EXHIBIT O - PROJECT MANUAL - VOLUME 2

MADISON MUNICIPAL BUILDING RENOVATION

215 Martin Luther King Jr. Blvd
Madison, WI 53703

BPW CONTRACT #7939 MUNIS 10129
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ARCHITECT
MSR, Ltd.

PRESERVATION ARCHITECT
Charles Quagliana, AIA

LANDSCAPE ARCHITECT
KSD, Inc.

CIVIL ENGINEER
Vierbicher, Inc.

STRUCTURAL AND TECHNOLOGY ENGINEER
KJWW, Inc.

BUILDING ENVELOPE CONSULTANT
Insite Consulting Architects

MECHANICAL / ELECTRICAL / PLUMBING ENGINEER
MEP Associates

LIGHTING DESIGN
Gallina Associates

CODE AND LIFE SAFETY SYSTEMS
Summit Fire Consulting

ACOUSTICAL CONSULTING
KRA, Inc.

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WATER-BASED FIRE PROTECTION SYSTEMS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES & DESIGN STANDARDS

A. NFPA 13, “Standard for the Installation of Sprinkler Systems”, 2013 edition.

B. NFPA 14, “Standard for the Installation of Standpipes and Hose Systems”, 2013 edition.

C. NFPA 25, “Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems”, 2008 edition.

D. NFPA 70, “National Electrical Code”, 2011 edition.

E. NFPA 72, “National Fire Alarm and Signaling Code”, 2013 edition.

F. 2009 International Building Code (IBC).

G. 2015 International Fire Code (IFC).

1.3 SUMMARY

A. This Section pertains to the materials and installation for water-based fire protection systems. This includes all fire sprinklers, piping, valves, hangers, and related equipment. Water-based fire protection systems may include wet systems and standpipe systems.

1.4 SCOPE OF WORK

A. As part of this contract, the Division 21 contractor is responsible for providing the design and installation of the water based fire protection systems. The systems shall be fully functional, code-compliant. Provide a complete fire sprinkler and wet manual standpipe system throughout the entire building – except for locations as specifically identified as exempt either on the drawings, or in these specifications, or otherwise specifically exempted by code. See Proposal for Alternate Design related to omission of sprinkler protection with the attic. Demolition of existing associated pump and standpipe system is required.

B. The Division 21 contractor’s scope of work beings at the new 8” flanged combined underground service located in the Utility Room at Ground Level, as noted on the drawings. Zone controls are located in Utility Room 020. Ground Level is supplied by a separate Zone and Levels 1 thru 3 are on a combined Zone located at Ground Level.

C. Due to the historic sensitivity of select areas, pipe routing is limited to “back of house” spaces. See drawings for pipe routing and sprinkler locations in these areas. Coordination with the architect and general contractor is required for all pipe routing.

D. A mock-up will be required as follows: Room 260: Typical north-south faux wood beam refinishing, min. 8ft long, including new concealed sprinkler head and cap finish, historic rosette detail, and min. 4ft length of intermediate east-west faux cross-beams. Coordinate with Architect.

E. The fire protection system layout indicated on the drawings is diagrammatic and is intended to show the general arrangement of the system and DOES NOT necessarily show all features or

components of the system. The fire protection system installation shall include all piping and materials obviously necessary though not specifically mentioned or shown.

F. Division 21 shall be responsible for design and subsequent installation of the fire protection systems. Requirements for the fire protection systems arise from a variety of sources such as building codes, fire codes, and Owner requirements. As these contract documents do not reiterate all of the requirements, it is necessary that the Division 21 contractor be thoroughly knowledgeable and experienced with these types of fire protection systems as the Division 21 contractor will be expected to comply with all stated contract requirements and all referenced codes, standards, and guidelines.

G. The fire protection system shall meet or exceed City of Madison requirements and conform to applicable State and NFPA Codes and Standards. This shall include all City ordinances or policies adopted or enforced by the City.

H. Coordinate the system installation with building conditions and all trades.

I. Obtain required approvals from all Authorities Having Jurisdiction.

J. Signal wiring of the supervisory switches, flow switches, pressure switches and alarms shall be by Division 28.

K. Previous flow test data obtained from the City of Madison indicated the following:

1. Date of Test: October 28, 2014
2. Static: 60 psi
3. Residual: 52 psi
4. Flow: 1160 gpm
5. Location: Hydrants on East Doty - connect to 10” watermain

L. An updated flow test shall be obtained by the Division 21 contractor, in compliance with NFPA 291, after all city main alterations in the area have been completed. Hydraulic calculations shall be based on the updated flow test.

M. Signal wiring of the supervisory switches, flow switches, pressure switches and alarms shall be by Division 28.

N. Power wiring for sprinkler system air compressors shall be by Division 26.

1.5 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System. Automatic sprinklers are attached to piping containing water that is connected to the City water supply and fed through a fire pump. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts the fusible link or destroys frangible device.

1. From the new underground service, provide dedicated systems/zones/sub-zones for wet-pipe fire sprinklers as noted on drawings.

B. Wet Standpipe System: Manual Class I wet-type standpipe system connected to the City water supply and fed through the Fire Department Connection (FDC).

1. Provide manual wet standpipe system to serve the building.
2. Provide 2 ½-in hose connections at the locations indicated on drawings.

a. Hose Valves shall be provided at the highest intermediate landing
b. Supply piping shall be routed through chases/shafts located outside the stair enclosure

1.6 PERFORMANCE REQUIREMENTS

A. The Division 21 contractor shall provide complete fire sprinkler/standpipe system design and installation. All materials and the system installation shall be compliant with the contract documents, the 2009 International Building Code (IBC), 2015 International Fire Code (IFC),

and all applicable codes/standards referenced by those documents to the National Fire Protection Association (NFPA).

B. When referenced codes, standards, guidelines, approval lists, data sheets or contract documents are in conflict, the most stringent requirements shall govern. In no case shall an installation be in violation of code requirements.

C. The Division 21 contractor shall provide all required drain piping and attachments, properly sized, to accommodate required testing (i.e. Main Drain, etc.). Such drain piping shall be provided whether or not it is indicated on the drawings.

1. Zone and valve assembly main drains shall be discharged at grade level to a floor drain and/or mop sink provided by others. Coordinate final location of drain and any necessary permanent piping to drain with other trades.

1.7 SUBMITTALS

A. Fire protection shop drawing submittals shall be prepared in compliance with all applicable NFPA standards. Complete shop drawing submittals shall include: drawings, hydraulic calculations and materials submittal data.

B. Submit three complete sets of sprinkler shop drawings to each Authority Having Jurisdiction. Obtain all required approvals prior to equipment ordering, fabrication and/or installation.

C. Submit three complete sets of sprinkler shop drawings to the Architect of Record and Engineer of Record for review and comment. Obtain notification of acceptance from Architect and Engineer prior to equipment ordering, fabrication and/or installation.

D. Drawings and hydraulic calculations shall be signed by a registered Professional Engineer, indicating that the work was prepared by him/her or under his/her direct supervision. This is a State of Minnesota Design Guideline requirement. The engineer shall be proficient in fire protection systems design.

E. Drawing submittals shall include, but not be limited to, the following:

1. Installation drawings, in CAD format, drawn to scale.
2. Contractors name, address and telephone number.
3. Project location, including street address.
4. Name of owner and/or occupant.
5. Site plan indicating the size and location of the water main and underground service as well as the flow and gauge hydrants utilized in the flow test.
6. Elevation of the gauge hydrant relative to the finished floor at the fire sprinkler service entrance into the building.
7. North arrow.
8. Manufacturer, type, temperature rating, nominal orifice size, and sprinkler identification number (SIN) of sprinklers.
9. Piping types.
10. Center to center cut length dimensions and nominal pipe sizes.
11. All control valves, check valves, drain pipes and test connections, etc.
12. The boundary of each hydraulically calculated area.
13. Hydraulic calculation nodes indicated on the drawing corresponding to the nodes used in the calculations.
14. Room number and room name (or use) for each room.
15. Hazard classification of each area or room (i.e., Light Hazard, Ordinary Hazard Group 1, Ordinary Hazard Group 2, etc.)
16. Ceiling construction including ceiling elevations.
17. Building cross section.
18. Location of walls and partitions.
19. Pipe hanger types and locations.
20. The volume of each dry-pipe system in gallons.

F. Hydraulic calculation submittals shall be prepared in a format as described in NFPA 13, 2013, 23.3.5. and 23.4

G. Material submittals shall include all components to be installed and/or specified, including, but not limited to the following:

1. Piping and fitting materials, including sprinkler specialty fittings.
2. Pipe hangers and supports.
3. Valves, including isolation valves, check valves, and specialty valves and trim.
4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
5. Fire department connection, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
6. Alarm devices, including electrical data—tamper switches, flow switches, exterior horn/strobe, etc.

1.8 RECORD DRAWINGS

A. The Division 21 contractor shall maintain at the jobsite a set of field installation drawings on which the progress of the installation shall be recorded clearly, neatly, accurately, and promptly as the work progresses.

B. Upon completion of the project, transpose any changes noted on the field installation drawings to the CAD shop drawings to create CAD record drawings of the fire sprinkler system.

1.9 PROJECT CLOSEOUT DOCUMENTATION

A. Comply with the requirements of Division 1. In addition, provide at least two copies of as-built fire protection documents prior to final closeout of the project. As-built documentation shall include, but is not limited to, the following:

1. Title page.
2. Table of contents.
3. Emergency service guidance.
4. Inspection/testing/maintenance requirements from the Minnesota State Fire Code.
5. Manufacturer’s literature on all specified equipment and trim.
6. Electronic copies of the CAD record drawings.
7. Paper printouts of each CAD record drawing.
8. A bound copy of the 2008 edition of NFPA 25.
9. A signed copy of the Contractor’s Under Ground Material and Test Certificate as described in NFPA 13, 2013, Chapter 10.
10. A signed copy of the Contractor’s Above Ground Material and Test Certificate as described in NFPA 13, 2013, Chapter 24.
11. A signed copy of the Contractor’s Standpipe Above Ground Material and Test Certificate as described in NFPA 14, 2013, Chapter 11.

B. At the discretion of the Owner, provide a minimum 2 hours of training to Owner after approval of system by Authority Having Jurisdiction and Engineer of Record.

1.10 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire protection systems to assume design and installation responsibility.

B. Welding: Qualify processes and operators according to NFPA and other necessary certifications.

C. NFPA Standards: Fire protection system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems" (2013 edition)
2. NFPA 14, "Installation of Standpipe and Hose Systems" (2013 edition)
3. NFPA 25, “Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems” (2008 edition)
4. NFPA 70, “National Electrical Code” (2013 edition)
5. NFPA 72, “National Fire Alarm Code” (2013 edition)

D. Comply with requirements of NFPA for submittals, approvals, materials, installation, inspections, and testing.

1. Comply with all manufacturers’ requirements for design and installation.

1.11 COORDINATION

A. Coordinate design and installation of fire protection pipe, sprinklers, etc. with other construction that penetrates walls and ceilings, including light fixtures, speakers, HVAC equipment, and partition assemblies. Coordinate work with all other trades and existing building conditions.

