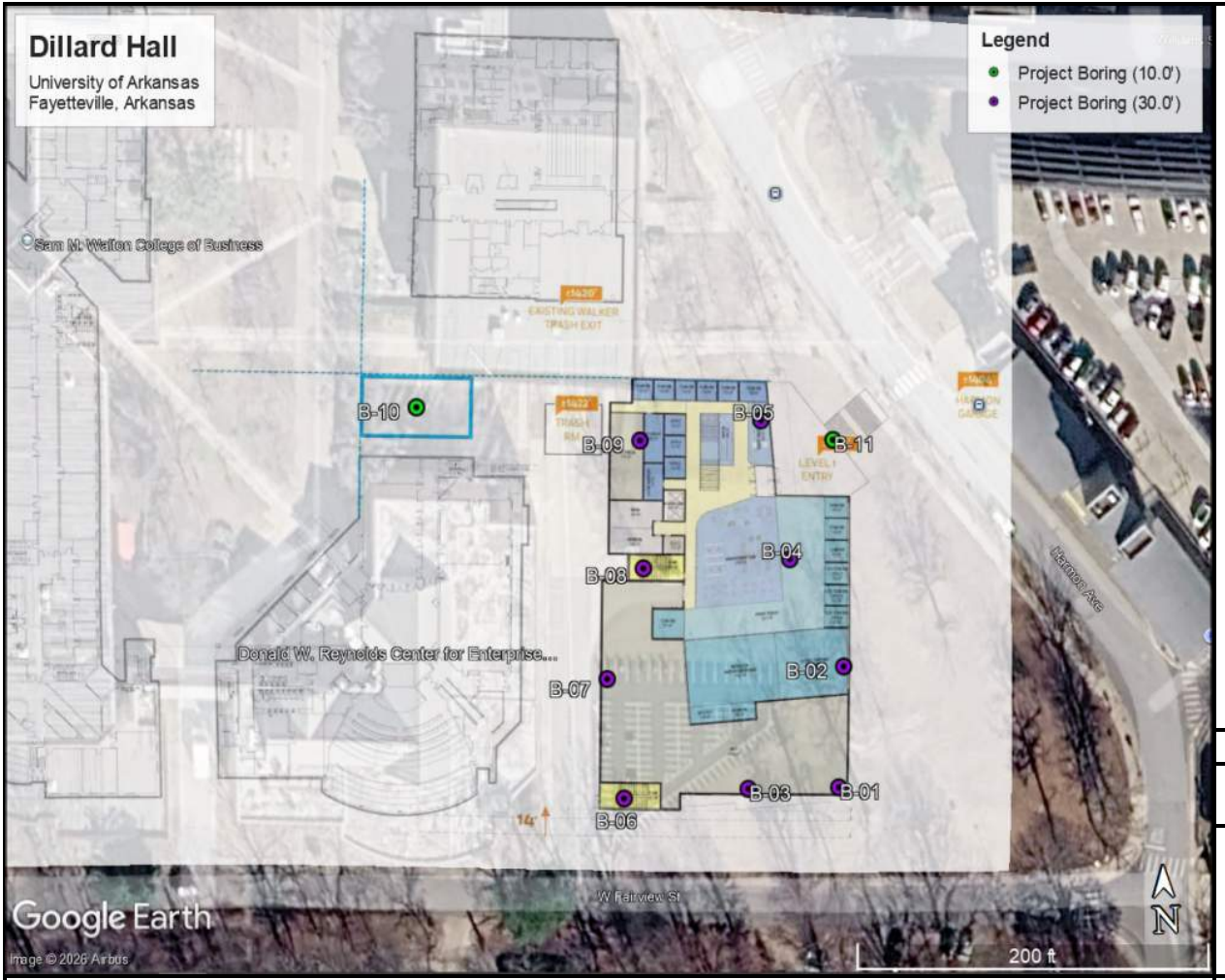
mce.us.com

Appendix A: BORING LAYOUT



UNIVERSITY OF ARKANSAS

PROJECT NUMBER

26-3843

McCLELLAND CONSULTING ENGINEERS
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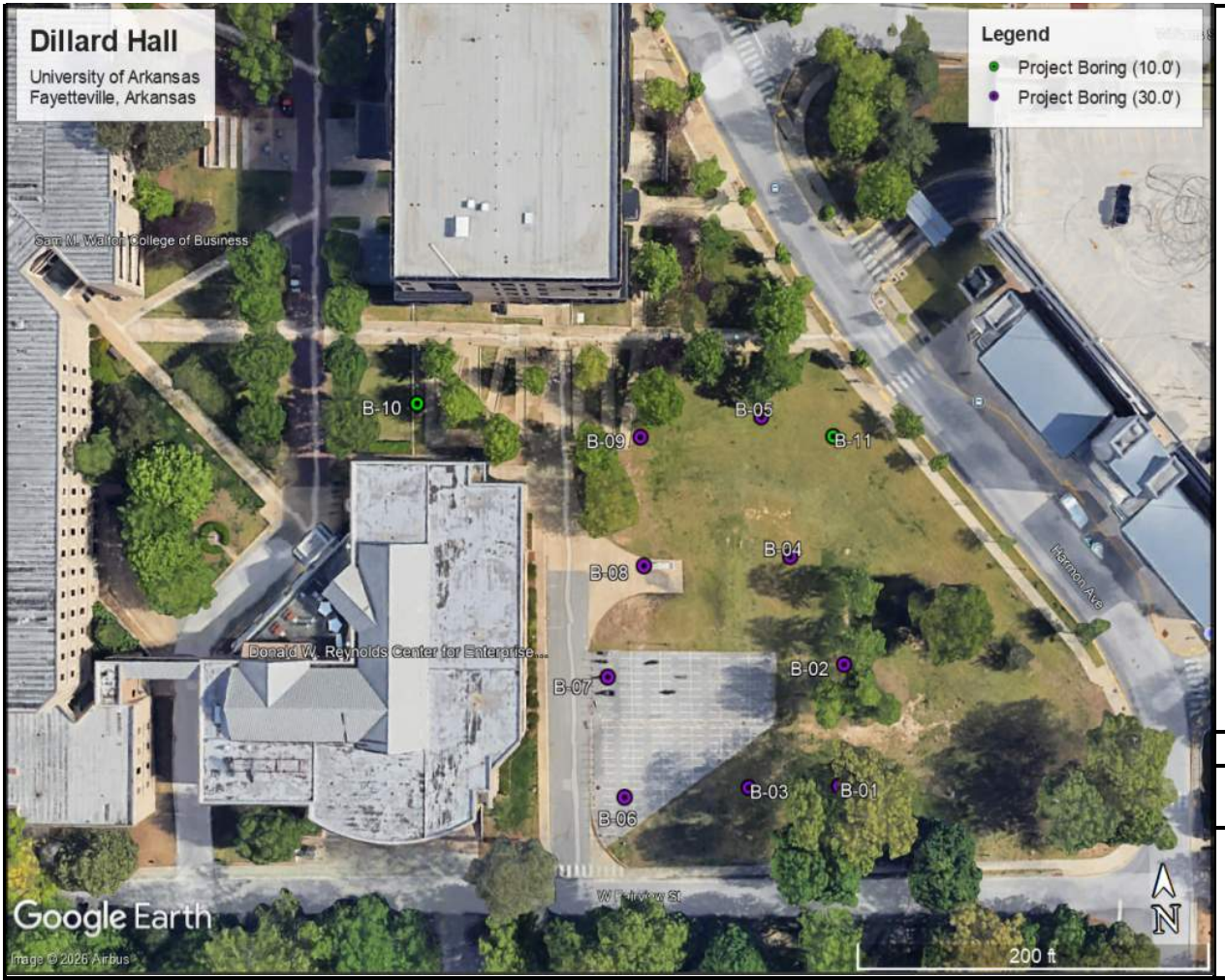
Dillard Hall

Fayetteville, Arkansas

PLATE 1



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PROJECT NUMBER
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Fayetteville, Arkansas

PLATE 2

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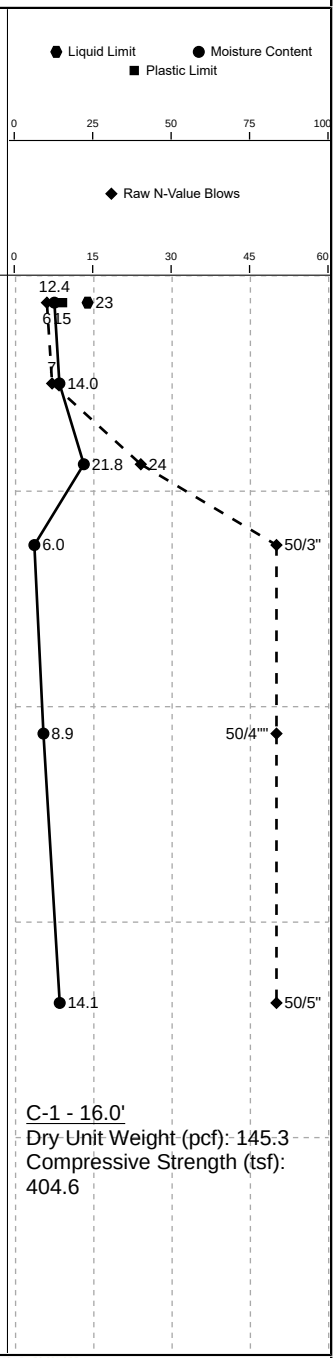
Appendix B: BORING LOGS

Dillard Hall

Soil Boring: B-01

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064436, -94.172859
Date Started:	05/21/2025	Date Completed:	05/21/2026	Ground Elev.:	1419.41'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Sample Number	Blow Counts (N/Refusal)
		TOPSOIL: (6") 0.5		
		(CL) SANDY LEAN CLAY: Reddish Brown to Brown; Medium Stiff to Stiff; Low Plasticity; Dry; Few to Little Gravel; Some Sands; Mostly Fines	S1	6-4-2 (6)
		Reddish Brown to Dark Brown; Stiff	S2	2-3-4 (7)
	1415	3.5 (SC) CLAYEY SAND WITH GRAVEL: Light Brown to Brown; Dense; Low to Moderate Plasticity; Dry	S3	6-24 (24)
5		5 (SM) WEATHERED SANDSTONE: Light Brown; Moderately Hard to Hard Dry; Hard Drilling at 5.0 Feet	S4	36-50/3" (50/3")
	1410	Light Brown to Brown;	S5	50/4" (50/4"")
10				
	1405	Perched Water at 14.0' Auger Refusal at 15.0 Feet 15	S6	50/5" (50/5")
15		SANDSTONE: Light Brown to Brown; Hard Run 1: 15.0' - 20.0' REC: 94% - RQD: 44% 17.5	R01	
	1400	WEATHERED SHALE: Gray; Horizontal Bedding; Soft		



C-1 - 16.0'
Dry Unit Weight (pcf): 145.3
Compressive Strength (tsf): 404.6

Boring Date: **05/21/2025**
Logged By: **Ryan Vance**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
14	-	-
N/A	-	-

Log of Soil Boring: B-01

Dillard Hall

156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-01

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064436, -94.172859
Date Started:	05/21/2025	Date Completed:	05/21/2026	Ground Elev.:	1419.41'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE

Depth (ft)	Elevation (ft)	Sample Graphic	Graphic Log	Soil Description and Remarks	Sample Number	Blow Counts (N/Refusal)	Liquid Limit / Moisture Content / Plastic Limit (0, 25, 50, 75, 100) / Raw N-Value Blows (0, 15, 30, 45, 60)
				WEATHERED SHALE: Gray; Horizontal Bedding; Soft			
				Run 2: 20.0' - 25.0'			
				REC: 100% - RQD: 70% 21			
				SHALE: Dark Gray; Horizontal Bedding; Moderately Hard	R02		
	1395						
25				25			
				End of Boring at 25.0 Feet			

Boring Date: **05/21/2025**
Logged By: **Ryan Vance**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
14	-	-
N/A	-	-

Log of Soil Boring: B-01

Dillard Hall

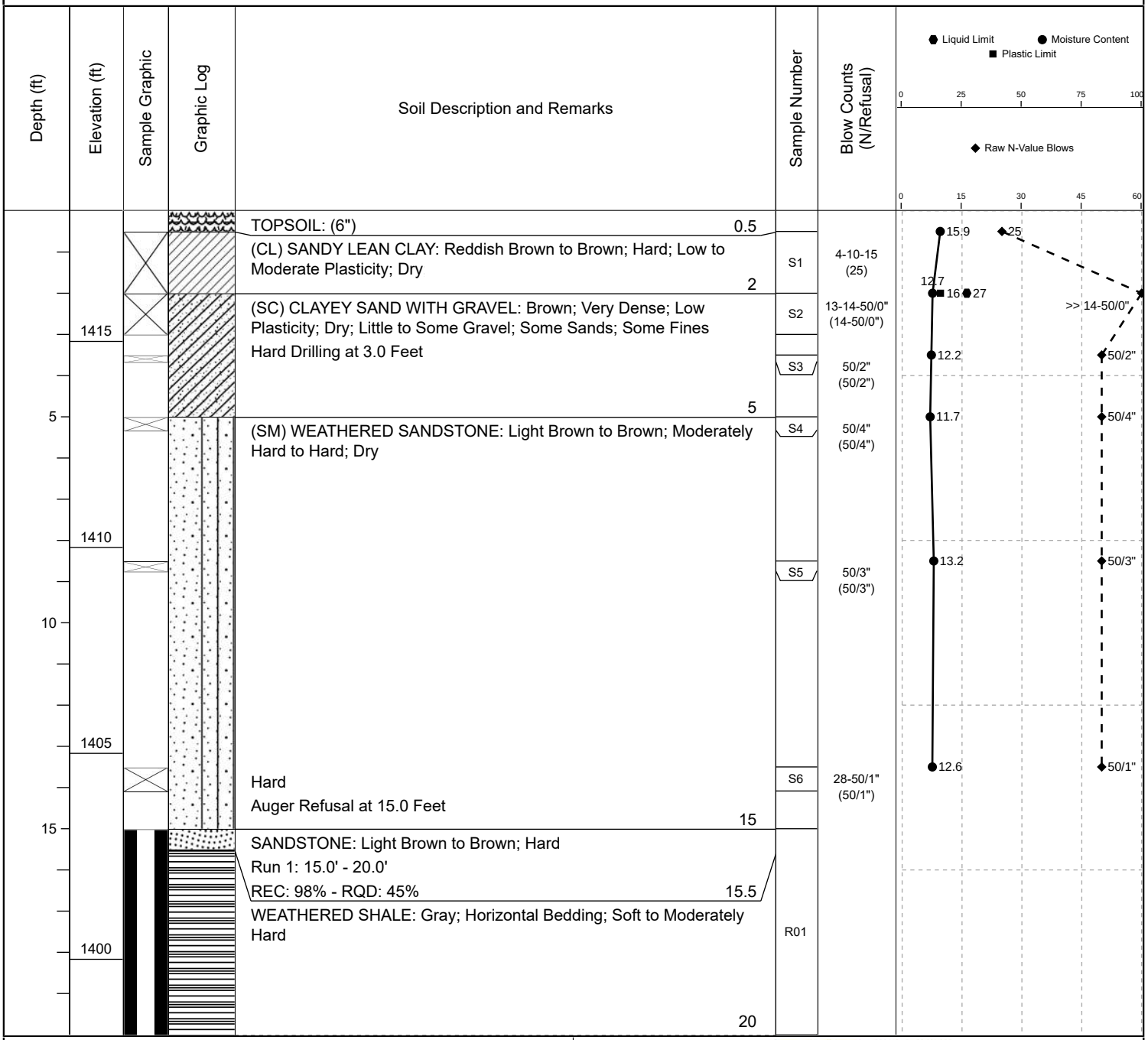
156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-02

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064610, -94.172843
Date Started:	05/21/2026	Date Completed:	05/21/2026	Ground Elev.:	1418.17'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE



Boring Date: **05/21/2026**
Logged By: **Chayse Dean**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-02

Dillard Hall

156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-02

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064610, -94.172843
Date Started:	05/21/2026	Date Completed:	05/21/2026	Ground Elev.:	1418.17'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE

Depth (ft)	Elevation (ft)	Sample Graphic	Graphic Log	Soil Description and Remarks	Sample Number	Blow Counts (N/Refusal)	Liquid Limit / Moisture Content / Plastic Limit (0, 25, 50, 75, 100) / Raw N-Value Blows (0, 15, 30, 45, 60)
	1395			SHALE: Dark Gray; Horizontal Bedding; Moderately Hard Run 2: 20.0' - 25.0' REC: 97% - RQD: 70%	R02		C-2 - 24.0' Dry Unit Weight (pcf): 158.6 Compressive Strength (tsf): 57.7
25				25			
				End of Boring at 25.0 Feet			