B. The Division 21 contractor is responsible for coordinating with the Architect of Record in regards to various features of the fire protection design, as depicted throughout this specification. Examples include exposed pipe routing, sprinkler types in various areas of the building (i.e. recessed pendent, concealed, etc.), sprinkler finishes in various areas of the building, fire department connection, exterior alarm bell/horn-strobe, etc.

1. As noted under submittal requirements, fire protection layouts for the building shall be submitted to the Architect of Record for review purposes, prior to fabrication of the fire protection components.

1.12 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than 300 psig.

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

C. References to sprinkler piping, sprinkler systems, etc., shall be considered to include the standpipe piping, standpipe systems, etc., where reasonably appropriate.

1.13 WARRANTIES

A. Unless otherwise described under the Conditions of the Contract, the Division 21 Contractor shall warranty this installation for a minimum of 1-year from date of substantial completion.

B. Furnish manufacturer’s warranty information for fire suppression materials.

1.14 IMPAIRMENT OF EXISTING FIRE PROTECTION SYSTEMS

A. Notify Construction Manager no fewer than two days in advance of proposed interruption of standpipe service. Do not proceed with interruption of existing standpipe service without Construction Manager's written permission.

B. The Division 21 contractor shall be responsible to coordinate all fire protection system impairments and the extent of required fire watch with the owner and the local fire department. Any impairments shall be in compliance with the locally adopted fire code.

C. The Division 21 contractor shall coordinate the phasing of the work such that any required impairment duration is kept to a minimum.

PART 2 - PRODUCTS

2.1 COMPLIANCE

A. All materials and products shall comply with the requirements of the contract documents, NFPA, Owner, Engineer of Record, and Authority Having Jurisdiction.

2.2 EXTERIOR UNDERGROUND

A. Ductile iron pipe, AWWA C151. Required prior to first fire protection control valve.

B. At transition from below grade to above grade only, galvanized piping may be used when externally coated in compliance with AWWA C203 and wrapped in compliance with AWWA C105.

2.3 UNDERGROUND WATER PIPE FITTINGS AND JOINING METHODS

A. Underground water pipe fittings and joining shall be:

1. Restrained joint mechanical fittings having a minimum rating of 350 psi in accordance with AWWA C111 and AWWA C153.
2. Gasketed flanged connections having a minimum rating of 350 psi in accordance with AWWA C111 and AWWA C153.

2.4 ABOVE GROUND PIPING

A. General requirements:

1. Pipe shall be new and shall indicate the manufacturer's name together with the applicable ASTM standard clearly marked along the length of piping.
2. Steel piping shall be rated for a working pressure at least 300 PSI.
3. Piping installed in above grade exterior applications or in otherwise corrosive environments shall be galvanized.

B. Wet system piping:

1. 2” piping and smaller: Black steel pipe, ASTM A135 or A53, Schedule 40.
2. 2-1/2” piping and larger: Black steel pipe, ASTM A135 or A53, Schedule 10.
3. CPVC piping: allowed only at piping supplying Room 260. See drawings for location.

C. Interior piping from fire department connection to the fire department connection check valve:

1. Galvanized steel pipe, Schedule 10, ASTM A135 or A53.

2.5 ABOVE GROUND PIPE FITTINGS AND JOINING METHODS

A. Screwed Fittings:

1. Wet Systems: Cast iron or malleable iron fittings, ASME B16.3 or ASME B16.4, standard weight, class 125 (or 150) for pressures up to 175 PSI; or class 250 (or 300), extra heavy pattern, where system pressures range from 175 PSI up to 300 PSI.

B. Flanged Fittings:

1. Cast iron, gasketed, short body, ASME B 16.1, class 125, for pressures up to 250 PSI. Flange bolts shall be hexagon head, cadmium plated, dimensions in compliance with ASME B 18.2.

C. Welded Fittings:

1. Steel, rated for pressures of at least 300 PSI, standard weight, black, and in compliance with ASME B 16.9, ASME B 16.25, ASTM A 234, ASME B 16.5, and ASME B 16.11.

D. Grooved Fittings and Couplings:

1. Grooved fittings and couplings shall be ASTM A536 ductile iron. Gaskets shall pressure-responsive, synthetic EPDM rubber gasket, ASTM D-2000. Steel bolts and nuts shall be ASTM B-633 zinc plated.
2. Grooved fittings and couplings shall be rated for pressures up to at least 300 PSI.
3. Grooved fittings and couplings used on wet-pipe systems shall be enamel coated.
4. Grooving tools and coupling gaskets shall be from the same manufacturer as the couplings.
5. Acceptable Manufacturer: Victaulic or approved equal.

E. Schedule 10 and Schedule 40 steel pipe shall be joined by:

1. Screwed joints in compliance with specification ASME B 1.20.1
2. Welded joints in compliance with specification ASME B31.1, Chapter 5 (black pipe only).
3. Approved combination of couplings, gaskets and grooves. Grooves shall be rolled or cut and they shall be dimensionally compatible with the couplings.
4. Saddle type fittings and drilled T-branch style fittings shall not be considered an approved joining method.

F. Plastic Piping:

1. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
2. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

2.6 CONTROL VALVES

A. Valves shall be UL Listed and/or FM approved, with 175 PSI minimum pressure rating. When system pressures at valves are in excess of 175 PSI, provide valves with a working pressure of at least 300 PSI, or provide pressure-reducing valves to limit pressures to 175 PSI or less.

B. Each valve which controls the water supply to the sprinkler system shall be supervised by an approved means. Valves noted on drawings as “supervised” shall be electronically supervised. Coordinate voltage requirements for electronic supervision with Divisions 26 and 28.

C. Provide locks on valves as described in Part 3.

D. OS&Y Valves

1. Cast iron body, with outside stem and yoke and flanged connections. Comply with UL-262 and AWWA C-509.
2. Acceptable Manufacturer: Kennedy, Mueller, Nibco, Wilkins, or approved equal.

E. OS&Y Valve Supervisory Switch

1. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw, switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

F. Butterfly Valves

1. Ductile iron body and disk. EPDM seals and gaskets. Weatherproof actuator housing
2. approved for indoor or outdoor use. Pre-wired supervisory switch.
3. Acceptable Manufacturer: Victaulic Firelock, Milwaukee Butterball, or approved equal.

2.7 CHECK VALVES

A. All check valves shall have a soft seat and shall have maximum working pressure of at least 175 PSI. When system pressures at valves are in excess of 175 PSI, provide valves with a working pressure of at least 300 PSI, or provide pressure-reducing valves to limit pressures to 175 PSI or less.

B. Check valves used for fire department connections shall be equipped with a ball drip.

2.8 DRAIN VALVES

A. Drain valves shall be full port, lockable ball valves, bronze body, 400 PSI WOG, ball valve, locking lever handle, chrome-plated bronze or stainless steel ball, teflon seat, teflon stuffing box seal, screwed connection.

B. Acceptable Manufacturer: Apollo, Nibco, Milwaukee, Wilkins or approved equal.

2.9 STANDPIPE HOSE VALVE – STANDARD PRESSURE

A. 2-1/2" angle hose valve, cast brass, including cap and chain. Hose threads to match City requirements. Provide where static pressures at fire pump churn are less than 175 PSI.

B. Acceptable Manufacturer: Potter Roemer 4065 or approved equal.

C. Acceptable Manufacturer: Potter Roemer 4053 or approved equal.

2.10 SPRINKLER PRESSURE RELIEF VALVE

A. Fire sprinkler pressure relief valve shall be brass, ¾" male threaded inlet, field adjustable for pressures between 15 PSI and 175 PSI. Final setting shall be arranged to open valve at pressures exceeding 175 PSI.

B. Acceptable Manufacturer: Watts Regulator, Series 530C or approved equal.

2.11 DETECTOR CHECK AND METER

A. Listed detector check valve with bypass meter sized as required by City.

B. Acceptable Manufacturer: Ames Series 1000 DCV, Wilkins 910, or approved equal.

2.12 QUICK RESPONSE SPRINKLERS

A. Quick response sprinklers shall be UL Listed and/or FM approved. Pressure rating shall be 175 PSI minimum. Sprinklers shall have a temperature rating between 155 and 170 degrees Fahrenheit unless otherwise shown in drawings or indicated herein. Escutcheon colors must match sprinklers. Select only models with UL Listing and/or FM approval for intended application.

B. Quick response sprinklers shall be used in light and ordinary hazard occupancies except where noted on drawings, specified herein, or exempted or prohibited by code.

C. The Division 21 contractor is responsible for coordinating sprinkler finishes with the Architect of Record.

D. Upright or pendent sprinklers (on exposed piping):

1. Finish to be as selected by architect.
2. Tyco TY-FRB, Reliable Model F1FR, or equal.

E. Horizontal sidewall sprinklers:

1. Finish to be as selected by architect.
2. Standard Coverage: Tyco TY-FRB, Reliable Model F1FR, or equal.
3. Extended Coverage: Tyco TY-FRB, SW-20, or equal.

F. Horizontal concealed sidewall sprinkler:

1. Finish to be as selected by architect.
2. Standard Coverage: Reliable Model G56 Concealed or equal.
3. Extended Coverage: Reliable Model G6-80 Concealed or equal.

G. Concealed pendent sprinklers:

1. Finish to be as selected by architect.
2. Standard Coverage: Tyco Reliable Model G4A, or equal.
3. Extended Coverage: Tyco Model RFII or equal.

H. Provide the following sprinkler types at the locations indicated below unless otherwise noted on drawings or specified herein.

1. Areas Without Ceilings: Upright, pendent, or sidewall sprinklers.
2. Suspended Ceilings: Concealed pendent sprinklers.
3. Gypsum Ceilings: Concealed pendent sprinklers.
4. Wall Mounting: Concealed sidewall sprinklers.

I. For areas where no specific sprinkler spray pattern is designated on drawings, extended coverage sprinklers may be utilized where acceptable by code and accounting for all encountered obstructions.

J. Where standard spray sprinklers are designated on drawings to be installed, extended coverage sprinklers shall not be substituted for standard spray sprinklers without prior approval by the Engineer of Record.

K. Provide wire cage type sprinkler guards, including fastening device for attaching to exposed sprinklers, at locations as described in Part 3.

2.13 FIRE DEPARTMENT CONNECTION

A. Fire department connection shall be shall be wall type, chrome plated brass body with polished chrome-plated brass trim 4-way, 2-1/2" x 2-1/2" x 4", bottom outlet, square body, complete with plugs and chains (or as required by the City).

B. Fire department connections shall be permanently labeled with escutcheon ring “AUTO-SPKR AND STANDPIPE”. Hose threads to match City requirements.

C. Acceptable Manufacturer: Potter Roemer 5780, or approved equal.

2.14 OUTSIDE ALARM

A. Audio/visual type outside alarm. Horn and light shall be an integral unit suitable for use in a location exposed to the weather. Coordinate voltage with Division 28.

B. Acceptable Manufacturer: Wheelock Series ASWP or approved equal.

2.15 WATER FLOW ALARM SWITCHES - WET SYSTEMS

A. Paddle-operated-type water-flow detector with electrical supervision. UL Listed and/or FM approved, minimum 175 PSI working pressure rating and designed for horizontal or vertical installation.

B. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

C. The flow switch shall have a sensitivity setting to be less than the flow of one sprinkler.

D. Acceptable Manufacturer: Potter VSR series or approved equal.

2.16 PRESSURE GAUGES

A. Description: UL Listed and/or FM approved, 3-1/2- to 4-1/2-inch-diameter, dial pressure gauge with range of 0 to 250-psig minimum. Include caption "WATER" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 UNDERGROUND PIPING

A. All underground piping which will be filled with water under normal conditions must be installed with a minimum depth of cover of 7’-6”.

B. Exterior underground fire protection piping shall be provided with suitable joint restraint as described in NFPA 13, 2010, 10.8.

C. Trenches shall provide solid and continuous bearing for all pipe installed. Over excavation shall be backfilled to the proper grade with compacted earth, sand, fine gravel or similar material. Piping may not be supported by rocks or blocks at any point. Rocky soil shall be over excavated to a depth equal to one times the pipe diameter or six (6") inches whichever is greater and backfilled to the proper grade with compacted granular material.

3.2 ABOVEGROUND PIPING

A. The Division 21 contractor is responsible for coordinating sprinkler and standpipe pipe routing throughout the building. Coordinate piping installation with all other trades.

B. Coordinate the routing and installation of exposed piping with the Architect of Record prior to fabrication of piping. Exposed sprinkler pipe is not permitted in areas where concealing the piping above a ceiling is possible, except where specifically allowed by the Architect of Record or explicitly described on the drawings. Routing of piping through historically sensitive areas is prohibited without prior approval and coordination with the Architect of Record and general contractor.

C. Sprinkler pipe routing shall be reviewed with the Architect to minimize alterations of existing ceilings, walls, etc. as well as disruptions. Division 21 is responsible for replacing ceiling tile, gypsum board, etc. and repairing any damage caused by installation of the fire protection system.

D. Piping in exposed conditions shall be installed with necessary clearances from building operations, utilities, etc. Adjust locations to maintain necessary clearances if so directed by Owner or Engineer of Record.

E. Painting of exposed sprinkler pipe, hangers and supports shall be by Division 9 and shall be done in locations as directed per the Architect of Record. The Division 21 contractor shall remove all adhesive labeling on sprinkler piping designated to be painted.

F. Sprinkler piping joint construction shall comply with the requirements of NFPA 13, 2013, 6.5.

G. Welded pipe outlets shall be shop welded.

H. Welded joints shall not be used for galvanized-steel pipe.

I. Flanges, flanged fittings, unions, nipples, and transition and special fittings shall have pressure ratings at least equal to or higher than the system pressure that may be encountered.

J. Piping shall be run in a straight line, parallel or perpendicular to walls and partitions, whenever possible.

K. Properly brace all system piping and equipment to prevent movement during operation.

L. Provide piping escutcheons where exposed piping passes through floors, walls and ceilings.

M. Piping hangers and supports shall comply with NFPA 13, 2010, Chapter 9. Spacing between supports shall comply with NFPA 13, 2010, Table 9.2.2.1.

N. Piping penetrations through fire rated walls, fire rated floors, and fire rated ceilings shall be provided with UL Listed fire stopping assemblies.

O. Piping shall not be routed over electrical panels or through elevator equipment rooms or shafts.

P. Piping serving electrical rooms shall be dedicated to the electrical room and shall terminate in the electrical room. Piping shall not route through an electrical room to serve additional rooms or areas within the building.

Q. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

R. Provide inspector's test connections complete with discharge piping and shutoff valve, sized and located in compliance with NFPA 13, 2013, 8.17.4.2 Location and outlet discharge are subject to approval by the Authority Having jurisdiction and the Engineer of Record.

S. Provide relief valves on all wet sprinkler systems as described in NFPA 13, 2013, 7.1.2.1. The relief valve shall be set to operate at 175 psi or 10 psi in excess of the maximum system pressure whichever is greater. If multiple zones are provided, a relief valve shall be installed on each zone. Pipe relief valve discharge to connect to main drain or drain riser piping.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

D. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

E. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

G. Apply appropriate tape or thread compound to external pipe threads.

H. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

J. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

3.4 PIPE SLEEVES

A. Comply with Section 210517.

3.5 DRAINAGE

A. Provide sprinkler piping drains to provide system drainage as required by NPPA 13, 2013, 8.16.2. Drain locations are subject to approval by the Engineer of Record and Architect of Record.

B. Wet sprinkler piping may be installed pitched or level. Provide drains at low points and trapped water locations.

C. Provide drains at low points and trapped water locations as required by NFPA 13, 2013, 8.16.2.5.2 for wet systems. Drain locations are subject to approval by the Engineer of Record and Architect of Record.

D. Provide main drain(s), drain valve and pressure gauge on each sprinkler system zone or riser. Drain pipe sizing shall comply with NFPA 13, 2013, 8.16.2.4.1 through 8.16.2.4.8. Main drain shall discharge to provided floor drain/mop sink in utility room. Coordinate final location and any permanent drain piping required with other trades.

E. Provide drain piping for fire department connection check valve ball drip.

F. In climates subject to freezing, provide a minimum 4 ft of exposed drain pipe in a heated area between the drain valve and the exterior wall when the drain piping extends through the wall to the outside.

3.6 VALVES

A. Provide UL Listed and/or FM Approved fire protection valves for applications where required by NFPA 13.

B. All valves regulating the water supply to sprinklers shall be electronically supervised. Supervised valve switch contact adjustment shall be by the Division 21 contractor. Switches shall be mounted so not to interfere with normal operation of valve and shall be adjusted to operate within two revolutions of the valve control, or when the stem has moved, no more than one-fifth of the distance from its normal position.

C. Coordinate and wiring of fire sprinkler fire alarm devices (flow switches, tamper switches, etc.) with Division 28. Wiring is by Division 28.

D. All valves controlling water supplies for automatic sprinklers shall be locked or secured in the open position.

E. Provide OS&Y gate valves at the service entrance to the building on both sides of the service entrance check valve.

3.7 SPRINKLER INSTALLATION

A. Sprinklers shall be located in a regular pattern, perpendicular and parallel with building lines, in perfect alignment with other ceiling components such as lights, air diffusers, grilles, and speakers.

B. Adjustments in sprinkler locations shall be anticipated during shop drawing review, and shall be allowed for in the Base Bid.

C. Refer to Part 2 for sprinkler types and finishes.

D. Sprinkler locations shall be reviewed and accepted by the Architect of Record before any piping is fabricated or installed. Provide additional sprinklers (in excess of NFPA requirements) for aesthetics at the discretion of the Architect of Record.

E. Sprinklers shall be located +/- 2 inch of the center of tile in acoustical ceiling tile areas, unless noted otherwise. Sprinklers shall be located no closer than 4 inches from any ceiling edge or from any other ceiling component in public areas.

F. Do not install wet-type pendent or sidewall sprinklers in areas subject to freezing. The Division 21 Contractor is responsible for notifying the Engineer of Record of any areas that may require dry sprinklers or alternative means to avoid potential freezing.

G. Provide escutcheon plates for pendent sprinklers mounted in finished ceilings and horizontal sidewall sprinklers mounted on walls. Maximum depth of escutcheon below ceiling or out from wall shall be 1-1/4". Two piece escutcheons exceeding a depth of 1-1/4" are not permitted. Escutcheon diameters shall not exceed 3-inch.

H. Provide sprinkler guards at the following locations:

1. Where moving objects are likely to cause sprinkler damage.
2. Where sprinkler is installed less than 7'-6" above finished floor.
3. Where noted on drawings.
4. Where otherwise required by the owner.

I. Provide high temperature sprinklers near heat-producing devices in compliance with NFPA 13, 2013, 8.3.2.5.

J. Provide sprinklers above and below fixed obstructions over 48" in width in compliance with NFPA 13, 2013, 8.5.5.3.1. This shall include ductwork, HVAC equipment, and open overhead garage doors.

K. Provide sprinklers at stairways in compliance with NFPA 13, 2013, 8.14.3.

L. Concealed combustible spaces shall be protected in compliance with NFPA 13, 2013, 8.15.1 through 8.15.1.7.

3.8 WET STANDPIPE SYSTEM INSTALLATION

A. Contractor shall provide a hydraulically calculated Class I manual wet standpipe system.

B. In no case shall wet standpipe distribution piping be less than 4".

C. Additional compensation shall not be granted for standpipe distribution piping up to and including 8" in diameter if such pipe sizing is necessary to satisfy hydraulic calculation requirements for the standpipe system or attached sprinkler system.

D. The standpipe system shall be hydraulically calculated to provide a residual pressure of 100 PSI at the hydraulically most remote hose connection. Total system flow rate shall be 500 GPM for the most remote standpipe and 250 GPM for each additional standpipe up to a maximum of 750 GPM.

E. All hose connections shall be unobstructed in compliance with NFPA 14, 2013, 7.3.1.2 and located at the highest intermediate landing.

3.9 FIRE DEPARTMENT CONNECTIONS

A. Mount fire department connection at a location approved by the Authority Having Jurisdiction and the Architect of Record. Location shall be fully visible and recognizable from the street and shall be arranged so that hose lines can be attached to the inlets without interference from nearby objects. Fences, bushes, trees, walls or similar objects shall not obstruct the fire department connection.

B. Fire department connection mounting height shall be between 18" and 48" above grade.

C. Size fire department connection piping to comply with NFPA 13, 2013, 8.17.2.3, unless otherwise specified or noted on drawings.

D. Fire department connections with 2-1/2" connection inlets shall have a minimum of 3 inlets unless otherwise specified.

E. Verify that equipment hose threads match Fire Department requirements.

F. To protect against freezing, fire department connection piping shall extend from the inside face of the exterior wall a minimum of 4'-0" prior the installation of the fire department connection check valve.

G. A listed check valve shall be installed in each fire department connection as described in NFPA 13, 2013, 8.17.2.5.1

3.10 OUTSIDE ALARM

A. Horn/strobe alarm shall be located above the fire department connection. Mounting height of alarm shall be at least 8 feet above grade but no greater than 20 feet.

B. Coordinate wiring of alarm with Division 28.

3.11 ELECTRICAL CONNECTIONS

A. All wiring of fire protection system components shall comply with NFPA 70 and NFPA 72.

B. Wiring is provided as described in Part 1.

3.12 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers and piping.

B. Protect fire protection equipment from damage until Substantial Completion.

C. Upon completion of painting within the building, remove all temporary protective coverings attached to sprinklers to protect from paint overspray

3.13 SPRINKLER SYSTEM HAZARD CLASSIFICATIONS

A. Sprinkler hazard classifications shall comply with NFPA 13, 2013, Chapter 5. See drawings for specific requirements.

B. Hazard classifications shall correspond with the following unless otherwise noted:

1. Electrical room and mechanical rooms shall be considered as Ordinary Hazard Group 1.
2. Miscellaneous storage areas, as defined by NFPA 13, 2013, 3.9.1.18; with the following configurations, shall be considered Ordinary Hazard Group 2.
    a) Class I to Class III commodities stored 12 feet or less in height.
    b) Class IV commodities stored 10 feet or less in height.
    c) Group A plastics stored 5 feet or less in height.
3. Unless otherwise noted or otherwise required by the authority having jurisdiction or code, remaining non storage areas shall be considered as Light Hazard.

3.14 SPRINKLER SYSTEM HYDRAULIC CALCULATIONS

A. Base design densities and base remote areas shall be as noted below:

1. Light Hazard: 0.10 GPM per sq. ft. over the most remote 1500 sq. ft.
2. Ordinary Hazard Group 1: 0.15 GPM per sq. ft. over the most remote 1500 sq. ft.
3. Ordinary Hazard Group 2: 0.20 GPM per sq. ft. over the most remote 1500 sq. ft.
4. Where extended coverage sprinklers are used, the base design area shall be that noted above or the area protected by 5 sprinklers, whichever are is greater, in compliance with NFPA 13, 2013, 11.2.3.2.2.3.

B. Allowable decreases to base remote areas are as noted below:

1. Wet systems with quick response sprinklers are allowed to have the design area reduced, based on ceiling heights, where permitted by NFPA 13, 2010, 11.2.3.2.3.1. The number of sprinklers in the design area shall never be less than 5 and unprotected ceiling pockets must not exist. If the area under consideration is below a sloped ceiling, the maximum height of

the room shall determine the allowable reduction as described in NFPA 13, 2010, 11.2.3.2.3.3.

2. The room design method; in compliance with NFPA 13, 2010, 11.2.3.3; is allowed where it is applicable. All rooms shall be enclosed with walls having a fire resistance rating equal to the water supply duration established for the protected occupancy. Openings shall be protected as described in NFPA 13, 2010, 11.2.3.3.5.

C. Apply increases to remote areas as noted below:

1. Where ceiling slopes exceed11.1.5.2 2" in 12", the design area for wet systems shall be increased by 30% without revising the density as required by NFPA 13, 2010, 11.2.3.2.4.
2. Where ceiling slopes are less than 2" in 12", the design area for dry systems shall be increased by 30% without revising the density as required by NFPA 13, 2010, 11.2.3.2.5.
3. Where ceiling slopes exceed 2" in 12", the design area for dry systems shall be increased by 69% without revising the density in accordance with NFPA 13, 2010, 11.2.3.2.4 and 11.2.3.2.5.

D. The hydraulic calculations shall include losses through water-service piping, valves, and backflow preventers. Calculate back to the test hydrant from the hydrant flow test and note the elevation of the test hydrant in relation to the floor slab on the submitted shop drawings.

E. The sprinkler system(s) shall be calculated to allow for a pressure safety factor. The safety factor shall be the amount of pressure available at the required flow that is above the required pressure at the required flow. The safety factor shall comply with the requirements of the Authority Having Jurisdiction but in no case be less than 5 PSI.

F. Pipe serving more than two sprinklers shall be a minimum of 1-1/4" in size or hydraulically calculated.

3.15 SIGNS

A. Provide permanent visible signs to identify all drains, test connections, control valves and fire department connections.

B. Signage shall comply with NFPA 13, 2013, 6.7.4 for valves, 8.17.2.4.7 for fire department connections, and 8.16.5 for riser assemblies.

C. Unless otherwise provided by Division 10, the Division 21 contractor shall provide permanent, durable, and readily visible signs for rooms containing the following: controls for air conditioning systems, sprinkler risers, sprinkler valves, or other fire detection or suppression or control elements. Comply with IFC section 510.1. Coordinate required locations and wording with the Authority Having Jurisdiction and Division 23.

D. The Division 21 contractor shall provide any additional signage pertaining to the fire protection system as may be required by the Authority Having Jurisdiction.

E. Provide hydraulic design information signs in compliance with NFPA 13, 2013, 25.5. Each sign shall be permanently marked, weatherproof metal or rigid plastic, and secured with corrosion resistant wire or chain. Such signs shall be placed at each zone control riser or sub zone. Each individual sign shall include the following information:

1. Location of the design area or areas
2. Discharge densities over the design area or areas
3. Required flow and residual pressure demand at the base of the riser
4. Occupancy classification or commodity classification and maximum permitted storage height and configuration
5. Hose stream allowance included in addition to the sprinkler demand
6. The name of the installing contractor

F. Provide general design information signs in compliance with NFPA 13, 2013, 25.6. Each sign shall be permanently marked, weatherproof metal or rigid plastic, and secured with corrosion resistant wire or chain. Each sign shall identify the system design basis and information relevant to the inspection, testing, and maintenance requirements for the system. Such signs shall be placed at each zone control riser or sub zone. Each individual sign shall include the following information:

1. Name and location of the facility protected
2. Presence of high-piled and/or rack storage
3. Maximum height of storage planned
4. Aisle width planned
5. Commodity classification
6. Encapsulation of pallet loads
7. Presence of solid shelving
8. Flow test data
9. Presence of flammable/combustible liquids
10. Presence of hazardous materials
11. Presence of other special storage
12. Location of auxiliary drains and low point drains
13. Original results of main drain flow test
14. Name of installing contractor or designer
15. Indication of presence and location of antifreeze or other auxiliary systems

3.16 SPRINKLER CABINET

A. Provide sprinkler cabinet near sprinkler system riser assembly with supply of extra sprinklers including each type and rating installed. Comply with NFPA 13, 2010, 6.2.9.

B. Provide wrench(es) suitable for use with all sprinklers installed.

C. At a minimum, provide quantities of spare sprinklers per the following schedule to comply with:

1. Projects having under 300 sprinklers, provide at least 6 sprinklers.
2. Projects having 300 to 1000 sprinklers, provide at least 12 sprinklers.
3. Projects having over 1000 sprinklers, provide at least 24 sprinklers.

3.17 WATER FLOW ALARMS

A. Provide flow switches to monitor sprinkler water flow in each installed zone or sub-zone. Flow switches shall not be mounted in or within 12” of any fitting that changes direction of water flow. Adjust delay setting to eliminate false alarms.

3.18 PRESSURE GAUGES

A. Provide pressure gauges at all locations as required by NFPA 13 and NFPA 14.

B. Pressure gauges shall be installed at the top of each standpipe riser.

C. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gauge and valve.

D. Install gauges to permit removal, and install where they will not be subject to freezing.

E. Provide a pressure gauge on the inlet side of each pressure reducing style hose valve.

F. Provide a pressure gage on the inlet and discharge side of each pressure reducing valve.

3.19 INSPECTORS TEST CONNECTIONS AND OUTLETS

A. Provide inspectors test connections and outlets at locations that will ensure each installed flow switch can be tested.

B. Inspector test piping shall be routed to drain to outside or to location approved by Engineer of Record.

C. Provide inspectors test connections and outlets at locations ensuring that each flow switch installed is capable of being tested.

D. Inspector's test connections shall be complete with discharge piping and shutoff valve and shall be sized and located to comply with NFPA 13, 2013, 8.17.4.

3.20 TESTING AND FLUSHING

A. The Division 21 contractor shall coordinate, perform, and pay for the required testing of the water-based fire protection systems.

B. Testing shall comply with the requirements of this Specification, all of the applicable governing codes, as well as the Authority Having Jurisdiction.

C. Notify the Authorities Having Jurisdiction in sufficient time to allow for a representative to be present for each test.

D. Documentation of the underground fire sprinkler piping system testing and acceptance procedures shall be the responsibility of the Division 21 contractor whether or not the Division 21 contractor installs the underground piping. If the Division 21 contactor is not the installing contractor, the Division 21 contactor shall make the proper arrangements with the installing contractor to ensure the required testing is performed and documented. The testing and documentation shall include:

1. System flushing in compliance with NFPA 13, 2013, 10.10.2.1.
2. Hydrostatic testing in compliance with NFPA 13, 2013, 10.10.2.2. If any leaks are found during the test, the system must be retested after the leaks have been corrected by the underground water / fire service installing contractor.
3. Furnish Contractors Underground Material and Test Certificate, to Architect/Engineer upon completion of all required tests.

E. Documentation of the above ground piping system testing and acceptance procedures shall be the responsibility of the Division 21 contractor. Testing shall comply with NFPA 13, 2013, chapter 16. The testing and documentation shall include:

1. Hydrostatic testing in compliance with NFPA 13, 2013, 25.2.1. If any leaks are found during the test, the system must be retested after the leaks have been corrected.
2. System operational tests in compliance with NFPA 13, 2013, 25.2.2.
3. Testing of all installed backflow prevention assemblies in compliance with NFPA 13, 2013, 25.2.5.
4. Furnish Contractors Aboveground Material and Test Certificate, to Architect/Engineer upon completion.

F. Documentation of the standpipe testing and acceptance procedures shall be the responsibility of the Division 21 contractor; shall be in compliance with NFPA 14, 2013, Chapter 11. The testing and documentation shall include:

1. Flush standpipe piping in compliance with NFPA 14, 2013, 11.2.
2. Hydrostatic testing in compliance with NFPA 14, 2013, 11.4. If any leaks are found during the test, the system must be retested after the leaks have been corrected.
3. Flow testing in compliance with NFPA 14, 2013, 11.5.
4. Manual Valve testing in compliance with NFPA 14, 2013, 11.6.
5. Pressure regulating devices shall be tested in compliance with NFPA 14, 11.5.6.
6. Furnish Contractors Standpipe Aboveground Material and Test Certificate, to Architect/Engineer upon completion.

END OF SECTION 21 1000

SECTION 220513
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium, as defined in NEMA MG 1.

C. Service factor 1.15.

2.4 SINGLE-PHASE MOTORS

A. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

B. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation.

Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 220517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Sleeve-seal systems.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. GPT; an EnPro Industries company.
   4. Metraflex Company (The).
   5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Plastic.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      b. Where existing walls do not allow for outer sleeve pipe, it may be omitted, and the sleeve system installed directly per manufacturer recommendations.
   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      b. Where existing walls do not allow for outer sleeve pipe, it may be omitted, and the sleeve system installed directly per manufacturer recommendations.
   3. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
   4. Concrete Slabs above Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   5. Interior Partitions:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

END OF SECTION

SECTION 220518
ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
C. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange.
B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
C. Install floor plates for piping penetrations of equipment-room floors.
D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.

END OF SECTION

SECTION 220519
METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Filled-system thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.

B. Related Sections:
   1. Section 221116 "Domestic Water Piping" for water meters inside the building.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Trerice, H. O. Co.
      b. Weiss Instruments, Inc.
   2. Standard: ASME B40.200.
   3. Case: Sealed type, cast aluminum or drawn steel; 5-inch (127-mm) nominal diameter.
   4. Element: Bourdon tube or other type of pressure element.
   5. Movement: Mechanical, with link to pressure element and connection to pointer.
   6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
   7. Pointer: Dark-colored metal.
   8. Window: Glass.
   9. Ring: Metal.
   10. Connector Type(s): Union joint, rigid, back; with ASME B1.1 screw threads.
   11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:
   1. Standard: ASME B40.200.
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Material for Use with Steel Piping: CRES.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
   10. Lagging Extension: Include on thermowells for insulated piping and tubing.
   11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Trerice, H. O. Co.
      b. Weiss Instruments, Inc.
   2. Standard: ASME B40.100.
   3. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2(DN 8 or DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
   8. Pointer: Dark-colored metal.
   9. Window: Glass.
   10. Ring: Metal.
   11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2(DN 8 or DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install thermometers in the following locations:
   1. Inlet and outlet of each water heater.
   2. As indicated on drawings and details.