Boring Date: **05/21/2026**
Logged By: **Chayse Dean**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-02

Dillard Hall

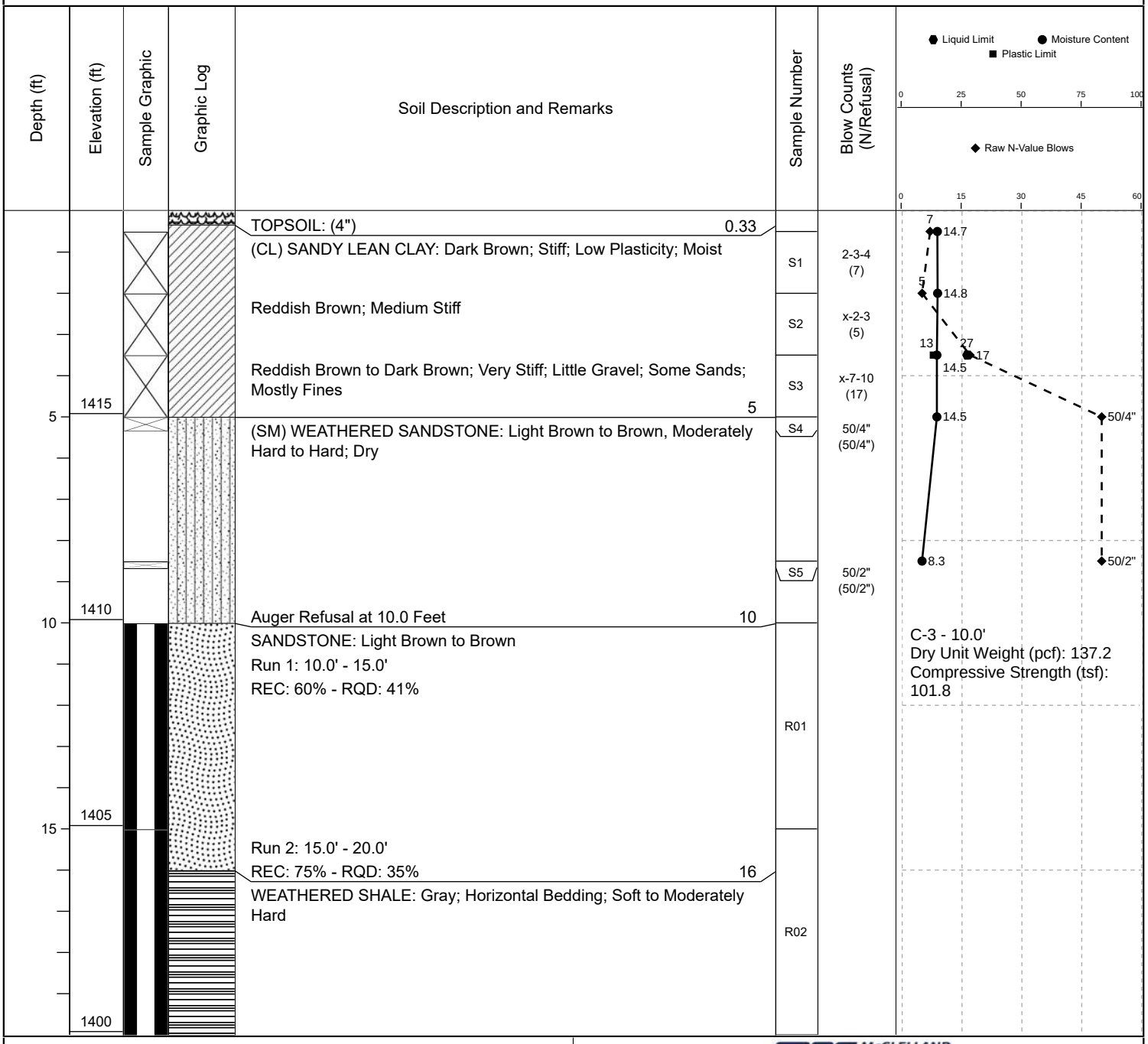
156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-03

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064439, -94.173026
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1419.92'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE



Boring Date: **05/22/2026**
Logged By: **Ryan Vance**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-03

Dillard Hall

156 N Buchanan Ave, Fayetteville, AR 72701, USA

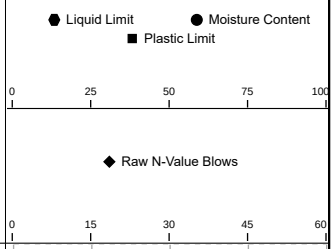
Project No.: 26-3843

Dillard Hall

Soil Boring: B-03

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064439, -94.173026
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1419.92'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE

Depth (ft)	Elevation (ft)	Sample Graphic	Graphic Log	Soil Description and Remarks	Sample Number	Blow Counts (N/Refusal)
				WEATHERED SHALE: Gray; Horizontal Bedding; Soft to Moderately Hard		
				Run 3: 20.0' - 25.0'		
				REC: 98% - RQD: 62% 22		
				SHALE: Dark Gray; Horizontal Bedding; Moderately Hard	R03	
	1395					
25				25		
				End of Boring at 25.0 Feet		



Boring Date: **05/22/2026**
Logged By: **Ryan Vance**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-03

Dillard Hall

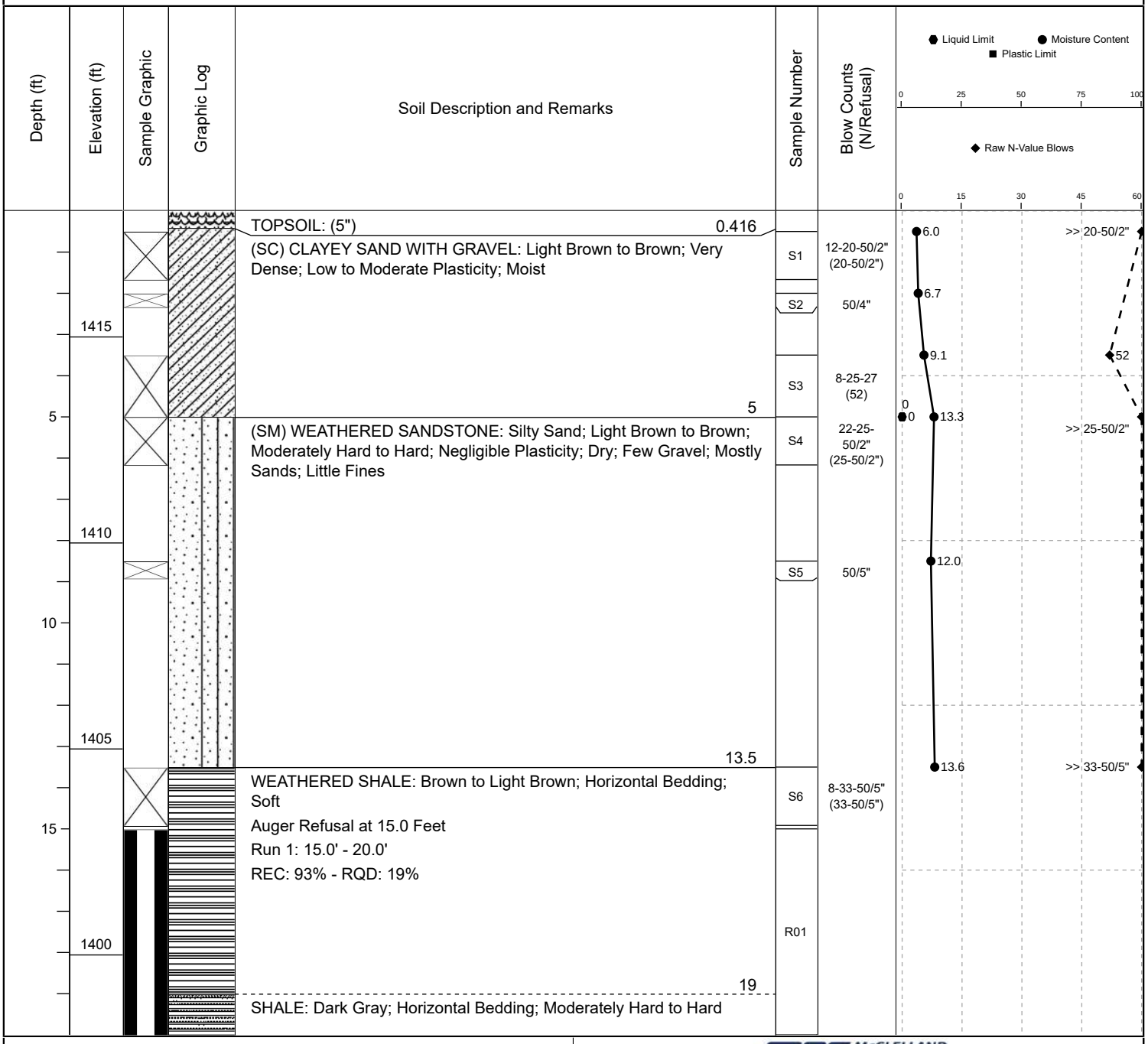
156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-04

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064767, -94.172936
Date Started:	05/21/2026	Date Completed:	06/22/2026	Ground Elev.:	1418.06'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE



Boring Date: **05/21/2026**
Logged By: **Chayse Dean**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-04

Dillard Hall

156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-04

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064767, -94.172936
Date Started:	05/21/2026	Date Completed:	06/22/2026	Ground Elev.:	1418.06'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE

Depth (ft)	Elevation (ft)	Sample Graphic	Graphic Log	Soil Description and Remarks	Sample Number	Blow Counts (N/Refusal)	Liquid Limit / Moisture Content / Plastic Limit (0, 25, 50, 75, 100) / Raw N-Value Blows (0, 15, 30, 45, 60)
	1395			SHALE: Dark Gray; Horizontal Bedding; Moderately Hard to Hard Run 2: 20.0' - 25.0' REC: 85% - RQD: 35%	R02		C-4 - 24.0' Dry Unit Weight (pcf): 158.2 Compressive Strength (tsf): 106.8
25				25 End of Boring at 25.0 Feet			

Boring Date: **05/21/2026**
Logged By: **Chayse Dean**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-04

Dillard Hall

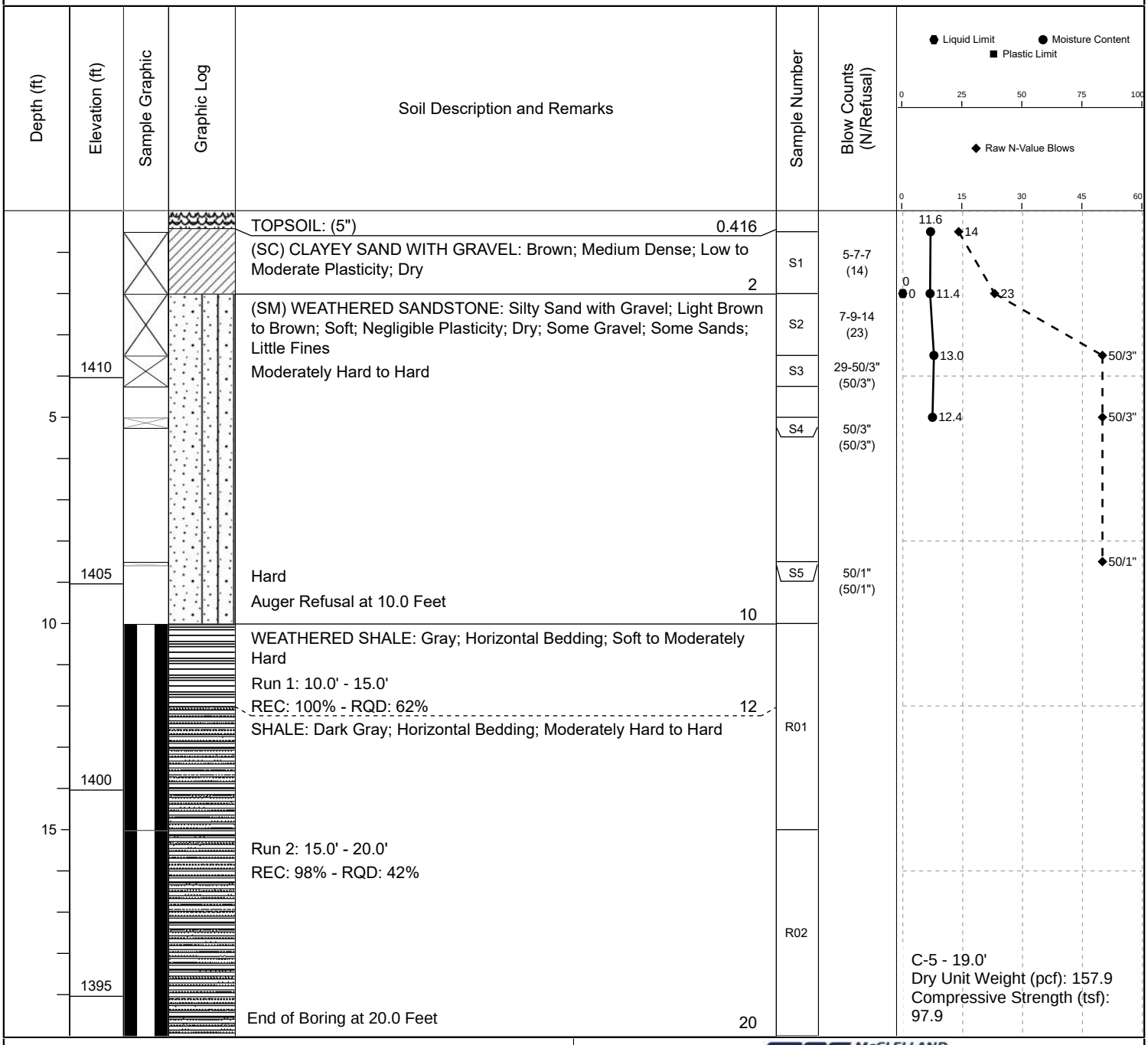
156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-05

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064969, -94.172978
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1414.04'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE



Boring Date: **05/22/2026**
Logged By: **Ryan Vance**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-05

Dillard Hall

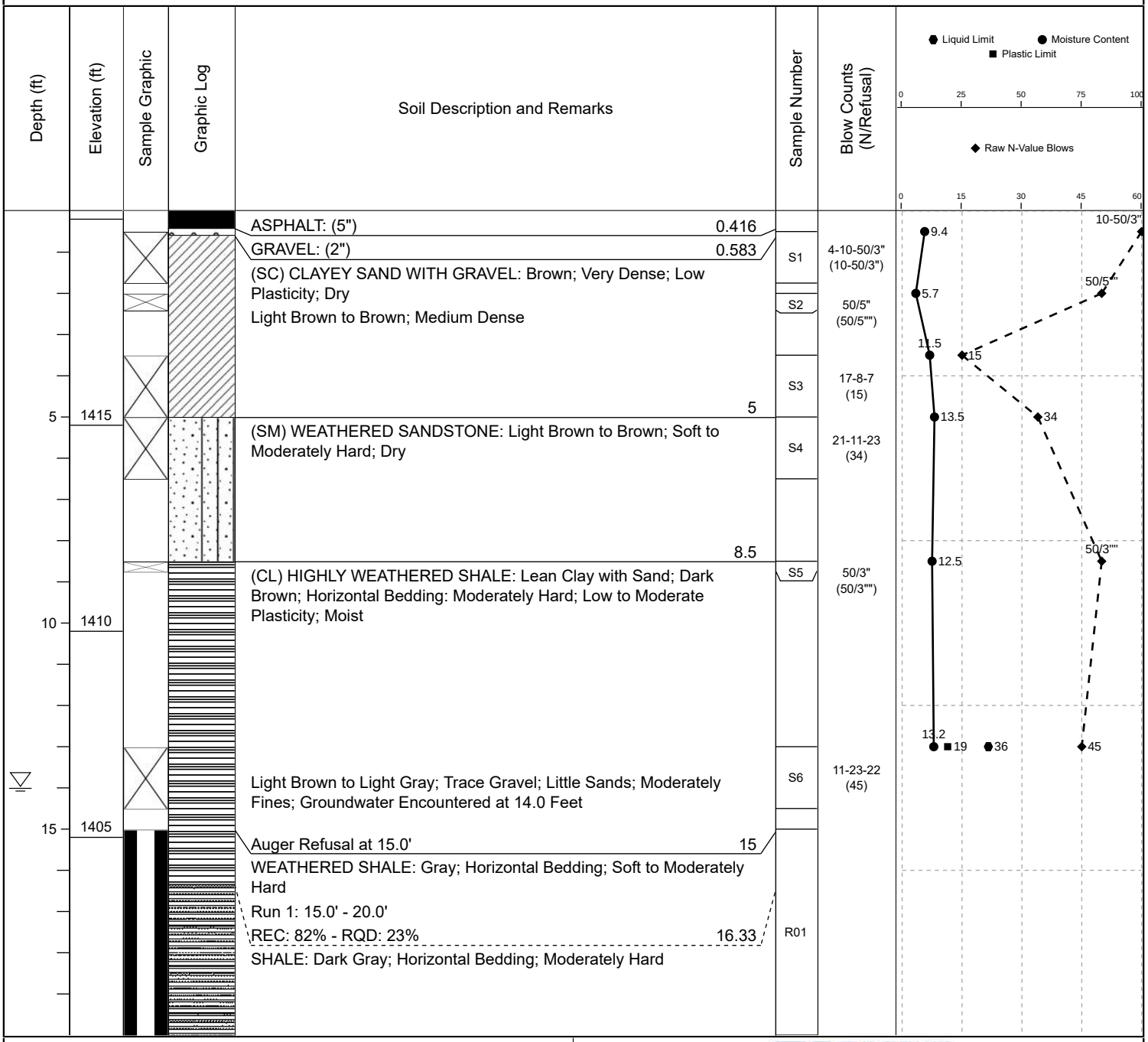
156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-06

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064432, -94.173254
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1420.20'
Drill Rig:	CME-45B	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE



Boring Date: **05/22/2026**
Logged By: **Ryan Vance**
Drilled By: **Joel Ruble**

Water Level

Depth	Hour	Date
14	-	-
N/A	-	-

Log of Soil Boring: B-06

Dillard Hall

156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-06

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064432, -94.173254
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1420.20'
Drill Rig:	CME-45B	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE

Depth (ft)	Elevation (ft)	Sample Graphic	Graphic Log	Soil Description and Remarks	Sample Number	Blow Counts (N/Refusal)	Liquid Limit / Moisture Content / Plastic Limit (0, 25, 50, 75, 100) / Raw N-Value Blows (0, 15, 30, 45, 60)
25				SHALE: Dark Gray; Horizontal Bedding; Moderately Hard Run 2: 20.0' - 25.0' REC: 90% - RQD: 48% 25	R02		
				End of Boring at 25.0 Feet			

Boring Date: **05/22/2026**
Logged By: **Ryan Vance**
Drilled By: **Joel Ruble**

Water Level

Depth	Hour	Date
14	-	-
N/A	-	-

Log of Soil Boring: B-06

Dillard Hall

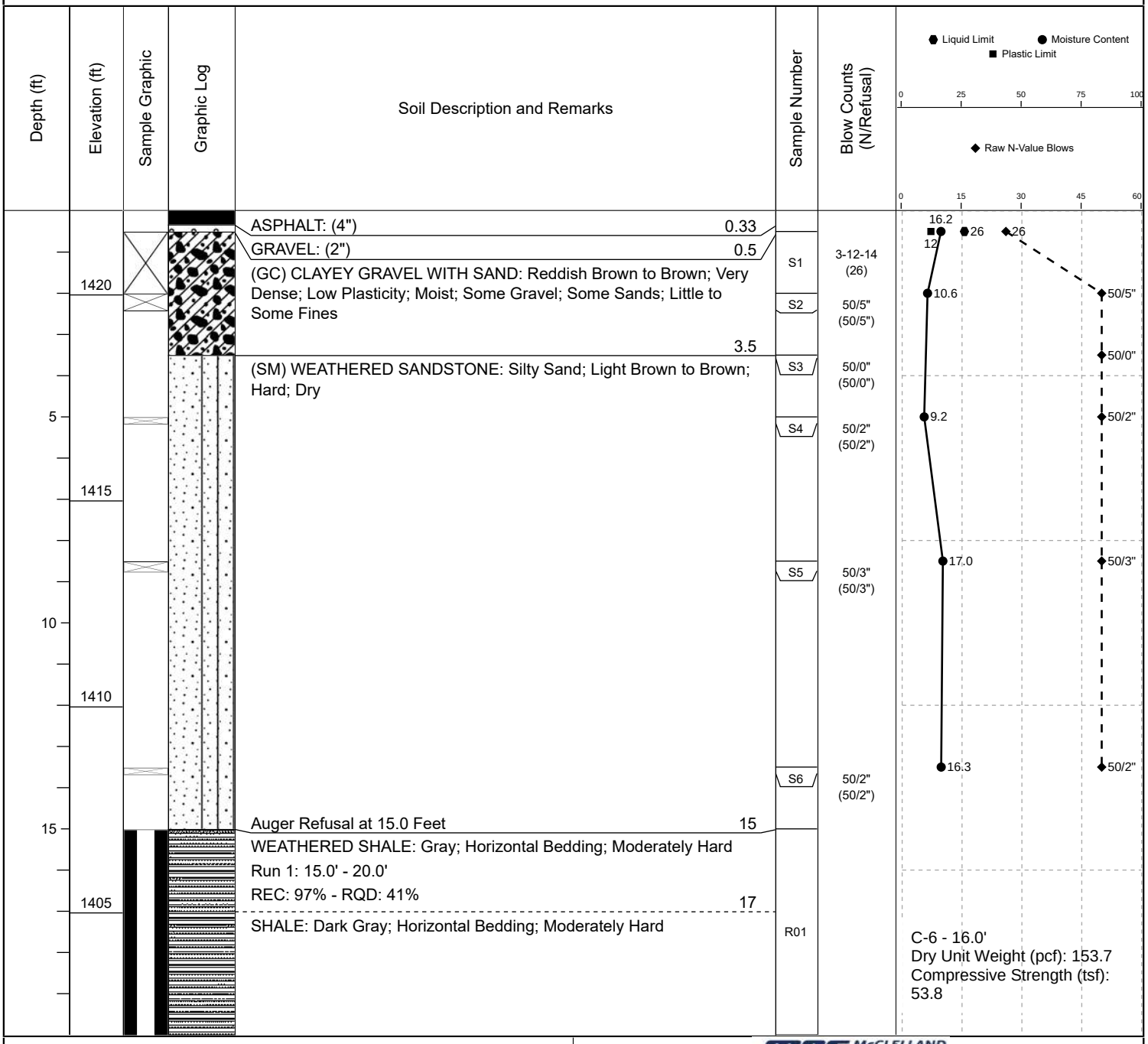
156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-07

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064605, -94.173278
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1422.04'
Drill Rig:	CME-45B	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE



Boring Date: **05/22/2026**
Logged By: **Caedmon Chiddister**
Drilled By: **Joel Ruble**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-07

Dillard Hall

156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-07

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064605, -94.173278
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1422.04'
Drill Rig:	CME-45B	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE

Depth (ft)	Elevation (ft)	Sample Graphic	Graphic Log	Soil Description and Remarks	Sample Number	Blow Counts (N/Refusal)	Liquid Limit / Moisture Content / Plastic Limit; Raw N-Value Blows
25	1400			SHALE: Dark Gray; Horizontal Bedding; Moderately Hard Run 2: 20.0' - 25.0' REC: 98% - RQD: 67%'	R02		C-7 - 24.0' Dry Unit Weight (pcf): 159.4 Compressive Strength (tsf): 62.8

End of Boring at 25.0 Feet

Boring Date: **05/22/2026**
Logged By: **Caedmon Chiddister**
Drilled By: **Joel Ruble**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-07

Dillard Hall

156 N Buchanan Ave, Fayetteville, AR 72701, USA

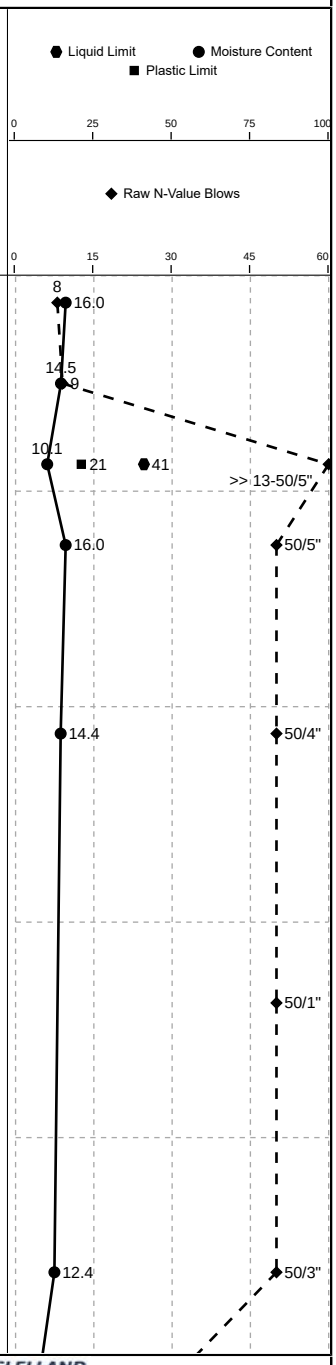
Project No.: 26-3843

Dillard Hall

Soil Boring: B-08

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064762, -94.173205
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1422.22'
Drill Rig:	CME-45B	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Sample Number	Blow Counts (N/Refusal)
		CONCRETE: (6") 0.5		
	1420	(GC) CLAYEY GRAVEL WITH SAND: Reddish Brown to Brown; Loose to Medium Dense; Moderate Plasticity; Moist	S1	3-4-4 (8)
		Medium Dense	S2	4-4-5 (9)
		Brown; Very Dense; Dry; Mostly Gravel; Little Sands; Little to Some Fines 5	S3	4-13-50/5" (13-50/5")
5	1415	(SM) WEATHERED SANDSTONE: Light Brown to Brown; Moderately Hard; Dry	S4	43-50/5" (50/5")
			S5	50/4" (50/4")
10	1410			
		Moderately Hard to Hard	S6	50/1" (50/1")
15	1405	18.5		
		WEATHERED SHALE: Gray; Horizontal Bedding; Moderately Hard to Hard; Moist	S7	43-50/3" (50/3")



Boring Date: **05/22/2026**
Logged By: **Caedmon Chiddister**
Drilled By: **Joel Ruble**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-08

Dillard Hall

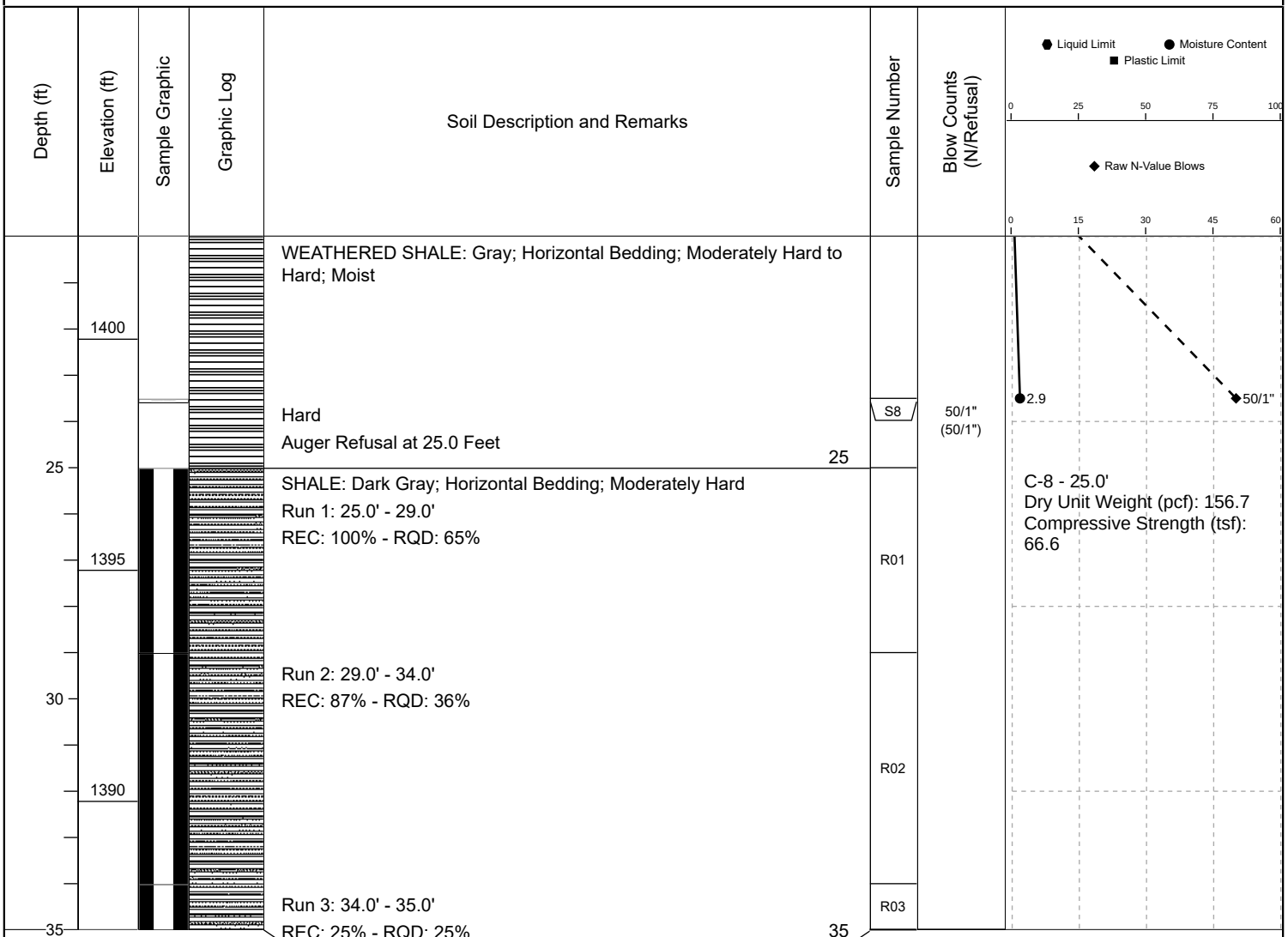
156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-08

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064762, -94.173205
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1422.22'
Drill Rig:	CME-45B	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE



Boring Date: **05/22/2026**
Logged By: **Caedmon Chiddister**
Drilled By: **Joel Ruble**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-08

Dillard Hall

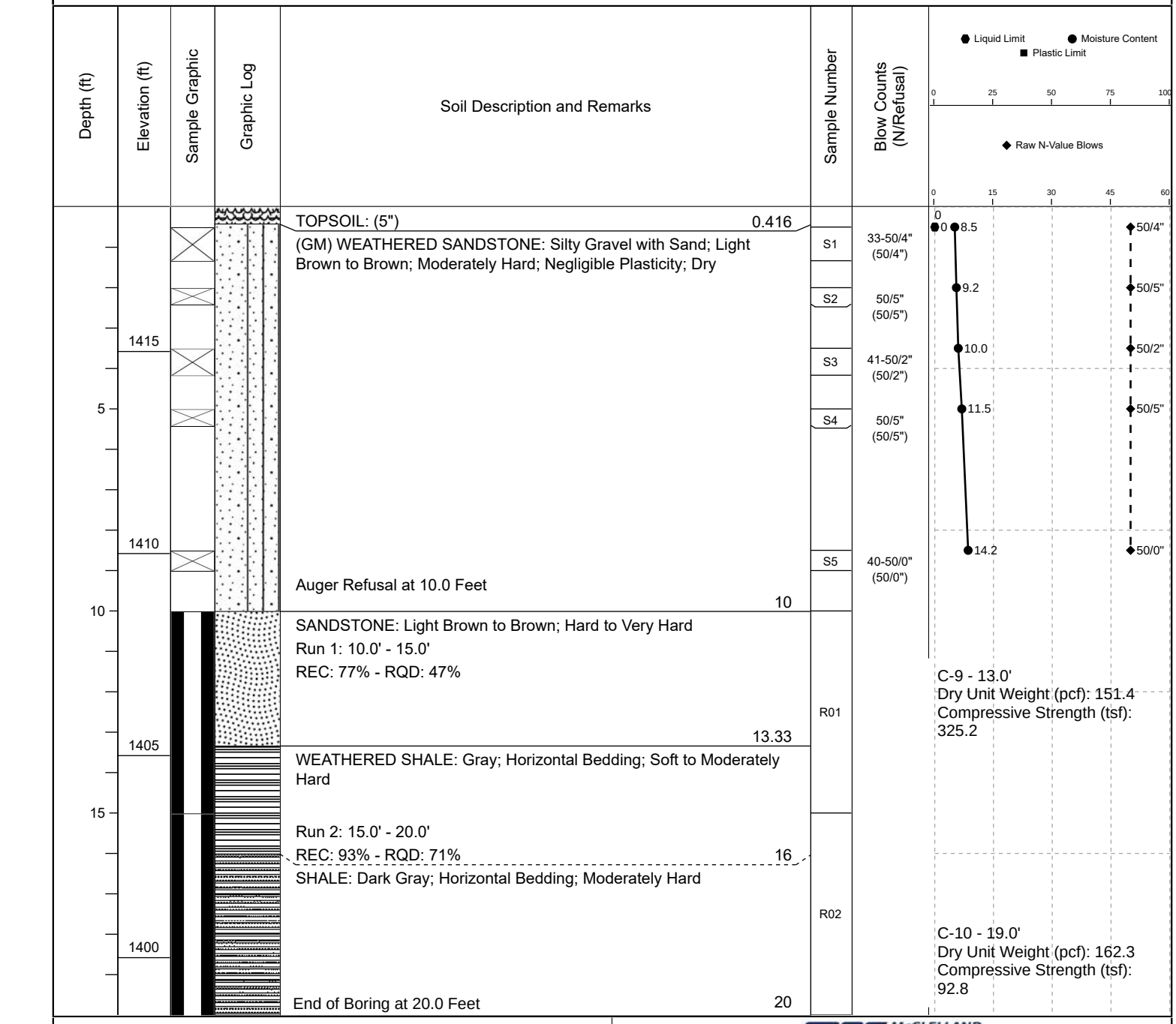
156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-09