I. Install pressure gages in the following locations:
   1. Before and after water softener.

2. As indicated on drawings and details.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.
B. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi and 0 to 600 kPa.

END OF SECTION

SECTION 220523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Bronze swing check valves.
   3. Iron swing check valves.

B. Related Sections:
   1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
   2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.
   3. Section 221319 "Sanitary Waste Piping Specialties" for valves applicable only to this piping.
   4. Section 221423 "Storm Drainage Piping Specialties" for valves applicable only to this piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service, including lead free requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Handlever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Grooved: With grooves according to AWWA C606.
   3. Solder Joint: With sockets according to ASME B16.18.
   4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Conbraco Industries, Inc.
      b. Crane; Crane Energy Flow Solutions.
      c. Hammond Valve.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Watts; a Watts Water Technologies company.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Stainless steel.
      i. Ball: Stainless steel, vented.
      j. Port: Full.

2.3 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Crane; Crane Energy Flow Solutions.
      b. Hammond Valve.
      c. Milwaukee Valve Company.
      d. NIBCO INC.
      e. Watts; a Watts Water Technologies company.
   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow.
      d. Body Material: ASTM B 62, bronze.
      e. Ends: Threaded.
      f. Disc: Bronze.

2.4 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Crane; Crane Energy Flow Solutions.
      b. Hammond Valve.
      c. Milwaukee Valve Company.
      d. NIBCO INC.
      e. Watts; a Watts Water Technologies company.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. CWP Rating: 200 psig.
      c. Body Design: Clear or full waterway.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Throttling Service: Ball..
   2. Shut-off service: Ball.
   3. Pump-Discharge Check Valves:
      a. NPS 2and Smaller: Bronze swing check valves with bronze disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5and Larger: Flanged ends.
   4. For Steel Piping, NPS 2and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   3. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2and Larger:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
   3. Iron Swing Check Valves: Class 125, metal seats.

END OF SECTION

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Equipment supports.

B. Related Sections:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   2. Standard: MFMA-4.
   3. Channels: Continuous slotted steel channel with inturned lips.
   4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
   6. Metallic Coating: Electroplated zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Coordinate with all trades prior to creating shop drawings or fabricating materials.
B. Coordinate hanger types with vertical space available.
C. Coordinate with architectural plans for hanger features and areas not available for direct hanger support. Refer to plans.
D. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

E. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

F. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

G. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

H. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   5. Pipes NPS 8and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Medium (MSS Type 32): 1500 lb.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 220548.13
VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipe-riser resilient supports.
   2. Spring hangers.

B. Related Requirements:
   1. Section 230548.13 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
   1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
   2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.2 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
   1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."
B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
C. Contractor shall provide spring hangers on all domestic water mains. Refer to plan notes.
D. Contractor shall provide pipe riser resilient support on all domestic water main risers. Refer to plan notes.

END OF SECTION

SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Valve tags.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Brady Corporation.
      b. Kolbi Pipe Marker Co.
      c. Seton Identification Products.
   2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   3. Letter Color: Black.
   4. Background Color: White.
   5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
   8. Fasteners: Stainless-steel rivets or self-tapping screws.
   9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Kolbi Pipe Marker Co.
   3. Marking Sevices Inc.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Kolbi Pipe Marker Co.
   3. Seton Identification Products.

B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link chain or beaded chain.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   2. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   3. Near major equipment items and other points of origination and termination.
   4. Spaced at maximum intervals of 15 feet along each run. Reduce intervals to 5 feet in areas of congested piping and equipment.
   5. On piping above removable acoustical ceilings, spaced as noted above.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

1. Domestic Water Piping:
    a. Background: Safety green.
    b. Letter Colors: White.
2. Sanitary Waste and Storm Drainage Piping:
    a. Background Color: Safety purple.
    b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
    a. Cold Water: 1-1/2 inches, round.
    b. Hot Water: 2 inches, round.
2. Valve-Tag Colors:
    a. Cold Water: Safety green.
    b. Hot Water: Safety green.
3. Letter Colors:
    a. Cold Water: White.
    b. Hot Water: White.

END OF SECTION

SECTION 220719
PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:
   1. Domestic cold-water piping.
   2. Domestic hot-water piping.
   3. Domestic recirculating hot-water piping.
   4. Roof drains and rainwater leaders.
   5. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:
   1. Section 220716 "Plumbing Equipment Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
   2. Product Data for MR 5: For materials extracted, harvested or recovered, as well as manufactured within the region.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric Insulation: closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide product by one of the following:
   a. Aeroflex USA, Inc.
   b. Armacell LLC.
   c. K-Flex USA.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide product by one of the following:
   a. Johns Manville; a Berkshire Hathaway company.
   b. Knauf Insulation.
   c. Owens Corning.
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Phenolic:

1. Products: Subject to compliance with requirements, provide product by one of the following:
   a. ITW Insulation.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
4. Factory applied jacket: ASJ.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible elastomeric: Comply with MIL-A-24179A, Type II, Class 1.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Phenolic: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mildry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F(Minus 29 to plus 82 deg C).
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F(Minus 29 to plus 82 deg C).
   3. Solids Content: 60 percent by volume and 66 percent by weight.
   4. Color: White.

2.4 SEALANTS

A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F.
   4. Color: White or gray.
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: White.
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches(75 mm).
   2. Thickness: 11.5 mils(0.29 mm).
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches(50 mm).
   2. Thickness: 6 mils(0.15 mm).
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:
   1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal.
   2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
C. Wire: 0.062-inchsoft-annealed, stainless steel.

2.9 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Plumberex Specialty Products, Inc.
      b. Truebro.
      c. Zurn Industries, LLC.
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation

at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
   4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
   5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:
1. Secure single-layer insulation with stainless steel bands at 12-inch intervals and tighten bands without deforming materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6-inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. NPS 1 and Smaller: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Phenolic: 1 inch thick.
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/4 and Larger: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Phenolic: 1 inch thick.
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/2 and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Protective Shielding Guards.

E. Floor Drains, Traps, and Sanitary Drain Piping within 20 feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F(16 Deg C):
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Phenolic: 1 inch thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.

D. Piping, Exposed:
   1. PVC: 30 mils thick.

END OF SECTION

SECTION 221116
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

1.3 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify General Contractor no fewer than two days in advance of proposed interruption of water service.
   2. Do not interrupt water service without General Contractor's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
F. Copper Unions:
   1. MSS SP-123.
   2. Cast-copper-alloy, hexagonal-stock body.
   3. Ball-and-socket, metal-to-metal seating surfaces.
   4. Solder-joint or threaded ends.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:
   1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
B. Standard-Pattern, Mechanical-Joint Fittings:
   1. AWWA C110/A21.10, ductile or gray iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.
B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
C. Solder Filler Metals: ASTM B 32, lead-free alloys.
D. Flux: ASTM B 813, water flushable.
E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.
B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
B. Dielectric Unions:
   1. Standard: ASSE 1079.
   2. Pressure Rating: 150 psig.
   3. End Connections: Solder-joint copper alloy and threaded ferrous.
C. Dielectric Flanges:
   1. Standard: ASSE 1079.
   2. Factory-fabricated, bolted, companion-flange assembly.
   3. Pressure Rating: 150 psig.
   4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
D. Dielectric-Flange Insulating Kits:
   1. Nonconducting materials for field assembly of companion flanges.
   2. Pressure Rating: 150 psig.
   3. Gasket: Neoprene or phenolic.
   4. Bolt Sleeves: Phenolic or polyethylene.
   5. Washers: Phenolic with steel backing washers.
E. Dielectric Nipples:
   1. Standard: IAPMO PS 66.
   2. Electroplated steel nipple complying with ASTM F 1545.
   3. Pressure Rating and Temperature: 300 psig at 225 deg F.

4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
E. Install shutoff valve immediately upstream of each dielectric fitting.
F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
G. Install domestic water piping level without pitch and plumb.
H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
L. Install piping to permit valve servicing.
M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
N. Install piping free of sags and bends.
O. Install fittings for changes in direction and branch connections.
P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
R. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet(30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4(DN 25 and DN 32): 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2(DN 40 and DN 50): 96 inches with 3/8-inch rod.
   4. NPS 2-1/2(DN 65): 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5(DN 80 to DN 125): 10 feet with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet(3 m).

F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
         1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
         2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
      c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
      d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   2. Piping Tests:
      a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
      b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
      c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
      d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
      e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
      f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
      b. Adjust calibrated balancing valves to flows indicated.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

D. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be the following:
   1. Mechanical-joint, ductile-iron pipe; standard- pattern, mechanical-joint fittings; and mechanical joints.

E. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

END OF SECTION

SECTION 221119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Backflow preventers.
2. Balancing valves.
3. Temperature-actuated, water mixing valves.
4. Outlet boxes.
5. Wall hydrants.
6. Water-hammer arresters.
7. Water meters.

B. Related Requirements:
1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 223200 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
5. Section 224713 "Drinking Fountains" for water filters for water coolers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers :
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Conbraco Industries, Inc.
      b. Watts; a Watts Water Technologies company.
      c. Zurn Industries, LLC.
   2. Standard: ASSE 1013.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 12 psig maximum, through middle third of flow range.
   5. Body: Bronze for NPS 2 and smaller; steel with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
   6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   7. Accessories:
      a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
      b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
      c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Beverage-Dispensing-Equipment Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Conbraco Industries, Inc.
      b. Watts; a Watts Water Technologies company.
      c. Zurn Industries, LLC.
   2. Standard: ASSE 1022.
   3. Operation: continuous-pressure applications.
   4. Size: NPS 1/4 or NPS 3/8.
   5. Body: Stainless Steel.
   6. End connection: threaded.

2.4 BALANCING VALVES

A. Memory-Stop Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Conbraco Industries, Inc.
      b. Crane; Crane Energy Flow Solutions.
      c. Hammond Valve.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
   2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
   3. Pressure Rating: 400-psig minimum CWP.
   4. Size: NPS 2 or smaller.
   5. Body: Copper alloy.
   6. Port: Standard or full port.
   7. Ball: Chrome-plated brass.
   8. Seats and Seals: Replaceable.
   9. End Connections: Solder joint or threaded.
   10. Handle: Vinyl-covered steel with memory-setting device.

2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Lawler Manufacturing Company, Inc.
   b. Leonard Valve Company.
   c. Powers.
   d. Symmons Industries, Inc.
   e. Zurn Industries, LLC.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 110F
9. Valve Finish: Rough bronze.
10. Piping Finish: Copper.

2.6 OUTLET BOXES

A. Clothes Washer Outlet Boxes / Water Connection Boxes:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Acorn Engineering Company.
      b. Guy Gray Manufacturing Co., Inc.
      c. IPS Corporation.
      d. Watts; a Watts Water Technologies company.
      e. Zurn Industries, LLC.
   2. Mounting: Recessed.
   3. Material and Finish: Galvanized-steel or epoxy-painted-steel box and faceplate.
   4. Supply Shutoff Fittings: NPS 1/2 ball valves and NPS 1/2 copper, water tubing.
   5. Drain: NPS 1-1/2 standpipe and P-trap for direct waste connection to drainage piping.
   6. Water hammer arrestors, where scheduled, shall be provided from manufacturer, integral.

2.7 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Jay R. Smith Mfg. Co.
      b. Josam Company.
      c. Watts; a Watts Water Technologies company.
      d. Woodford Manufacturing Company.
      e. Zurn Industries, LLC.
   2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
   3. Pressure Rating: 125 psig.
   4. Operation: Loose key.
   5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   6. Inlet: NPS 3/4 or NPS 1.
   7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   8. Box: Deep, flush mounted with cover.
   9. Box and Cover Finish: Chrome plated.
   10. Operating Keys(s): One with each wall hydrant.

2.8 ROOF HYDRANTS

A. Non-freeze Roof Hydrants:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Jay R. Smith Mfg. Co.
      b. Josam Company.
      c. Watts; a Watts Water Technologies company.
      d. Woodford Manufacturing Company.
      e. Zurn Industries, LLC.

2. Standard: ASME A112.21.3M.
3. Type: Non-freeze, draining.
4. Operation: Loose key.
5. Outlet: garden-hose thread complying with ASME B1.20.7.
6. Operating Keys(s): One with each wall hydrant.

2.9 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Jay R. Smith Mfg. Co.
      b. Josam Company.
      c. Precision Plumbing Products.
      d. Sioux Chief Manufacturing Company, Inc.
      e. Watts; a Watts Water Technologies company.
      f. Zurn Industries, LLC.
   2. Standard: ASSE 1010 or PDI-WH 201.
   3. Type: Copper tube with piston.
   4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.10 WATER METERS

A. Compound-Type Water Meters - furnished by local utility
   1. Description:
      a. Standard: AWWA C702.
      b. Pressure Rating: 150-psig working pressure.
      c. Body Design: With integral mainline and bypass meters; totalization meter.
      d. Case: Bronze.
      e. Pipe Connections: Flanged.

B. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Provide backflow prevention in the following locations, and as required by authorities having jurisdiction.
   1. Hydronic system fill location: Reduced-Pressure-Principle Backflow Preventers.
   2. Ice-makers, coffee machines, refrigerators: Beverage-Dispensing-Equipment Backflow Preventers.

B. Backflow prevention installation:
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
   3. Do not install bypass piping around backflow preventers.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

F. Install water-hammer arresters in water piping according to PDI-WH 201, manufacturer recommendations, and as shown on plans.

3.2 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Reduced-pressure-principle backflow preventers.
   2. Calibrated balancing valves.
   3. Primary, thermostatic, water mixing valves.
   4. Primary water tempering valves.
   5. Outlet boxes.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 221123
DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. In-line centrifugal pumps.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.
B. Protect bearings and couplings against damage.
C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Bell & Gossett; a Xylem brand.
   2. Grundfos Pumps Corp.

B. Components:
1. The pumps shall be a wet rotor inline pump, in lead free bronze body construction specifically designed for quiet operation. Suitable standard operations at 230° F and 175 PSIG working pressure. The pump internals shall be capable of being serviced without disturbing piping connections.
2. The pump internals shall be capable of being serviced without disturbing piping connections.
3. Pump shall be equipped with a water-tight seal to prevent leakage.
4. Pump volute shall be of a lead free bronze for domestic water systems. The connection style on the bronze pumps shall be flanged.
5. Motor shall be a synchronous, permanent-magnet (PM) motor and tested with the pump as one unit. Conventional induction motors will not be acceptable.
6. Each motor shall have an Integrated Variable Frequency Drive tested as one unit by the manufacturer.
7. Integrated motor protection shall be verified by UL to protect the pump against over/under voltage, over temperature of motor and/or electronics, over current, locked rotor and dry run (no load condition).
8. Pump shall have MODBUS or BACnet connections built into the VFD as standard options.
9. Analog inputs, such as 0-10V and 4-20mA, are standard inputs built into the VFD.
10. Pumps shall be UL 778 listed and bear the UL Listed Mark for USA and Canada with on-board thermal overload protection.
11. Each pump shall be factory performance tested before shipment.

C. Operating Modes:
1. Proportional Pressure – The differential pressure will continuously increase or decrease along a linear curve based on the flow demand.
2. Constant Pressure – The pump maintains a constant differential pressure set by the user at any flow demand until the maximum speed is reached.
3. Constant Speed – The pump maintains a constant speed at any flow rate
4. Night Set Back – The pump will recognize a 10°C water temperature reduction and will switch to nighttime operation.
5. T-Constant – This control will use a PI algorithm to vary the speed of the pump in order to maintain a constant temperature of the fluid media.
6. Delta-T Constant – This control mode will use a PI algorithm to vary the speed of the pump in order to maintain a constant differential temperature between the built-in temperature sensor and external temperature sensor.
7. Delta-P-T – This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the fluid temperature.
8. Delta-P-Delta-T – This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the differential temperature between the built-in temperature sensor and external temperature sensor.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 50 to 125 deg F.
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V, ac.
7. Settings: Start pump at 95 deg F and stop pump at 105 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.
B. Install in-line centrifugal pumps with shaft vertical unless otherwise indicated.
C. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.
    1. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
    2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
D. Install thermostats in hot-water return piping and as detailed on plan.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to pumps to allow service and maintenance.
C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
    1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
        a. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
D. Install shutoff valve and strainer on suction side of each pump, and check and shutoff valves on discharge side of each pump. Install valves same size as connected piping.
    1. Install pressure gage at suction of each pump and pressure gage at discharge of each pump and as detailed on drawings. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."
E. Connect thermostats to pumps that they control.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 STARTUP SERVICE

A. Perform startup service.
    1. Complete installation and startup checks according to manufacturer's written instructions.
    2. Check piping connections for tightness.
    3. Clean strainers on suction piping.
    4. Set thermostats for automatic starting and stopping operation of pumps.
    5. Perform the following startup checks for each pump before starting:
        a. Verify bearing lubrication.
        b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
        c. Verify that pump is rotating in the correct direction.
    6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
    7. Start motor.
    8. Open discharge valve slowly.
    9. Adjust temperature settings on thermostats.

END OF SECTION

SECTION 221316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.
   2. Waste, Force-Main Piping: 100 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify General Contractor no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without General Contractor's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.
B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
C. CISPI, Hubless-Piping Couplings:
   1. Standards: ASTM C 1277 and CISPI 310.
   2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 COPPER TUBE AND FITTINGS

A. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
B. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.
C. Copper Pressure Fittings:
   1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
D. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
E. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.
F. Install piping at indicated slopes.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
    1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4and larger.
    2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
    3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
P. Install aboveground PVC piping according to ASTM D 2665.
Q. Install underground PVCpiping according to ASTM D 2321.
R. Install engineered soil and waste drainage and vent piping systems as follows:
    1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
    2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
    3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
S. Install force mains at elevations indicated.
T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 220523.
B. Shutoff Valves:
   1. Install shutoff (ball) valve on each sewage pump discharge.
C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
D. Backwater Valves: Install backwater valves in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
   2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   3. Vertical Piping: MSS Type 8 or Type 42, clamps.
   4. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet(30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   6. Base of Vertical Piping: MSS Type 52, spring hangers.
C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
D. Support vertical piping and tubing at base and at each floor.
E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inchminimum rods.
F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2(DN 40 and DN 50): 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5(DN 100 and DN 125): 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8(DN 150 and DN 200): 60 inches with 3/4-inch rod.
   5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches(1500 mm).
G. Install supports for vertical cast-iron soil piping every 15 feet.
H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4(DN 32): 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2(DN 40 and DN 50): 96 inches with 3/8-inch rod.
I. Install supports for vertical copper tubing every 10 feet(3 m).
J. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2(DN 40 and DN 50): 48 inches with 3/8-inch rod.
   2. NPS 3(DN 80): 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5(DN 100 and DN 125): 48 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8(DN 150 and DN 200): 48 inches with 3/4-inch rod.
K. Install supports for vertical ABS and PVC piping every 48 inches(1200 mm).
L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves in pit with pit cover flush with floor.
6. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
   1. Solid wall or Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.

E. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
   1. Solid-wall or Cellular-core PVC pipe; PVC socket fittings; and solvent-cemented joints.

F. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be the following:
   1. Hard copper tube, Type L(Type B); copper pressure fittings; and soldered joints.

END OF SECTION

SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Backwater valves.
   2. Cleanouts.
   3. Floor drains.
   4. Roof flashing assemblies.
   5. Through-penetration firestop assemblies.
   6. Miscellaneous sanitary drainage piping specialties.
   7. Flashing materials.
   8. Grease interceptors.

B. Related Requirements:
   1. Section 221423 "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.
   2. Section 334100 "Storm Utility Drainage Piping" for storm draining piping and piping specialties outside the building.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.
B. FRP: Fiberglass-reinforced plastic.
C. HDPE: High-density polyethylene plastic.
D. PE: Polyethylene plastic.
E. PP: Polypropylene plastic.
F. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Cleanouts
2. Floor drains
3. Roof flashing assemblies
4. Through-penetration firestop assemblies
5. Grease interceptors

B. LEED Submittals:
1. Product Data for MR 4: For recycled content.
2. Product Data for MR 5: For materials extracted, harvested or recovered, as well as manufactured within the region.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:
1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
   a. Jay R. Smith Mfg. Co.
   b. Josam Company.
   c. Watts; a Watts Water Technologies company.
   d. Zurn Industries, LLC.
2. Size: Same as connected piping.
3. Body: PVC.
4. Cover: Same material as body with threaded access check valve.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts:
1. ASME A112.36.2M, Cast-Iron Cleanouts:
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:
1. ASME A112.36.2M, Cast-Iron Cleanouts:
2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Closure: Brass plug with tapered threads.
7. Adjustable Housing Material: Cast iron with threads.
8. Frame and Cover Material and Finish: Rough bronze.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Medium Duty.
11. Riser: ASTM A 74, Serviceclass, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following
      a. Jay R. Smith Mfg. Co.
      b. Josam Company.
      c. Watts; a Watts Water Technologies company.
      d. Zurn Industries, LLC.
   2. Standard: ASME A112.6.3.
   3. Body Material: Gray iron.
   4. Seepage Flange: Required.
   5. Outlet: Bottom.
   6. Backwater Valve: Not required.
   7. Coating on Interior and Exposed Exterior Surfaces: Not required.
   8. Sediment Bucket: Not required.
   9. Top of Body and Strainer Finish: Rough bronze.
   10. Top Shape: Square.
   11. Top Loading Classification: Medium Duty.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
   1. Description: Manufactured assembly made of 4.0-lb/sq. ft.(20-kg/sq. m), 0.0625-inch- thick, lead flashing collar and skirt extending at least 10 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
      a. Open-Top Vent Cap: Without cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
   1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
   2. Size: Same as connected soil, waste, or vent stack.
   3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
   5. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Stack Flashing Fittings:
   1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.
B. Frost-Resistant Vent Terminals:
   1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
   2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

2.7 FLASHING MATERIALS

A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-milminimum thickness.
B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
D. Solder: ASTM B 32, lead-free alloy.
E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.8 GREASE INTERCEPTORS

A. Plastic grease interecptors:
1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following
a. Josam Company.
b. Schier Products.
c. Zurn Industries, LLC.
2. Standard: ASME A1112.14.3 for intercepting and retaining fats, oils, and greases from food-preparation.
3. Field-adjustable riser system.
4. Body material: seamless polyethylene
5. Diffusion and/or baffles interior to allow separation of greases.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting:
1. Install Section 033000 "Cast-in-Place Concrete."
B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4(DN 100). Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.
D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
I. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
J. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
K. Install wood-blocking reinforcement for wall-mounting-type specialties.