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064945, -94.173204
Date Started:	05/22/2026	Date Completed:	05/22/2026	Ground Elev.:	1418.58'
Drill Rig:	Diedrich D-50	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE



Boring Date: **05/22/2026**
Logged By: **Chayse Dean**
Drilled By: **Brooks Johnson**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-09

Dillard Hall

156 N Buchanan Ave, Fayetteville, AR 72701, USA

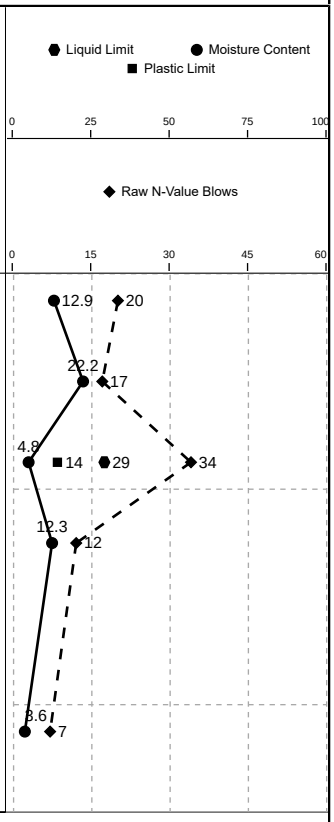
Project No.: 26-3843

Dillard Hall

Soil Boring: B-10

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.065002, -94.173606
Date Started:	05/26/2026	Date Completed:	05/26/2026	Ground Elev.:	1432.58'
Drill Rig:	CME-45B	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Sample Number	Blow Counts (N/Refusal)
		TOPSOIL: (4") 0.33		
	1430	(GC) CLAYEY GRAVEL WITH SAND: Brown; Medium Dense; Low to Moderate Plasticity; Dry	S1	5-8-12 (20)
		Reddish Brown to Brown; Moist	S2	10-10-7 (17)
		3.5		
5		(SC) CLAYEY SAND WITH GRAVEL: Reddish Brown to Brown; Dense; Low Plasticity; Moist; Some Gravel; Some Sands; Little Fines	S3	4-6-28 (34)
		Medium Dense	S4	10-7-5 (12)
	1425	8.5		
10		(GM) SILTY GRAVEL WITH SAND: Light Gray and Brown; Loose; Negligible Plasticity; Dry 10	S5	4-3-4 (7)



End of Boring at 10.0 Feet

Boring Date: **05/26/2026**
Logged By: **Caedmon Chiddister**
Drilled By: **Joel Ruble**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-10

Dillard Hall

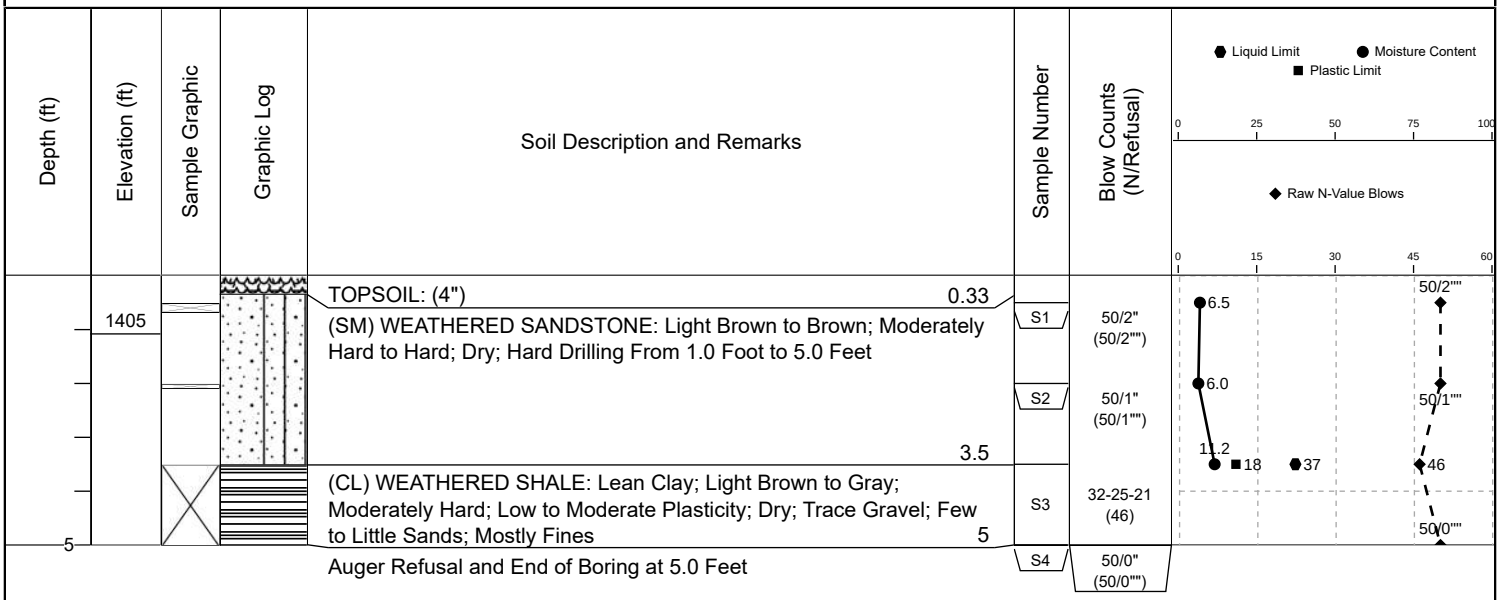
156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

Dillard Hall

Soil Boring: B-11

Project Number:	26-3843	Client Name:	University of Arkansas	Coordinates:	36.064937, -94.172844
Date Started:	05/26/2026	Date Completed:	05/26/2026	Ground Elev.:	1406.08'
Drill Rig:	CME-45B	Drilling Method:	Auger / Rock Coring	Tooling:	SPT Sampler & Rock Core
Hammer Type:	Auto	Hammer Weight:	140-lbs	Drilling Firm:	MCE



Boring Date:	**05/26/2026**
Logged By:	**Caedmon Chiddister**
Drilled By:	**Joel Ruble**

Water Level

Depth	Hour	Date
N/A	-	-
N/A	-	-

Log of Soil Boring: B-11

Dillard Hall

156 N Buchanan Ave, Fayetteville, AR 72701, USA

Project No.: 26-3843

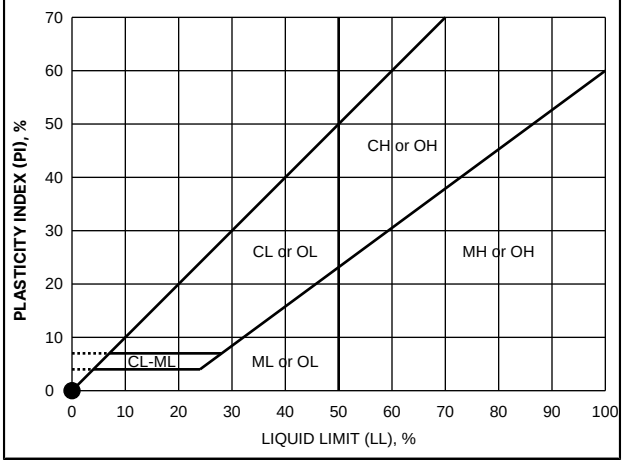
SOIL CLASSIFICATION CHART PER ASTM D 2488

PRIMARY DIVISIONS			SECONDARY DIVISIONS	
			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVEL more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly-graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly-graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly-graded GRAVEL with clay
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction retained on No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly-graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly-graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly-graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	SILT and CLAY liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic CLAY
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above 'A'-line)	organic CLAY
			OH (plots below 'A'-line)	organic SILT
	Highly Organic Soils		PT	Peat

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

PLASTICITY CHART



APPARENT DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPOOLING CABLE OR CATHEAD		AUTOMATIC TRIP HAMMER	
	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	3 - 8	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 23	15 - 42
Dense	31 - 50	64 - 105	23 - 38	43 - 70
Very Dense	> 50	> 105	> 38	> 70

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPOOLING CABLE OR CATHEAD		AUTOMATIC TRIP HAMMER	
	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)
Very Soft	< 2	< 3	< 2	< 2
Soft	2 - 4	3 - 5	2 - 3	2 - 3
Medium Stiff	5 - 8	6 - 10	3 - 6	4 - 6
Stiff	9 - 15	11 - 20	6 - 12	7 - 13
Very Stiff	16 - 30	21 - 39	12 - 23	14 - 26
Hard	> 30	> 39	> 23	> 26

McCLELLAND CONSULTING ENGINEERS
DESIGNED TO SERVE
an ESP COMPANY

1580 East Stearns Street
Fayetteville, Arkansas 72703
mce.us.com

Appendix C:
LABORATORY RESULTS

LABORATORY RESULTS SUMMARY

PROJECT Dillard Hall
PROJECT NO. 26-3843
LOCATION 1 University of Arkansas
CLIENT University of Arkansas

Boring ID	Sample ID	Moisture Content (%)	LL	PL	PI	Gravel (%)	Sand (%)	Fines (%)	USCS	USCS Description
B-01	S1	12	23	15	8	13	35	52	CL	Sandy Lean CLAY
B-01	S2	14								
B-01	S3	22								
B-01	S4	6								
B-01	S5	9								
B-01	S6	14								
B-01	R01									
B-01	R02									
B-02	S1	16								
B-02	S2	13	27	16	11	28	30	41	SC	Clayey SAND with...
B-02	S3	12								
B-02	S4	12								
B-02	S5	13								
B-02	S6	13								
B-02	R01									
B-02	R02									
B-03	S1	15								
B-03	S2	15								
B-03	S3	15	27	13	14	15	35	50	CL	Sandy Lean CLAY
B-03	S4	15								
B-03	S5	8								
B-03	R01									
B-03	R02									
B-03	R03									
B-04	S1	6								
B-04	S2	7								
B-04	S3	9								
B-04	S4	13	NP	NP	NP	8	71	21	SM	Silty SAND
B-04	S5	12								
B-04	S6	14								
B-04	R01									

LABORATORY RESULTS SUMMARY

PROJECT Dillard Hall
PROJECT NO. 26-3843
LOCATION 1 University of Arkansas
CLIENT University of Arkansas

Boring ID	Sample ID	Moisture Content (%)	LL	PL	PI	Gravel (%)	Sand (%)	Fines (%)	USCS	USCS Description
B-04	R02									
B-05	S1	12								
B-05	S2	11	NP	NP	NP	32	45	23	SM	Silty SAND with...
B-05	S3	13								
B-05	S4	12								
B-05	R01									
B-05	R02									
B-06	S1	9								
B-06	S2	6								
B-06	S3	12								
B-06	S4	14								
B-06	S5	13								
B-06	S6	13	36	19	17	2	23	75	CL	Lean CLAY with...
B-06	R01									
B-06	R02									
B-07	S1	16	26	12	14	37	34	29	GC	Clayey GRAVEL with...
B-07	S2	11								
B-07	S4	9								
B-07	S5	17								
B-07	S6	16								
B-07	R01									
B-07	R02									
B-08	S1	16								
B-08	S2	15								
B-08	S3	10	41	21	20	52	22	26	GC	Clayey GRAVEL with...
B-08	S4	16								
B-08	S5	14								
B-08	S7	12								
B-08	S8	3								
B-08	R01									
B-08	R02									

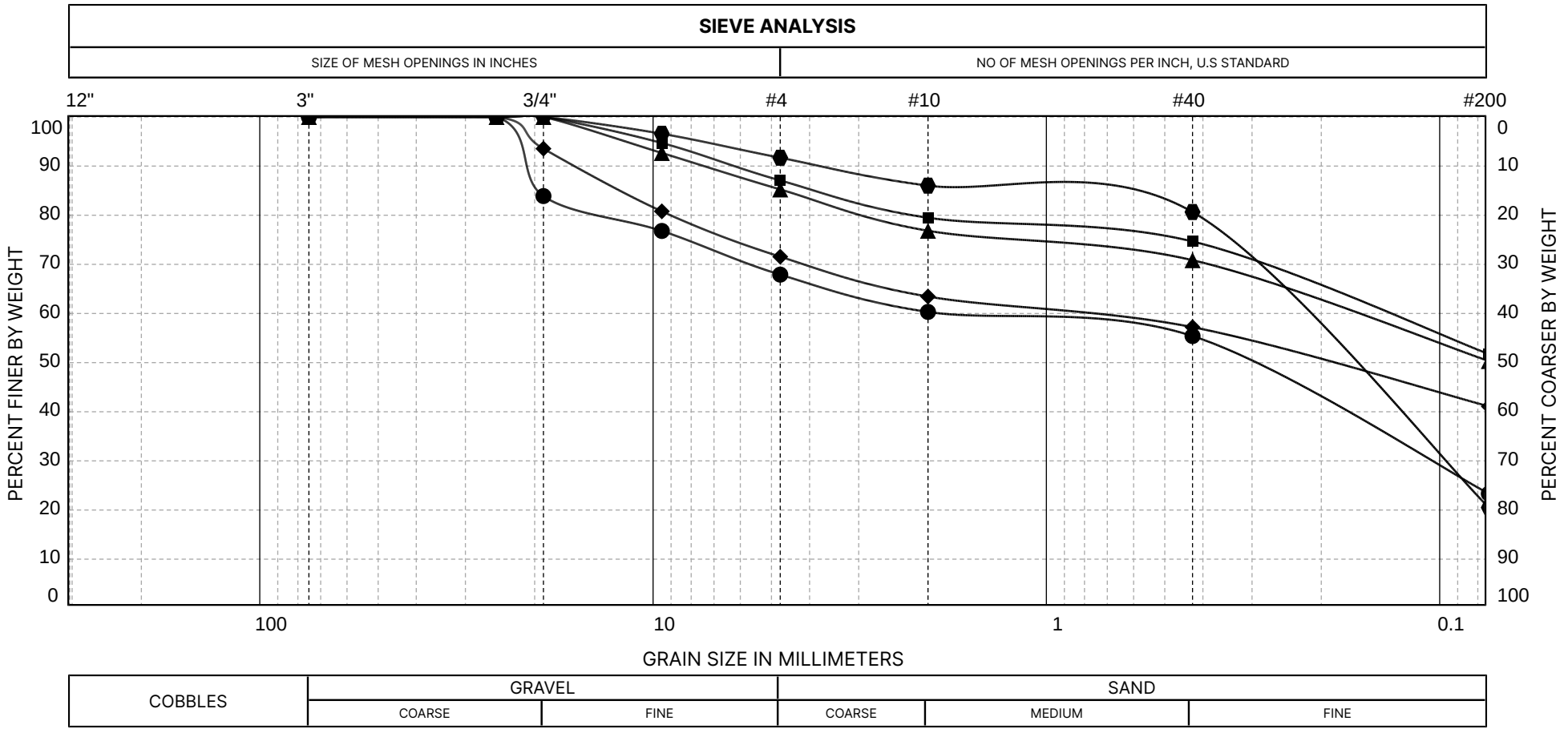
LABORATORY RESULTS SUMMARY

PROJECT Dillard Hall
PROJECT NO. 26-3843
LOCATION 1 University of Arkansas
CLIENT University of Arkansas