L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

M. Install grease interceptors, including trapping, venting, and flow-control fittings according to authority having jurisdiction and with clear space for servicing.

1. Flush with floor installation: set unit and extension, if required, with cover flush to finished floor.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Grease interceptors: Connect inlet and outlet to unit, and connect flow control fitting and vent to unit inlet and outlet piping.

3.3 FLASHING INSTALLATION

A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

B. Set flashing on floors and roofs in solid coating of bituminous cement.

C. Secure flashing into sleeve and specialty clamping ring or device.

D. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."

E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Grease interceptor.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221413
FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
B. Related Sections:
   1. Section 221429 "Sump Pumps" for storm drainage pumps.
   2. Section 334100 "Storm Utility Drainage Piping" for storm drainage piping outside the building.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.
   2. Storm Drainage, Force-Main Piping: 50 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify General Contractor no fewer than two days in advance of proposed interruption of storm-drainage service.
   2. Do not proceed with interruption of storm-drainage service without General Contractor's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Copper Drainage Fittings: ASME B16.23, cast-copper fittings or ASME B16.29, wrought-copper, solder-joint fittings.
B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
C. Copper Pressure Fittings:
   1. Copper Fittings: ASME B16.18, cast-copper-alloy fittings or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
D. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
E. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
D. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
E. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
    1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
    2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
M. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
N. Install aboveground PVC piping according to ASTM D 2665.
O. Install underground PVC piping according to ASTM D 2321.
P. Install force mains at elevations indicated.
Q. Plumbing Specialties:
    1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
    2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
B. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 220523.
B. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
    1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
    2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
    3. Vertical Piping: MSS Type 8 or Type 42, clamps.
    4. Individual, Straight, Horizontal Piping Runs:
        a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
        b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
        c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.
G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

H. Install supports for vertical PVC piping every 48 inches.
I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
C. Connect storm drainage piping to roof drains and storm drainage specialties.
1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
2. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."

D. Connect force-main piping to the following:
1. Sump Pumps: To sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
B. Aboveground storm drainage piping NPS 6 and smaller shall be the following:
1. Solid-wall or Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.
C. Underground storm drainage piping NPS 6 and smaller shall be the following:
1. Solid-wall or Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.
D. Underground, storm drainage piping NPS 8 and larger shall be the following:
1. Solid-wall or Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
E. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 shall be the following:
1. Hard copper tube, copper pressure fittings, and soldered joints.
F. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 shall be the following:
1. Hard copper tube, copper pressure fittings, and soldered joints.

END OF SECTION

SECTION 221423
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Through-penetration firestop assemblies.
5. Flashing materials.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. LEED Submittals:
1. Product Data for MR 4: Recycled content.
2. Product Data for MR 5: For materials extracted, harvested or recovered, as well as manufactured within the region.

1.4 QUALITY ASSURANCE

A. Mockup: Refer to Section 01 43 39 – Mockups for description of construction required to complete a mockup submittal for review.
B. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. Watts; a Watts Water Technologies company.
d. Zurn Industries, LLC.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.

4. Dimension of Body: Nominal 14-inch diameter.
5. Combination Flashing Ring and Gravel Stop: Not required.
6. Flow-Control Weirs: Not required.
7. Outlet: Bottom.
8. Dome Material: Cast iron.
9. Perforated Gravel Guard: Not required.
10. Vandal-Proof Dome: Not required.
11. Water Dam: 2 inches high.
12. Roof drain shall be compatible with and, approved by, the selected roof membrane manufacturer. Roof drains shall be included in the roof installation warranty (30 years). Plumbing contractor shall coordinate with general / roofing contractor.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Conductor Nozzles:
1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. Watts; a Watts Water Technologies company.
d. Zurn Industries, LLC.
2. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
3. Size: Same as connected conductor.

2.3 CLEANOUTS

A. Floor Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Standard: ASME A112.36.2M, for threaded, adjustable housing cleanouts.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule Material: Cast iron.
6. Adjustable Housing Material: Cast iron with threads.
7. Frame and Cover Material and Finish: Rough bronze.
8. Frame and Cover Shape: Square.
9. Top-Loading Classification: Medium Duty.
10. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Wall Cleanouts:
1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, cast-iron plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Square, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
1. Standard: ASTM E 814, for through-penetration firestop assemblies.
2. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
3. Size: Same as connected pipe.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.5 FLASHING MATERIALS

A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-milminimum thickness.
B. Fasteners: Metal compatible with material and substrate being fastened.
C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
D. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
    1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
    2. Install expansion joints, if indicated, in roof drain outlets.
    3. Position roof drains for easy access and maintenance.
B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
    1. Use cleanouts the same size as drainage piping up to NPS 4(DN 100). Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
    2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
    3. Locate cleanouts at minimum intervals of 50 feet Insert dimension for piping NPS 4 and smaller and 100 feet for larger piping.
    4. Locate cleanouts at base of each vertical soil and waste stack.
D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
F. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
G. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
H. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
    1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
    2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
    3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
B. Set flashing on floors and roofs in solid coating of bituminous cement.
C. Secure flashing into sleeve and specialty clamping ring or device.
D. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221429
SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Submersible sump pumps.
   2. Sump-pump basins and basin covers.

B. Related Section:
   1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Bell & Gossett; a Xylem brand.
      b. Grundfos Pumps Corp.
      c. Little Giant Pump Co.
      d. Weil Pump Company, Inc.
   2. Description: Factory-assembled and -tested sump-pump unit.
   3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
   4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
   5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron, semi-open design for clear wastewater handling, and keyed and secured to shaft.
   6. Pump and Motor Shaft: Stainless steel or steel, with factory-sealed, grease-lubricated ball bearings.
   7. Seal: Mechanical.
   8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   9. Controls:
      a. Enclosure: NEMA 250, Type 1.
      b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
      e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   10. Control-Interface Features:
      a. Remote Alarm Contacts: For remote alarm interface.
      b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         1) On-off status of pump.
         2) Alarm status.

2.2 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
   1. Material: Fiberglass.
   2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
   3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
   1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.4 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 223100
DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Commercial water softeners.
   2. Chemicals.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water softeners.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.

1.6 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Salt for Brine Tanks: Furnish in same form as and at least four times original load, but not less than 200 lb. Deliver on pallets according to the following:
      a. Plain Pellet Salt: In 40- or 50-lb packages.
   2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application.

B. UL Compliance: Fabricate and label water softeners to comply with UL 979, "Water Treatment Appliances."

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures of mineral and brine tanks.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   d. Attrition loss of resin exceeding 3 percent per year.
   e. Mineral washed out of system during service run or backwashing period.
   f. Effluent turbidity greater and color darker than incoming water.
   g. Fouling of underdrain system, gravel, and resin with turbidity or by dirt, rust, or scale from water softener or soft water, while operating according to manufacturer's written operating instructions.
2. Commercial Water Softeners, Warranty Period: From date of Substantial Completion.
   a. Mineral Tanks: Five years.
   b. Brine Tanks: 10 years.
   c. Control Valve: One year(s).

PART 2 - PRODUCTS

2.1 COMMERCIAL WATER SOFTENERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Capital Water Softener Inc.
2. Culligan International Company.
3. Kinetico Incorporated.

B. Description: Factory-assembled, pressure-type water softener.

1. Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects."
2. Configuration: Twin unit with two mineral tanks and one brine tank.
3. Mounting: On skids.
4. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.
5. Mineral Tanks: FRP, pressure-vessel quality.
   a. Construction: Non-ASME code.
   b. Pressure Rating: 100 psig minimum.
   c. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
   d. Liner: PE, ABS, or other material suitable for potable water.
6. Controls: Fully automatic; factory wired and factory mounted on unit.
   a. Adjustable duration of various regeneration steps.
   b. Push-button start and complete manual operation.
   c. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
   d. Sequence of Operation: Multiport pilot-control valve automatically pressure-actuates main operating valve through steps of regeneration and return to service.
7. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
   a. Slow opening and closing, nonslam operation.
   b. Diaphragm guiding on full perimeter from fully open to fully closed.
   c. Isolated, dissimilar metals within valve.

d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
e. Sampling cocks for soft water.
f. Special tools are not required for service.

8. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressure; does not require field adjustments.
   a. Demand-Initiated Control: Each mineral tank of twin mineral-tank unit is equipped with automatic-reset-head water meter that electrically activates cycle controllers to initiate regeneration at preset total in gallons. Head automatically resets to preset total in gallons for next service run. Electrical lockout prevents simultaneous regeneration of both tanks.
9. Brine Tank: Combination measuring and wet-salt storing system.
   a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
   b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawal and freshwater refill.
   c. Size: Large enough for at least four regenerations at full salting.

2.2 CHEMICALS

A. Mineral: High-capacity, sulfonated-polystyrene, ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.
B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.
   1. Form: Processed, plain salt pellets.

PART 3 - EXECUTION

3.1 WATER SOFTENER INSTALLATION

A. Equipment Mounting:
   1. Install commercial water softeners on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
B. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where piping is installed adjacent to equipment, allow space for service and maintenance of equipment.
C. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
   1. Metal general-duty valves are specified in Section 220523.
   2. Exception: Water softeners with factory-installed shutoff valves at locations indicated.
D. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."
   1. Exception: Water softeners with factory-installed pressure gages at locations indicated.
E. Install valved bypass in water piping around water softeners.
   1. Metal general-duty valves are specified in Section 220523.
   2. Water piping is specified in Section 221116 "Domestic Water Piping."
F. Install drains as indirect wastes to spill into open drains or over floor drains.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Water softeners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

B. Add water to brine tanks and fill with the following form of salt:
   1. Commercial Water Softeners: Processed, plain salt pellets.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
   1. ASTM D 859, "Test Method for Silica in Water."
   2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
   3. ASTM D 1068, "Test Methods for Iron in Water."
   4. ASTM D 1126, "Test Method for Hardness in Water."
   5. ASTM D 1129, "Terminology Relating to Water."
   6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain water softeners.

END OF SECTION

SECTION 223400
FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Commercial, power-vent, gas-fired, storage, domestic-water heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Periods: From date of Substantial Completion.
      a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
         1) Storage Tank: Three years.
         2) Controls and Other Components: One year(s).

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. HTP.
      b. PVI.
   2. Standard: ANSI Z21.10.3/CSA 4.3.
   3. Storage-Tank Construction: 316L stainless steel Non-ASME-code with 150-psig working-pressure rating.
      a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
         1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
   4. Heat Exchanger and Combustion System:
      a. Copper nickel, gasketless, heat exchanger with copper nickel secondary tube construction
      b. Modulating burner with 5:1 turndown and 96% thermal efficiency.
      c. High grade Inconel premix burner.
   5. Factory-Installed Storage-Tank Appurtenances:
      a. Anode Rod: Replaceable magnesium.
      b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
      c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
      d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
      e. Jacket: Steel with enameled finish.
      f. Burner: For use with power-vent, gas-fired, domestic-water heaters and natural-gas fuel.
      g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
      h. Temperature Control: Adjustable thermostat.
      i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
   6. Power-Vent System: Exhaust fan, interlocked with burner.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
   1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
   2. Maintain manufacturer's recommended clearances.
   3. Arrange units so controls and devices that require servicing are accessible.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   7. Install anchor bolts to elevations required for proper attachment to supported equipment.
   8. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
   1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."