Boring ID	Sample ID	Moisture Content (%)	LL	PL	PI	Gravel (%)	Sand (%)	Fines (%)	USCS	USCS Description
B-08	R03									
B-09	S1	9	NP	NP	NP	45	41	14	GM	Silty GRAVEL with...
B-09	S2	9								
B-09	S3	10								
B-09	S4	12								
B-09	S5	14								
B-09	R01									
B-09	R02									
B-10	S1	13								
B-10	S2	22								
B-10	S3	5	29	14	15	41	41	18	SC	Clayey SAND with...
B-10	S4	12								
B-10	S5	4								
B-11	S1	7								
B-11	S2	6								
B-11	S3	11	37	18	19	2	11	86	CL	Lean CLAY

GRAIN SIZE DISTRIBUTION TEST RESULTS

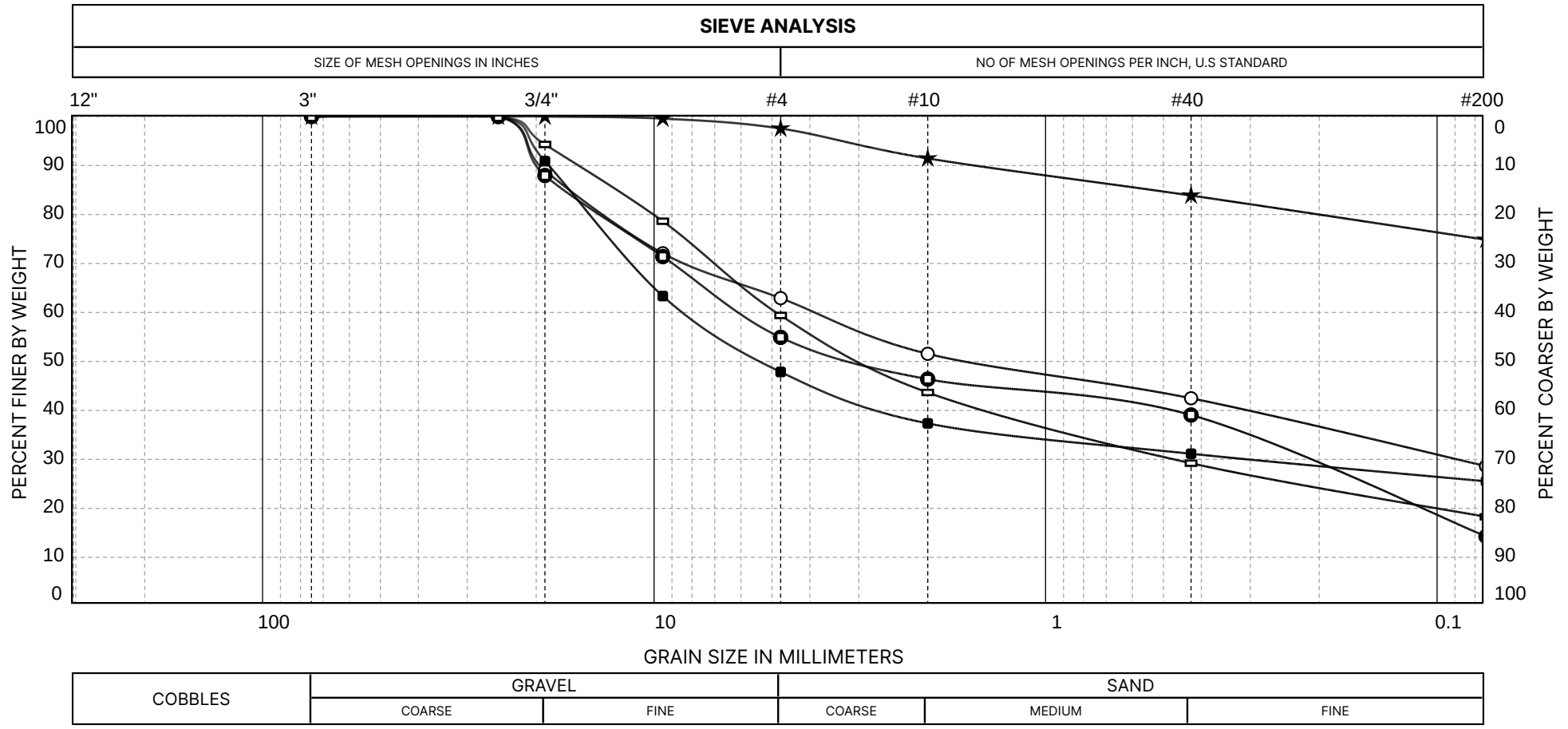
Dillard Hall
1 University of Arkansas



	EXPLORATION NUMBER	SAMPLE NUMBER	Depth'	USCS GROUP NAME	USCS SYMBOL	GRAVEL (%)	SAND (%)	FINES (%)	NAT WC (%)	D10 (mm)	D15 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D75 (mm)	D85 (mm)	D90 (mm)	D100 (mm)
■	B-01	S1	0.5	Sandy Lean CLAY	CL	13	35	52	12	0	0	0.01	0.07	0.13	0.46	3.86	6.19	19
◆	B-02	S2	2	Clayey SAND with gravel	SC	28	30	41	13	0	0	0.02	0.18	0.87	6.32	12.27	16.04	25
▲	B-03	S3	3.5	Sandy Lean CLAY	CL	15	35	50	15	0	0	0.01	0.07	0.15	1.38	4.64	7.42	19
⬢	B-04	S4	5	Silty SAND	SM	8	71	21	13	0.06	0.06	0.1	0.15	0.19	0.3	1.57	3.73	19
●	B-05	S2	2	Silty SAND with gravel	SM	32	45	23	11	0.04	0.05	0.1	0.27	1.88	8.21	19.56	21.06	25

GRAIN SIZE DISTRIBUTION TEST RESULTS

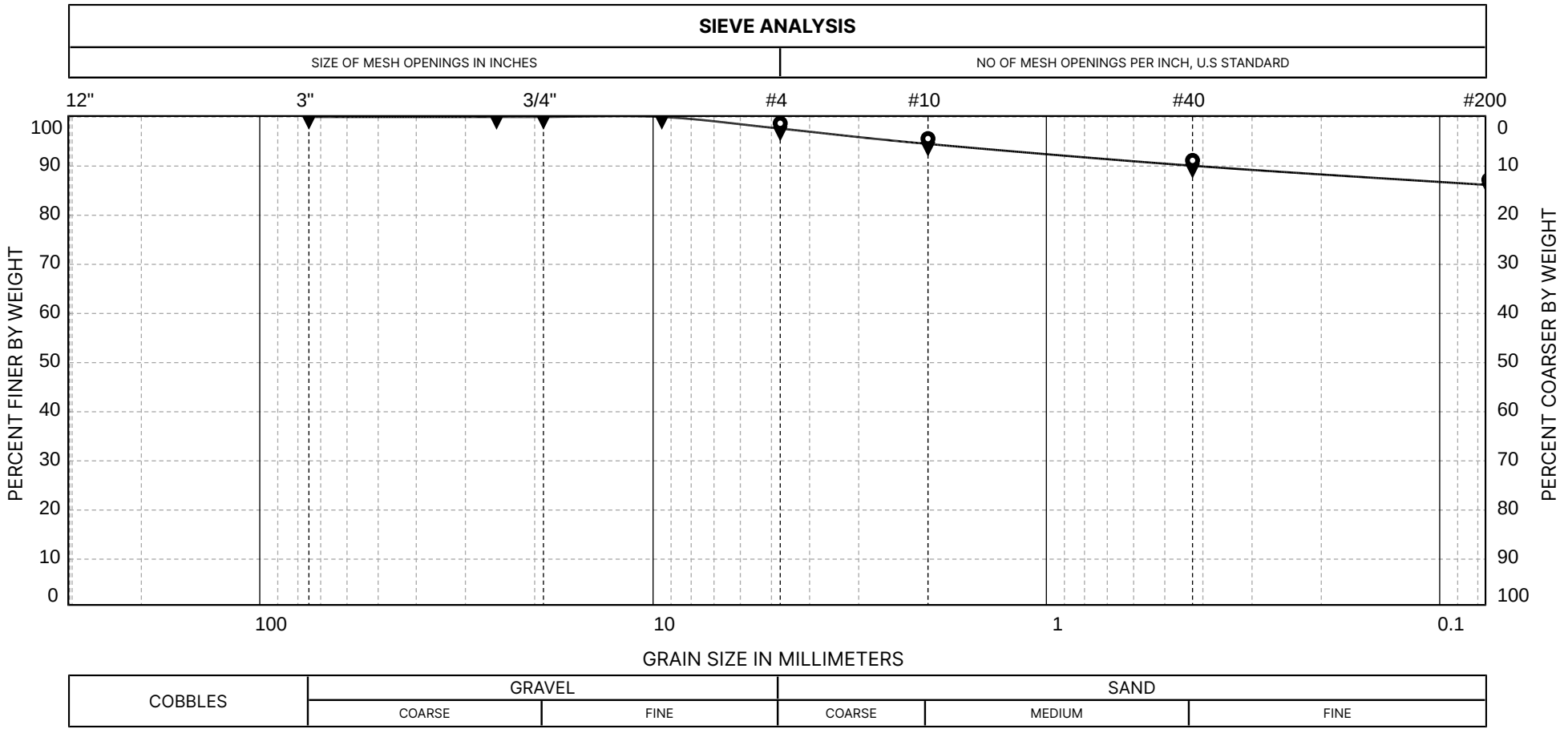
Dillard Hall
1 University of Arkansas



	EXPLORATION NUMBER	SAMPLE NUMBER	Depth'	USCS GROUP NAME	USCS SYMBOL	GRAVEL (%)	SAND (%)	FINES (%)	NAT WC (%)	D10 (mm)	D15 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D75 (mm)	D85 (mm)	D90 (mm)	D100 (mm)
★	B-06	S6	13	Lean CLAY with sand	CL	2	23	75	13	0	0	0	0	0	0.08	0.54	1.55	19
○	B-07	S1	0.5	Clayey GRAVEL with sand	GC	37	34	29	16	0.01	0.01	0.09	1.66	3.85	11.13	16.77	19.51	25
■	B-08	S3	3.5	Clayey GRAVEL with sand	GC	52	22	26	10	0	0	0.31	5.38	8.41	12.95	16.31	18.52	25
●	B-09	S1	0.5	Silty GRAVEL with sand	GM	45	41	14	9	0.06	0.08	0.2	3.14	6.12	11.2	17.35	19.9	25
□	B-10	S3	3.5	Clayey SAND with gravel	SC	41	41	18	5	0.02	0.04	0.47	2.99	4.88	8.29	12.41	15.54	25

GRAIN SIZE DISTRIBUTION TEST RESULTS

Dillard Hall
1 University of Arkansas



EXPLORATION NUMBER	SAMPLE NUMBER	Depth'	USCS GROUP NAME	USCS SYMBOL	GRAVEL (%)	SAND (%)	FINES (%)	NAT WC (%)	D10 (mm)	D15 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D75 (mm)	D85 (mm)	D90 (mm)	D100 (mm)
B-11	S3	3.5	Lean CLAY	CL	2	11	86	11	0	0	0	0	0	0	0.05	0.41	9.5

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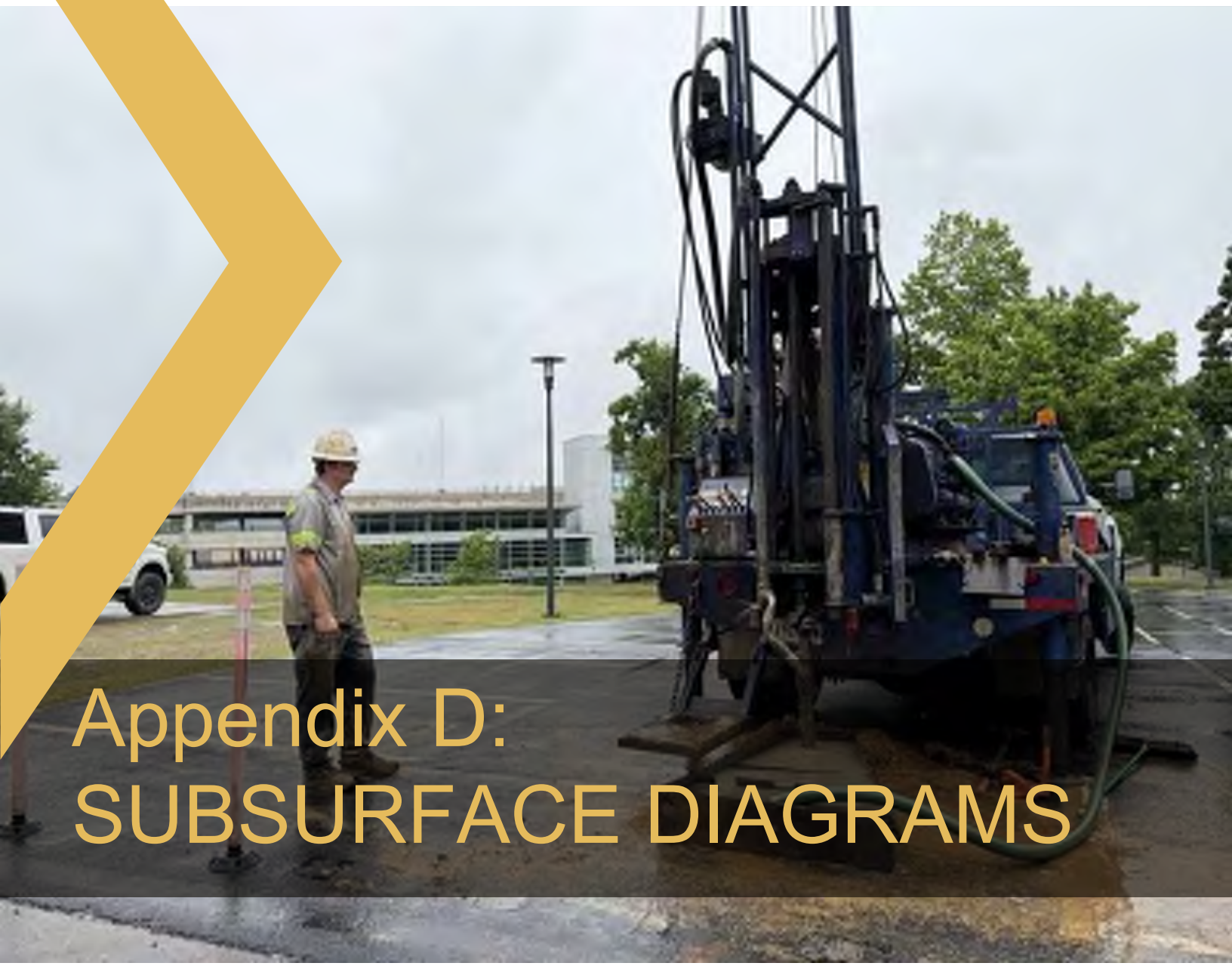

Appendix D: SUBSURFACE DIAGRAMS

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PROJECT NUMBER
26-3843

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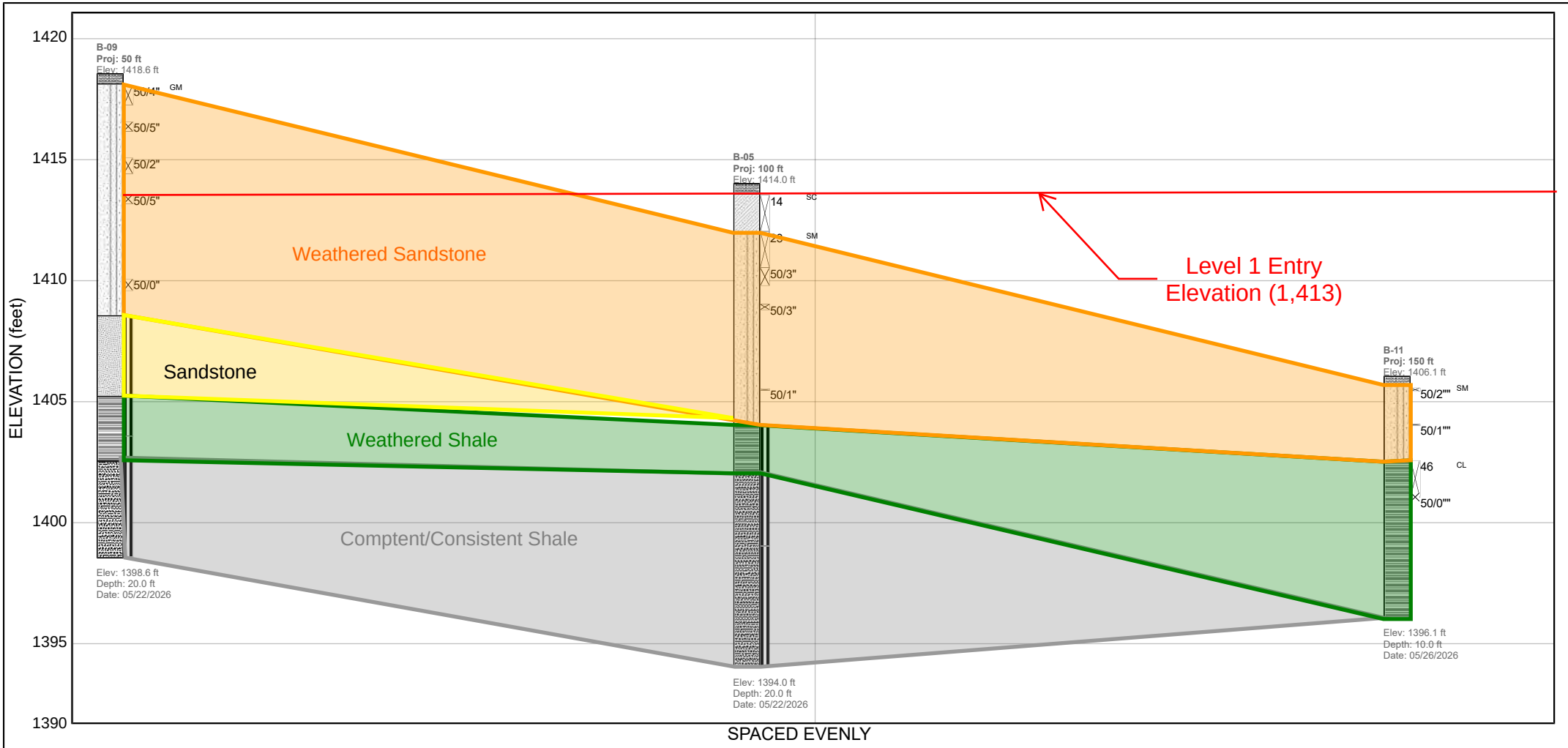
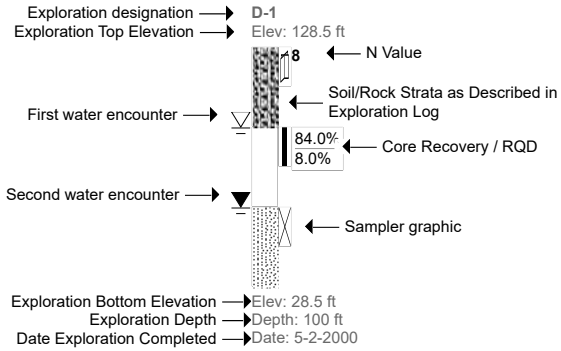
Fayetteville, Arkansas

PLATE 28



EXPLORATION LOG LEGEND



LEGEND KEY

- GM
- Sandstone
- SC
- Shale
- Topsoil
- weathered shale

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CROSS SECTIONS REPORT

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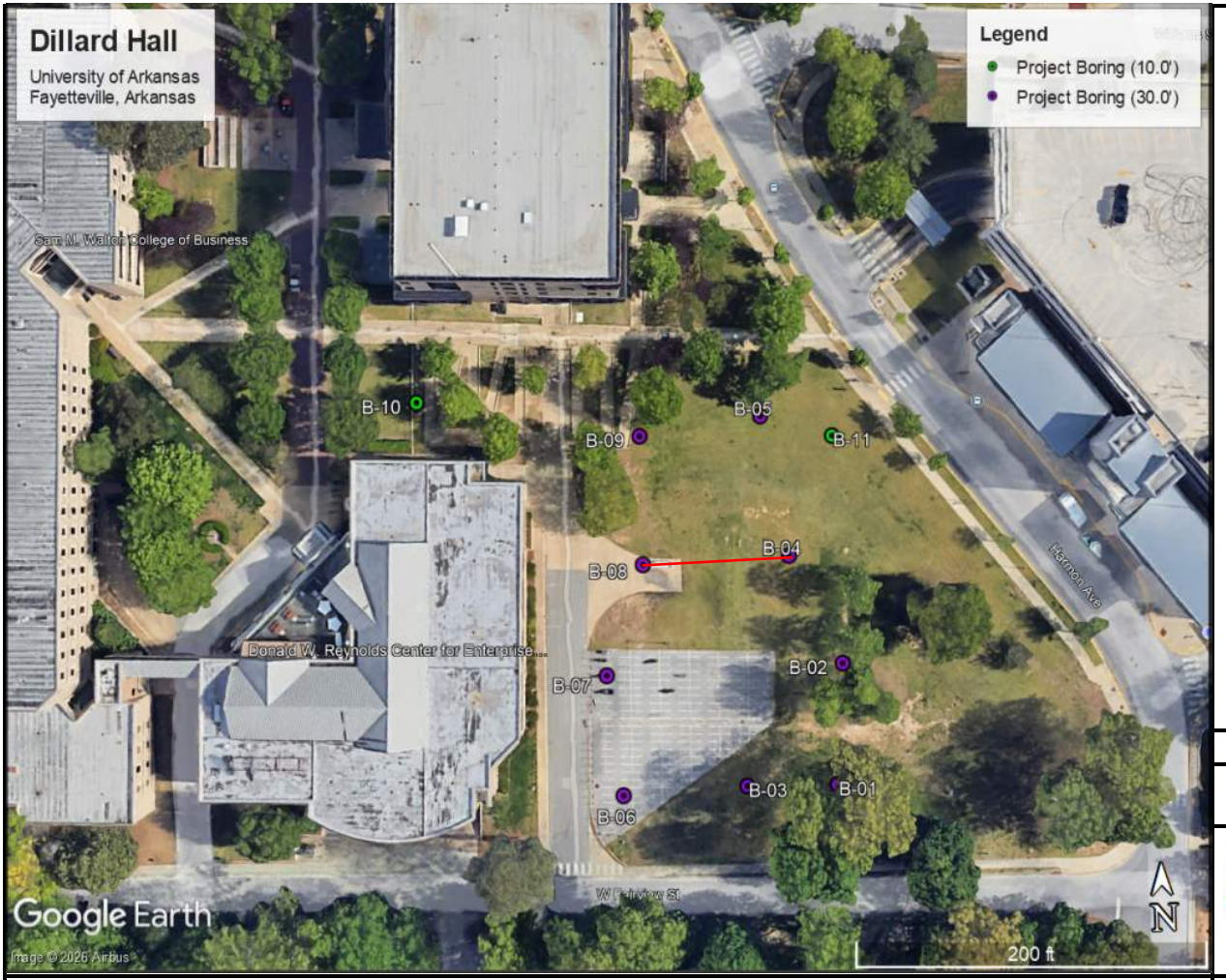
PLATE 29



UNIVERSITY OF ARKANSAS

PROJECT NUMBER
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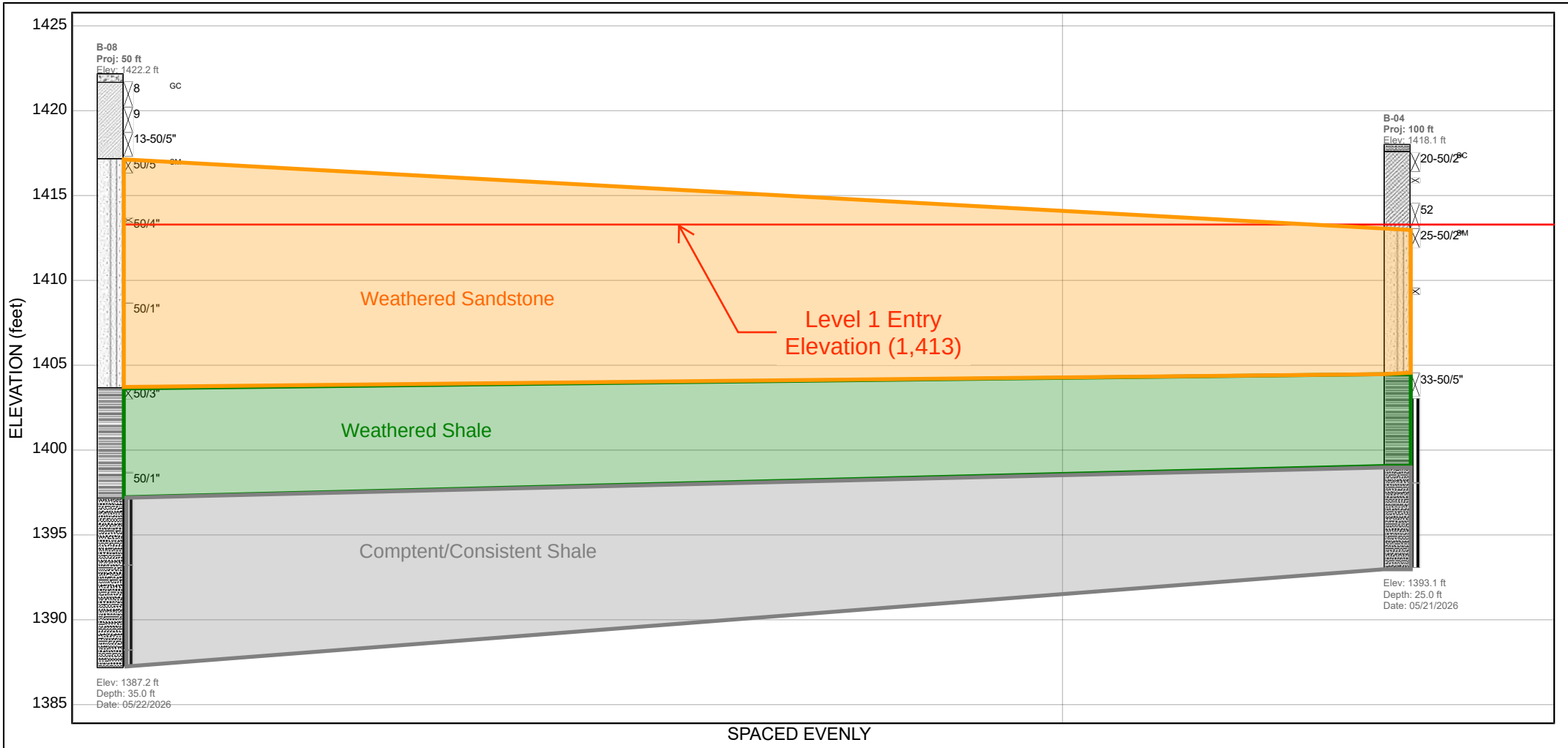
Dillard Hall
Fayetteville, Arkansas

PLATE 30



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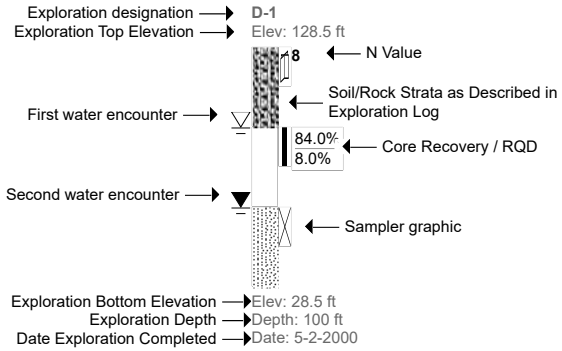

LEGEND KEY

- Concrete
- GC
- SC
- Shale
- SM
- Topsoil
- weathered shale

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CROSS SECTIONS REPORT

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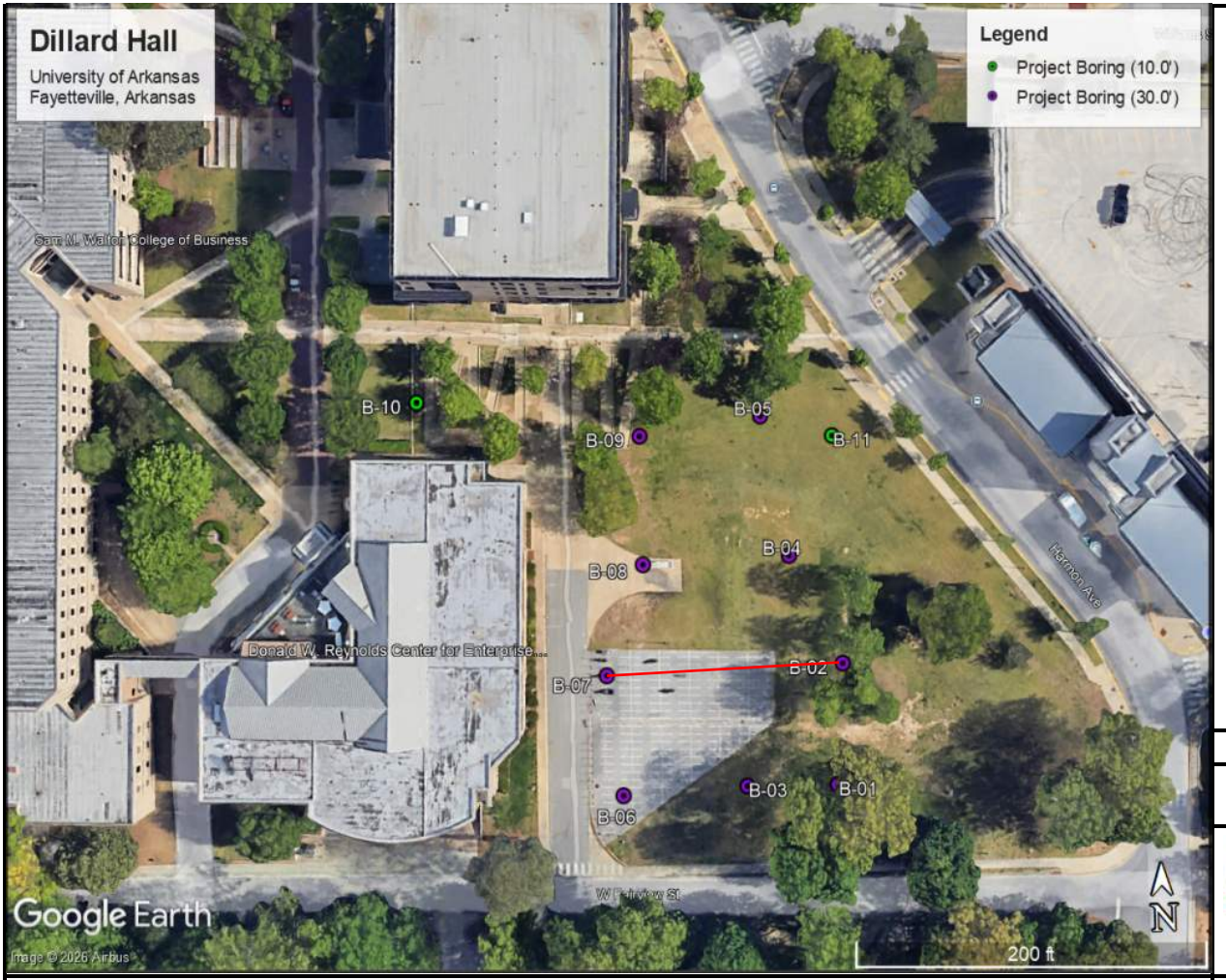
PLATE 31



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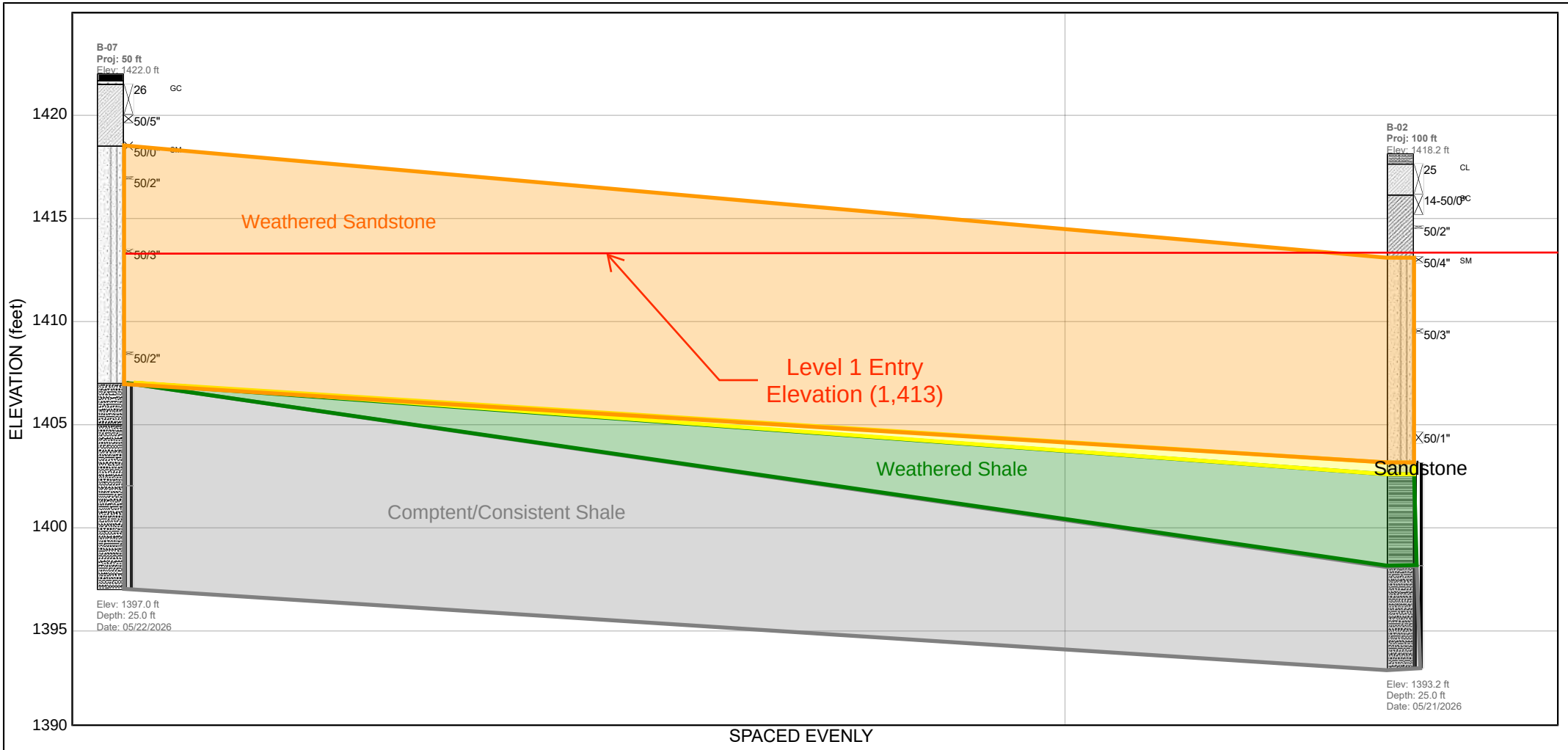
Fayetteville, Arkansas

PLATE 32



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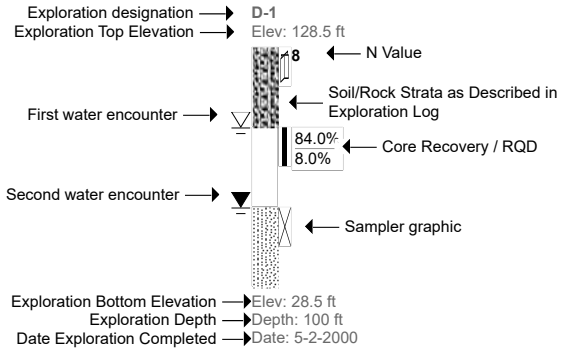

LEGEND KEY

- Asphalt
- GC
- Gravel
- Sandstone
- SC
- SM
- Topsoil
- WEATHERED SHALE
- WEATHERED SHALE

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PLATE 33

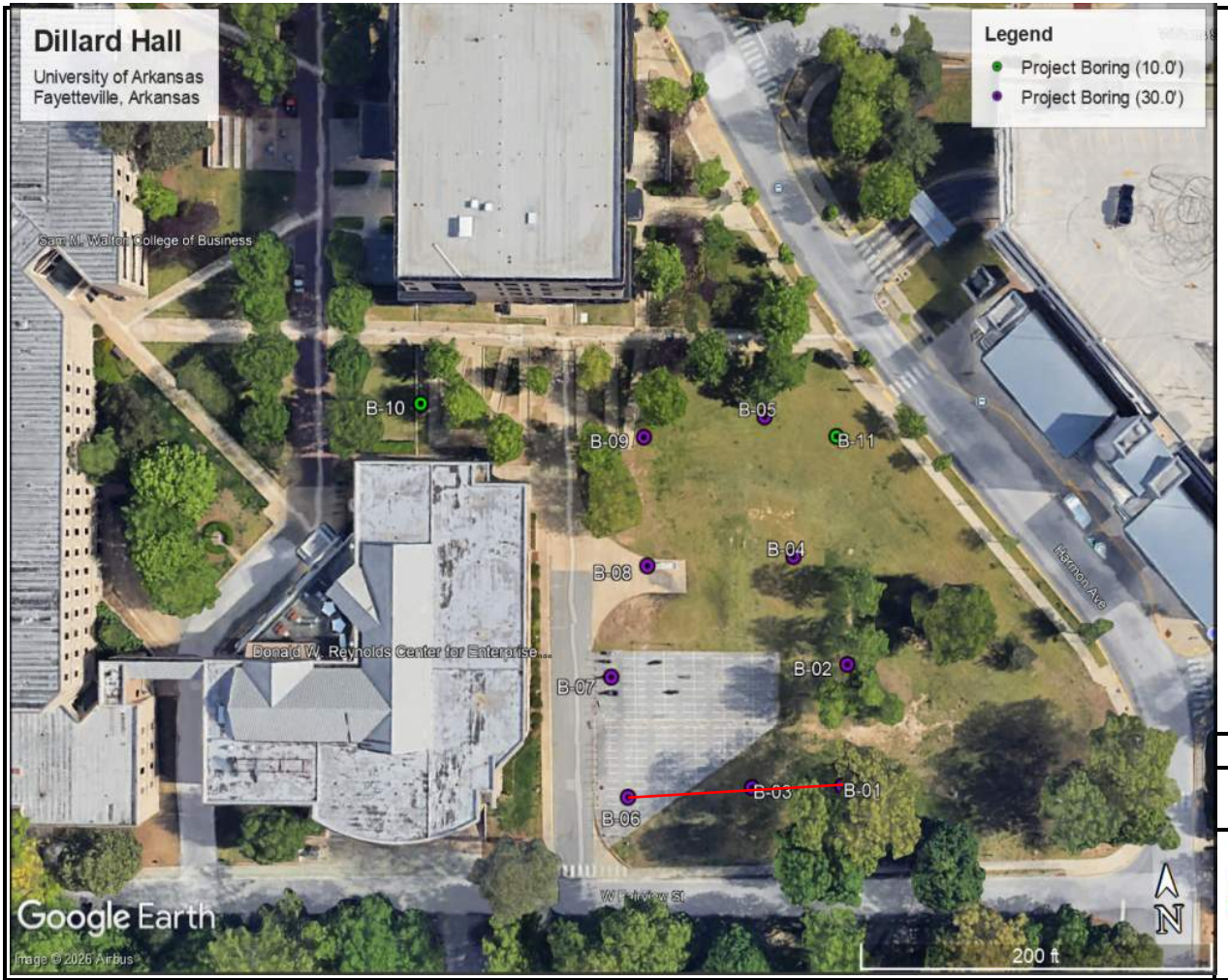

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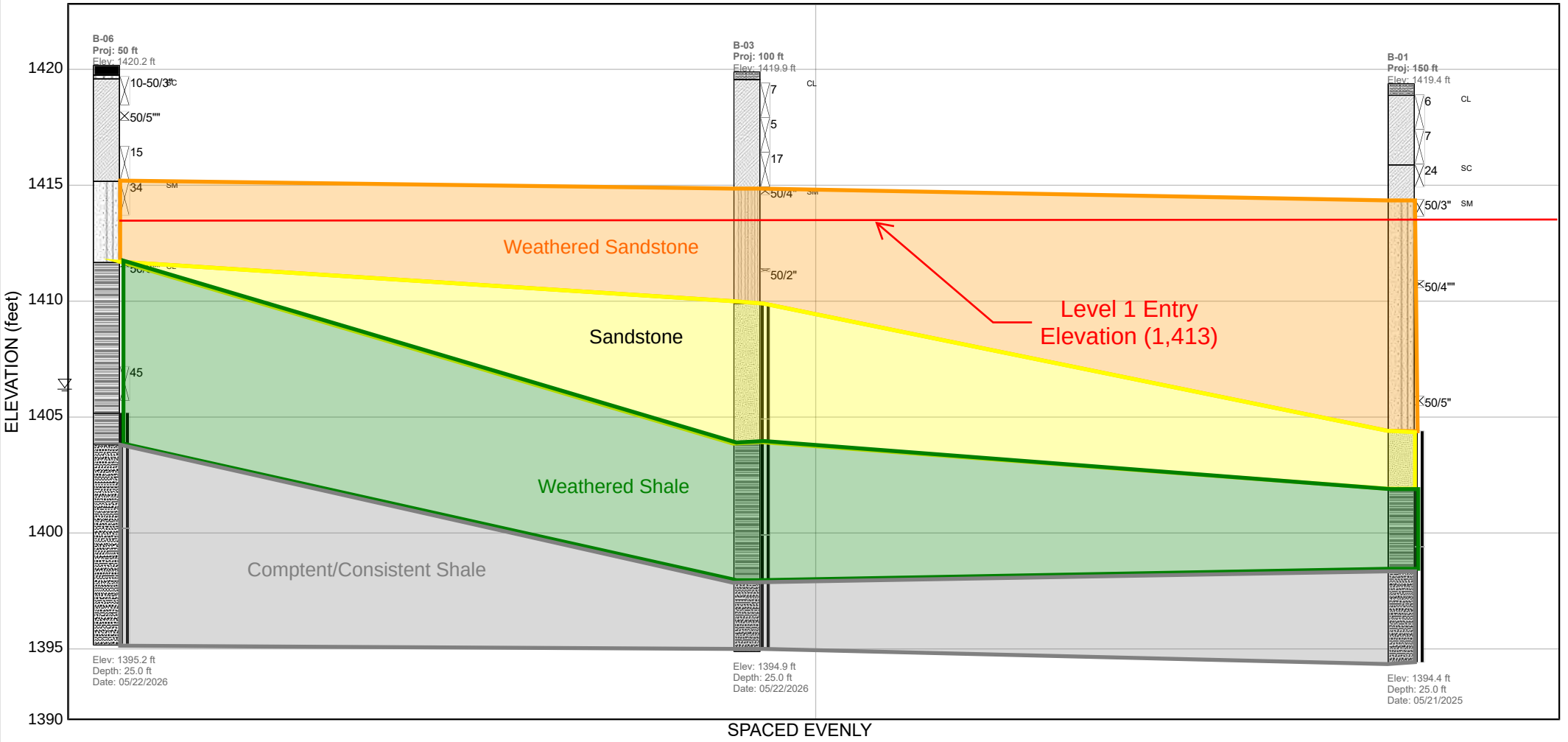
PLATE 34



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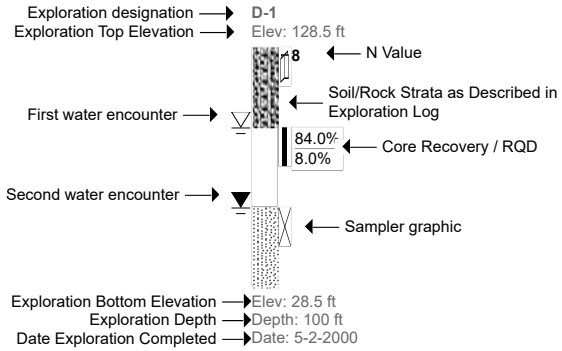

LEGEND KEY

- Asphalt
- CL
- Gravel
- Sandstone
- SC
- Shale
- SM
- SM
- Topsoil

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PLATE 35

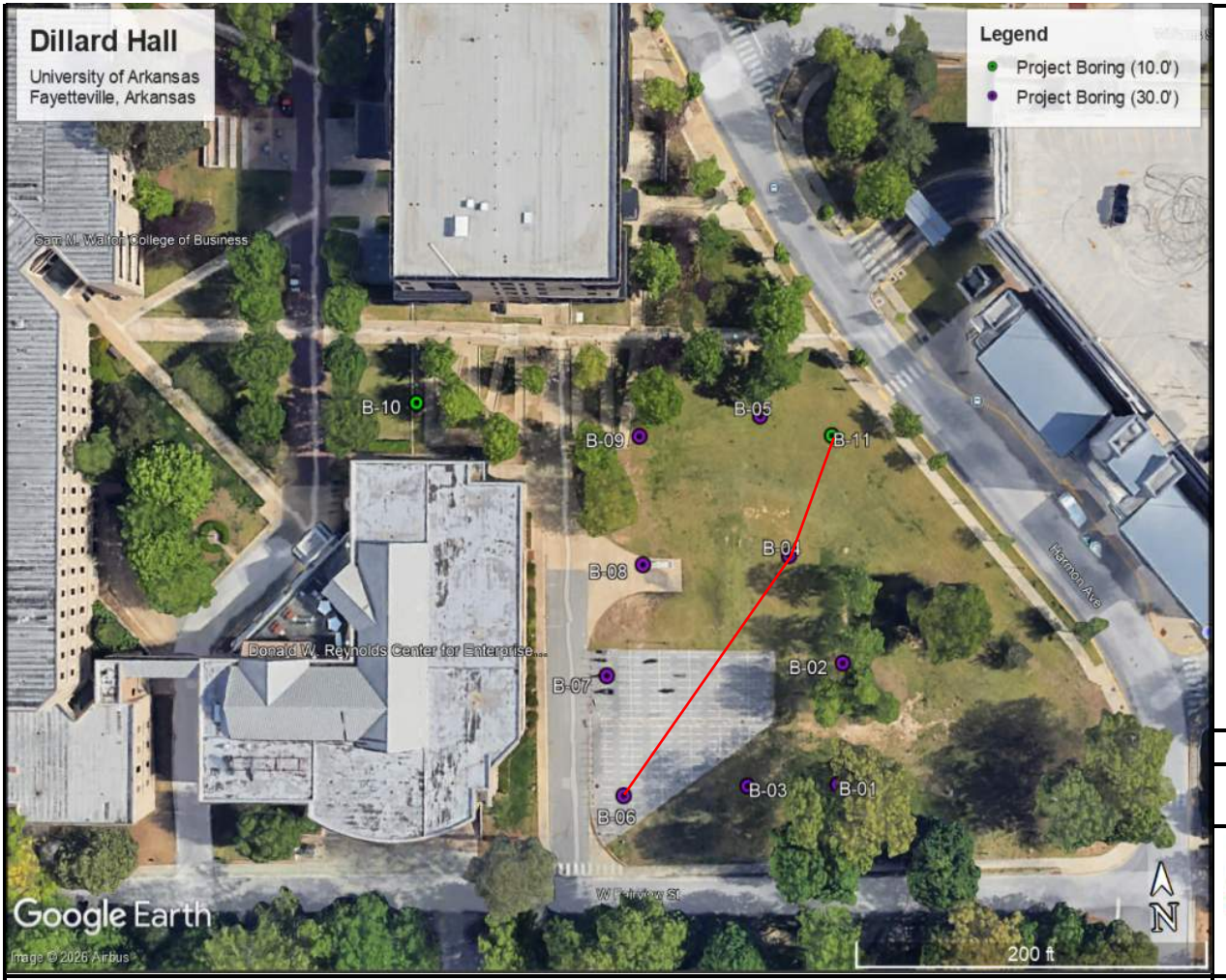

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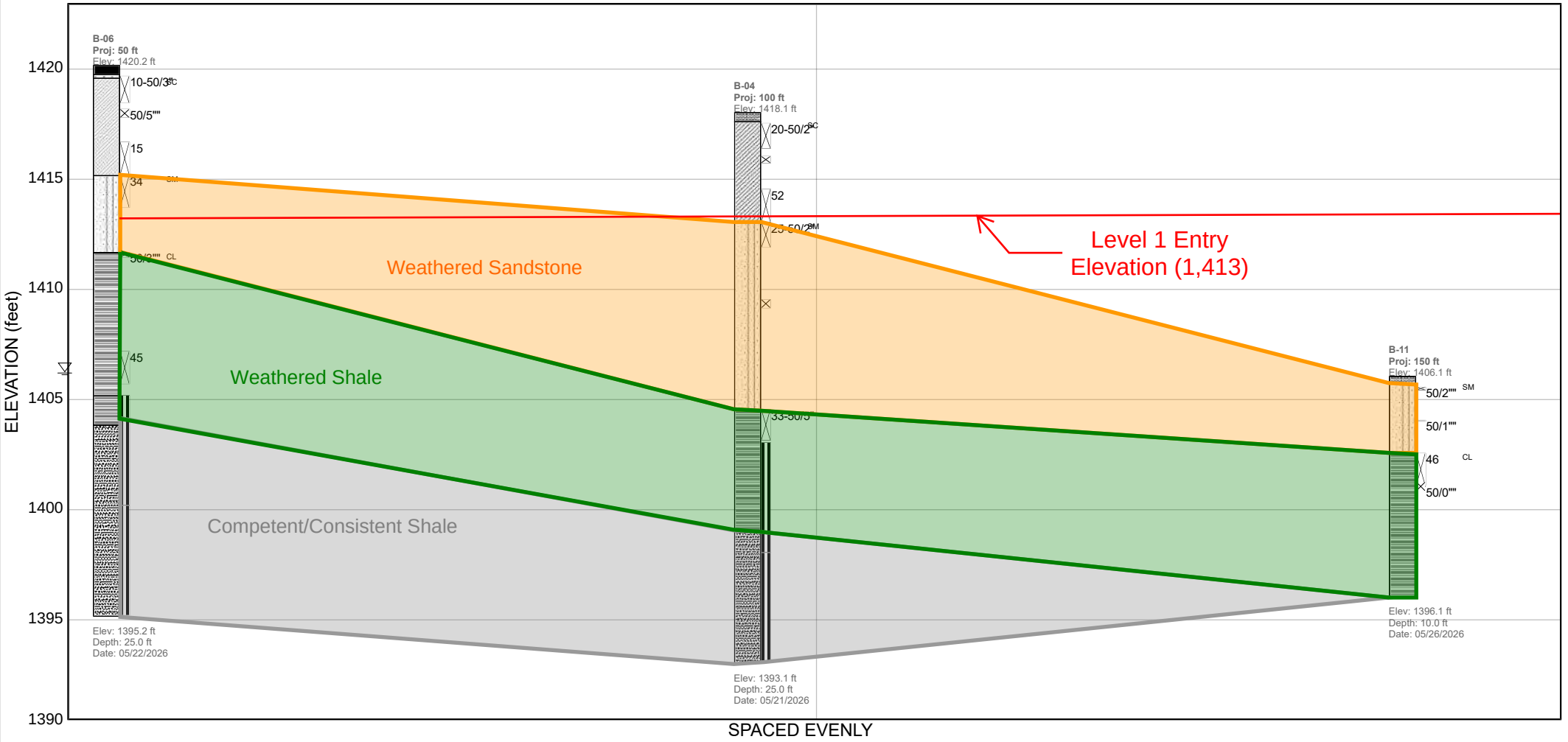
PLATE 36



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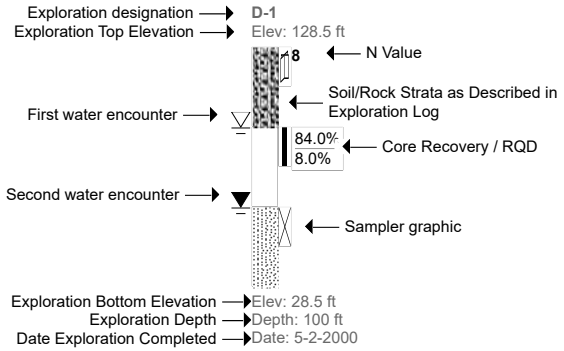
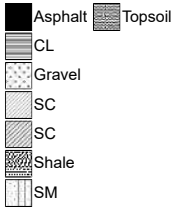


LEGEND KEY



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APPENDIX E:
CORE REPORTS

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Project Name: Dillard Hall
Project Number: 26-3843
Date Drilled/Cored: 05/21/2026

Rock Core Sample: Run #1 and #2
Rock Core Depths: 15.0’ – 25.0’
Boring Number: B-01

Comments:	Rock Descriptions:	Rock Coring Information:
Sandstone Transitions to Weathered Shale at 17.5’ and Weathered Shale Transition to Shale at 21.0’ within B-01.	Sandstone – Light Brown to Brown; Hard Weathered Shale – Gray; Horizontal Bedding; Soft Shale – Dark Gray with Horizontal Bedding; Moderately Hard	Run #1: REC = 94% RQD = 44% Run #2: REC = 100% RQD = 70%

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Rock Core Sample: Run #1 and #2
Rock Core Depths: 15.0’ – 25.0’
Boring Number: B-02

Comments:	Rock Descriptions:	Rock Coring Information:
Sandstone Transitions to Weathered Shale at 15.5’ and Weathered Shale Transition to Shale at 20.0’ within B-02.	Sandstone – Light Brown to Brown; Hard Weathered Shale – Gray; Horizontal Bedding; Soft to Moderately Hard Shale – Dark Gray; Horizontal Bedding; Moderately Hard	Run #1: REC = 98% RQD = 45% Run #2: REC = 97% RQD = 70%

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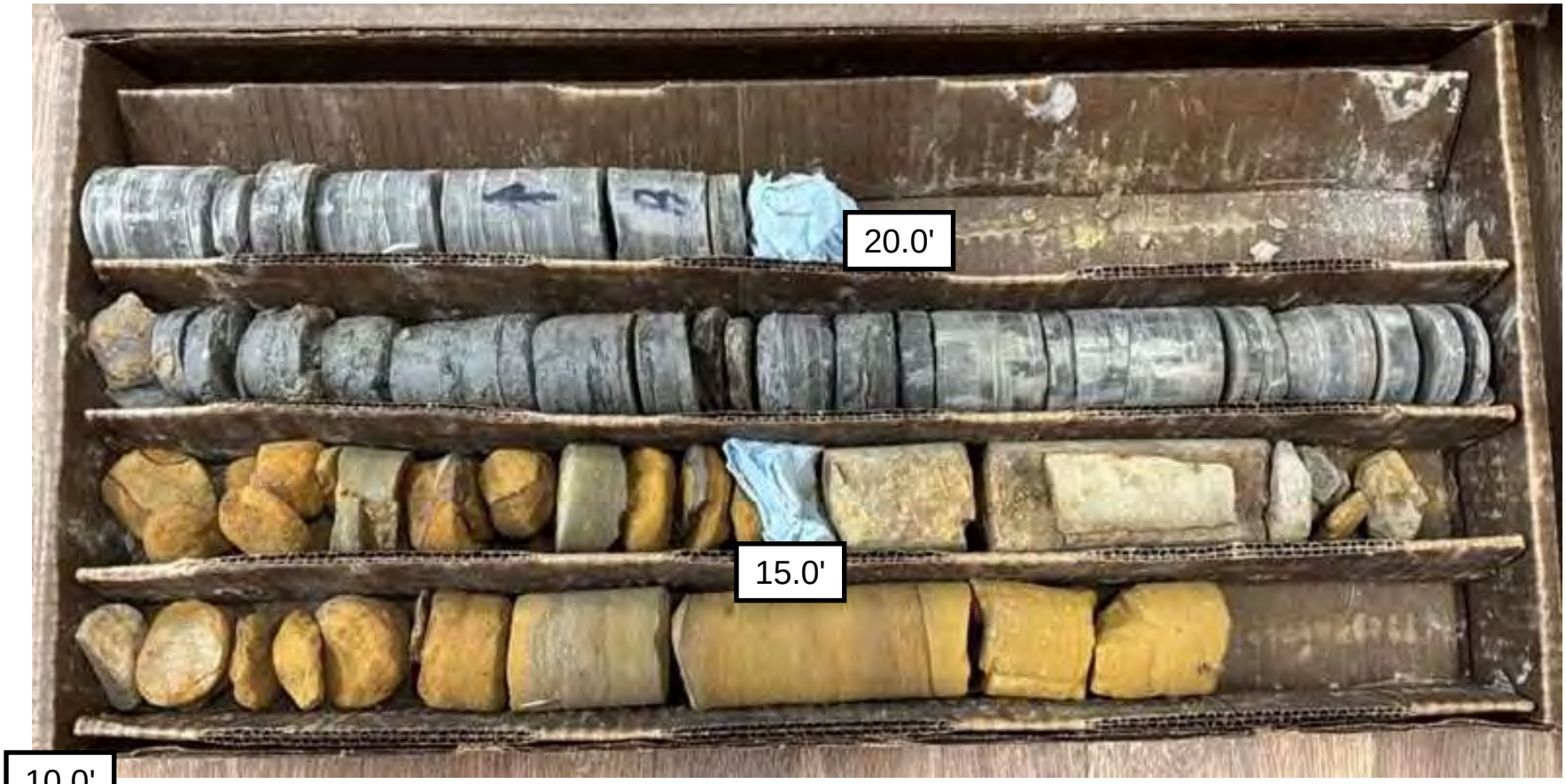
Date Drilled/Cored: 05/21/2026

Rock Core Sample: Run #1 and #2
Rock Core Depths: 10.0’ – 20.0’
Boring Number: B-03



Comments:	Rock Descriptions:	Rock Coring Information:
Sandstone Transitions to Weathered Shale at 16.0’ and Weathered Shale to Shale at 22.0’ within B-03.	Sandstone – Light Brown to Brown Weathered Shale – Gray; Horizontal Bedding; Soft to Moderately Hard	Run #1: REC = 60% RQD = 41% Run #2: REC = 75% RQD = 35%

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Project Name: Dillard Hall
Project Number: 26-3843
Date Drilled/Cored: 05/21/2026

Rock Core Sample: Run #3
Rock Core Depths: 20.0’ – 25.0’
Boring Number: B-03

Comments:	Rock Descriptions:	Rock Coring Information:
Sandstone Transitions to Weathered Shale at 14.0’ and Weathered Shale to Shale at 22.0’ within B-03.	Shale – Dark Gray, Horizontal Bedding; Moderately Hard	Run #3: REC = 98% RQD = 62%

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Project Name: Dillard Hall
Project Number: 26-3843
Date Drilled/Cored: 05/21/2026

Rock Core Sample: Run #1 and #2
Rock Core Depths: 15.0’ – 25.0’
Boring Number: B-04

Comments:	Rock Descriptions:	Rock Coring Information:
Weathered Shale Transition to Shale at 19.0’ within B-04.	Weathered Shale – Brown to Light Gray; Horizontal Bedding; Soft Shale – Dark Gray; Horizontal Bedding; Moderately Hard to Hard	Run #1: REC = 93% RQD = 19% Run #2: REC = 85% RQD = 35%

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Project Number: 26-3843
Date Drilled/Cored: 05/21/2026

Rock Core Sample: Run #1 and #2
Rock Core Depths: 10.0’ – 20.0’
Boring Number: B-05

Comments:	Rock Descriptions:	Rock Coring Information:
Weathered Shale Transition to Shale at 12.0’ within B-05.	Weathered Shale – Gray; Horizontal Bedding; Soft to Moderately Hard Shale – Dark Gray; Horizontal Bedding; Moderately Hard to Hard	Run #1: REC = 100% RQD = 62% Run #2: REC = 98% RQD = 42%

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Project Number: 26-3843
Date Drilled/Cored: 05/21/2026

Rock Core Sample: Run #1 and #2
Rock Core Depths: 15.0’ – 25.0’
Boring Number: B-06

Comments:	Rock Descriptions:	Rock Coring Information:
Highly Weathered Shale Transition to Weathered Shale at 15.0’, Weathered Shale to Shale transition at 16.33’ within B-06.	Weathered Shale: Gray; Horizontal Bedding; Soft to Moderately Hard Shale – Dark Gray; Horizontal Bedding; Moderately Hard	Run #1: REC = 82% RQD = 23% Run #2: REC = 90% RQD = 48%

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Project Name: Dillard Hall
Project Number: 26-3843
Date Drilled/Cored: 05/21/2026

Rock Core Sample: Run #1 and #2
Rock Core Depths: 15.0’ – 25.0’
Boring Number: B-07

Comments:	Rock Descriptions:	Rock Coring Information:
Weathered Shale Transition to Shale at 17.0’ within B-07.	Weathered Shale – Gray; Horizontal Bedding; Moderately Hard Shale – Dark Gray; Horizontal Bedding; Moderately Hard	Run #1: REC = 97% RQD = 41% Run #2: REC = 98% RQD = 67%

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Project Name: Dillard Hall
Project Number: 26-3843
Date Drilled/Cored: 05/21/2026

Rock Core Sample: Run #1, #2, #3
Rock Core Depths: 25.0' – 35.0'
Boring Number: B-08

Comments:	Rock Descriptions:	Rock Coring Information:
Shale at 25.0' within B-08.	Shale – Dark Gray; Horizontal Bedding; Moderately Hard	Run #1: REC = 100% RQD = 65% Run #2: REC = 87% RQD = 36% Run #2: REC = 25% RQD = 25%

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Project Name: Dillard Hall
Project Number: 26-3843
Date Drilled/Cored: 05/21/2026

Rock Core Sample: Run #1 and #2
Rock Core Depths: 10.0’ – 20.0’
Boring Number: B-09

Comments:	Rock Descriptions:	Rock Coring Information:
Sandstone Transitions to Weathered Shale at 13.33’, Weathered Shale to Shale at 16.0’ within B-09.	Sandstone – Light Brown to Brown; Hard to Very Hard Highly Weathered Shale – Gray: Horizontal Bedding; Soft to Moderately Hard Shale – Dark Gray; Horizontal Bedding; Moderately Hard	Run #1: REC = 77% RQD = 47% Run #2: REC = 93% RQD = 71%

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APPENDIX F:
L-PILE INPUTS

SOIL INPUT DATA FOR "LPILE"										
SOIL STRATA FROM SOILS BORINGS										
LPILE SOIL P-Y CURVE MODEL[1]	*Soft Clay (Matlock)*	*Stiff Clay with Free Water (Reese)*	*Stiff Clay w/o Free Water (Reese)*	*Sand (Reese)*	*Strong Rock (Vuggy Limestone)*	*Silt (cemented c-phi)*	*API Sand (O'Neill)*	*Weak Rock (Reese)*	*Liquefiable Sand*	*Stiff Clay w/o Free Water Using k*
EFFECTIVE UNIT WEIGHT[1] (pci)	*XX*	*XX*	115 pcf	120 pcf	*XX*	*XX*	*XX*	137 pcf	*XX*	*XX*
UN-DRAINED COHESION[1], c (psi)	*XX*	*XX*	14.0			*XX*				*XX*
FRICTION ANGLE[1] (degree)				28		*XX*	*XX*			
P-Y MODULUS[1], k (pci)		*XX*		225		*XX*	*XX*			*XX*
STRAIN FACTOR[1], ε_{50} (in/in)	*XX*	*XX*	0.006			*XX*				*XX*
YOUNG'S MODULUS[1], E_r (psi)								96,305 psi*		
UNIAXIAL COMPRESSIVE STRENGTH[1] (psi)					*XX*			745 psi		
ROCK QUALITY DESIGNATION[1], RQD (%)								40%		
WEAK ROCK PARAMETER[1], k_{rm}								0.0005		
VARIATION OF SUBGRADE MODULUS WITH DEPTH[2], K_h (tons/ft3)										
ADJUSTMENT FOR DEPTH[2]										
ADJUSTMENT FOR DIAMETER[2]										
ADJUSTMENT FOR SPACING OF TRAILING PIER										

1. Used for input to "LPILE" to generate P-Y curves.

2. Horizontal modulus of sub-grade reaction for user-input linear p-y curves. Adjustments are for depth for pier diameters greater than 12".

3. Required parameters for LPile soil P-Y curve model indicated by 'XX.'

*NOTE: Initial Modulus of Rock Mass calculated per Eq. 25 in Chapter 11 of Practical Rock Engineering, Hoek, 2008, with Geologic Strength Index (GSI) estimated per Table 6 of the same document.

Desired format for "LPILE" information to be included in the soils report, see attached.