D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 Domestic Water Piping Specialties."

F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

G. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Fill domestic-water heaters with water.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION

SECTION 224213.13
COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Water closets.
   2. Flushometer valves.
   3. Toilet seats.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:
   1. Product Data for Prerequisite WE 1, Credit WE2, and Credit WE 3: Documentation indicating flow and water consumption requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
   1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED WATER CLOSETS

A. Water Closets: Wall mounted, top spud, accessible where so designated.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. American Standard America.
b. Crane Plumbing, L.L.C.
c. Kohler Co.
d. TOTO USA, INC.
e. Zurn Industries, LLC.

2. Bowl:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Siphon jet.
   d. Style: Manual flushometer valve.
   e. Height: Standard and accessible, per plans.
   f. Rim Contour: Elongated.
   g. Water Consumption: 1.28 gal. per flush.
   h. Spud Size and Location: NPS 1-1/2; top.
3. Support:
   a. Standard: ASME A112.6.1M.
   b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Commercial grade, steel, floor-mount, by J.R. Smith, Josam, MIFAB, Wade, Watts, or Zurn.
   c. Water-Closet Mounting Height: Handicapped/elderly according to ICC/ANSI A117.1.

2.2 FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves:
1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Sloan Valve Company
   b. Zurn Industries, LLC
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Consumption: 1.28 gal. per flush.
9. Minimum Inlet: NPS 1.
10. Minimum Outlet: NPS 1-1/4.

2.3 TOILET SEATS

A. Toilet Seats:
1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. American Standard America.
   b. Kohler Co.
   c. TOTO USA, INC.
   d. Zurn Industries, LLC.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Standard).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Water-Closet Installation:
   1. Install per manufacturer recommendations.
   2. Install level and plumb according to roughing-in drawings.
   3. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
   4. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
B. Support Installation:
   1. Install per manufacturer recommendations.
   2. Set level and plumb, and secure in place to floor and walls providing solid bearing and secure mounting, for wall-hung urinals. Bolt fixture carriers to floor and walls.
   3. Secure rough-in fixture piping to prevent movement of exposed piping.
   4. Use carrier supports with waste-fitting assembly and seal.
   5. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
C. Flushometer-Valve Installation:
   1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
   2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
   3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
   4. Install actuators in locations that are easy for people with disabilities to reach.
   5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
D. Install toilet seats on water closets.
E. Wall Flange and Escutcheon Installation:
   1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
   2. Install deep-pattern escutcheons if required to conceal protruding fittings.
   3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
F. Joint Sealing:
   1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
   2. Match sealant color to water-closet color.
   3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
B. Install protective covering for installed water closets and fittings.
C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224213.16
COMMERCIAL URINALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Urinals.
   2. Flushometer valves.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:
   1. Product Data for Prerequisite WE 1, Credit WE2, and Credit WE 3: Documentation indicating flow and water consumption requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
   1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

A. Urinals: Wall hung, back outlet, washout**;** accessible where noted on plan.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. American Standard America.
      b. Crane Plumbing, L.L.C.

c. Kohler Co; Bardon.
d. TOTO USA, INC.
e. Zurn Industries, LLC.

2. Fixture:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Washout with extended shields.
   d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
   e. Water Consumption: Ultra-Low.
   f. Spud Size and Location: NPS 3/4, top.
   g. Outlet Size and Location: NPS 2, back.
   h. Color: White.
3. Waste Fitting:
   a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
   b. Size: NPS 2.
4. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Commercial grade, steel, floor-support, by J.R. Smith, Josam, MIFAB, Wade, Watts, or Zurn.

2.2 URINAL FLUSHOMETER VALVES

A. Hard-Wired, Solenoid-Actuator, Piston Flushometer Valves:
1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Sloan Valve Company.
   b. TOTO USA, INC.
   c. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
9. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Consumption: 0.125 gal. per flush.
11. Minimum Inlet: NPS 3/4.
12. Minimum Outlet: NPS 3/4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
B. Examine walls and floors for suitable conditions where urinals will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Urinal Installation:
1. Install per manufacturer recommendations.
2. Install urinals level and plumb according to roughing-in drawings.
3. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:
1. Install per manufacturer recommendations.
2. Set level and plumb, and secure in place to floor and walls providing solid bearing and secure mounting, for wall-hung urinals. Bolt fixture carriers to floor and walls.

3. Secure rough-in fixture piping to prevent movement of exposed piping.
4. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
5. Use carriers without waste fitting for urinals with tubular waste piping.
6. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flushometer-Valve Installation:
1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.

D. Wall Flange and Escutcheon Installation:
1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Joint Sealing:
1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
D. Where installing piping adjacent to urinals, allow space for service and maintenance.
E. Coordinate electrical connections with electrical.

3.4 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
B. Install protective covering for installed urinals and fittings.
C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224216.13
COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Lavatories.
   2. Faucets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:
   1. Product Data for Prerequisite WE 1, Credit WE2, and Credit WE 3: Documentation indicating flow and water consumption requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Servicing and adjustments of automatic faucets.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

A. Lavatory L-1: Oval, vitreous china, undercounter mounted.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. American Standard.
      b. Crane Plumbing LLC.
      c. Kohler Co.

d. Sloan Valve Company.
e. Zurn Industries LLC.

2. Fixture:
   a. Standard: ASME A112.19.2/CSA B45.1.
   b. Type: For undercounter mounting.
   c. Nominal Size: Oval, 19 by 16 inches.
   d. Faucet-Hole Punching: One hole.
   e. Faucet-Hole Location: On countertop, centered.
   f. Color: White.
   g. Mounting Material: Sealant and undercounter mounting kit.

2.2 VITREOUS CHINA WALL-MOUNTED LAVATORIES

A. Lavatory L-2: Square, vitreous china, wall-mounted.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. American Standard.
      b. Crane Plumbing LLC.
      c. Kohler Co.
      d. Sloan Valve Company.
      e. Zurn Industries LLC.
   2. Fixture:
      a. Standard: ASME A112.19.2/CSA B45.1.
      b. Type: Wall-hung.
      c. Nominal Size: Oval, 20 by 18 inches.
      d. Faucet-Hole Punching: One hole.
      e. Faucet-Hole Location: Rear center.
      f. Color: White.
      g. Mounting Material: Sealant and undercounter mounting kit.

2.3 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets for L-1 and L-2: Automatic-type, hard-wired, electronic-sensor-operated, mixing, solid-brass valve.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. American Standard.
      b. Crane Plumbing LLC.
      c. Kohler Co.
      d. Sloan Valve Company.
      e. Zurn Industries LLC.
   2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
   3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   4. General: Include hot- and cold-water integral above-deck mixing; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
   5. Body Type: Single hole.
   6. Body Material: Commercial, solid brass, chrome plated.
   7. Finish: Polished chrome plate.
   8. Maximum Flow Rate: 0.5 gpm.
   9. Mounting Type: Deck, concealed.
   10. Spout: Rigid type.
   11. Spout Outlet: Laminar flow.
   12. Drain: Grid-type.

2.4 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
E. Operation: Wheel handle.
F. Risers:
1. NPS 1/2.
2. ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

2.5 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.
B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
C. Trap:
1. Size: NPS 1-1/2 by NPS 1-1/4.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
B. Examine counters and walls for suitable conditions where lavatories will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.
B. Install supports, affixed to building substrate, for wall-mounted lavatories.
C. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
D. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
E. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
D. Coordinate electrical connections with electrical.

3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
B. Adjust water pressure at faucets to produce proper flow.
C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.
B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed lavatories and fittings.
D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224216.16
COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Service basins.
   2. Service sinks.
   3. Utility sinks.
   4. Handwash sinks.
   5. Sink faucets.
   6. Supply fittings.
   7. Waste fittings.

B. Related Requirements:
   1. Section 224100 "Residential Plumbing Fixtures" for residential sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:
   1. Product Data for Prerequisite WE 1 and Credit WE 3, Credit WE2, and Credit WE 3: Documentation indicating flow and water consumption requirements.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sinks to include in maintenance manuals.

1.5 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.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

A. Service Basins MS-1: Plastic, floor mounted.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Acorn.
      b. Fiat Products.
      c. E.L. Mustee.
   2. Fixture:
      a. Standard: IAPMO/ANSI Z124.6.
      b. Material: Structural fiberglass.
      c. Nominal Size: Shown on plans.
      d. Rim Guard: Stainless steel; on all top surfaces.
      e. Drain: Grid with NPS 3 outlet.
   3. Mounting: On floor and flush to wall.
   4. Options:
      a. Faucet, from manufacturer, including vacuum breaker
      b. Mop hanger.

2.2 SERVICE SINKS

A. Service Sinks S-2: Durastone twin unit, floor-mounted.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Acorn.
      b. Fiat Products.
      c. E.L. Mustee.
   2. Fixture:
      a. Standard: IAPMO/ANSI Z124.
      b. Type: Two-compartment.
      c. Nominal Size: 40 by 24 inches.
      d. Color: White.
      e. Mounting: NPS 2 P-trap standard with grid strainer inlet, cleanout, and floor flange.
   3. Options:
      a. 4” O.C. 7” swing-out faucet, with hot and cold lever handles, from manufacturer.

2.3 HANDWASH SINKS

A. Handwash Sinks S-1: Stainless steel, counter-top.
   1. Manufacturers: Subject to compliance with requirements provide product indicated on Drawings or comparable product by one of the following:
      a. American Standard.
      b. Elkay.
   2. Fixture:
      a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
      b. Type: Basin with radius corners, back for faucet, and support brackets.
      c. Nominal Size: Refer to plans.
   3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
   4. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
   5. Accessories:
      a. Faucet; as scheduled and specified.
      b. Hot water and cold water spigots, provided as separate item as scheduled
         1) Hot and cold water connections up through deck require additional hole punch in sink and/or counter.
         2) Cold water connection is through replaceable filter unit; install filter in secured bracket below sink, in cabinetry, accessible.

3) Hot water connection is through electrical heating element; install heater in cabinetry below sink, accessible.

2.4 SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets S-1: Manual type, two-lever-handle mixing valve.

1. Commercial, Solid-Brass Faucets.
   a. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following:
      1) American Standard.
      2) Chicago Faucet.
      3) Sloan.
      4) Zurn.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Centerset Single hole.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 1.0 gpm.
8. Handle(s): Wrist blade, 4 inches.
9. Mounting Type: Deck, exposed.
10. Spout Type: Swivel gooseneck.
11. Spout Outlet: Aerator Laminar flow

2.5 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type with inlet connection matching supply piping.

2.6 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

2.7 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.
B. Install supports, affixed to building substrate, for wall-hung sinks.
C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
D. Set floor-mounted sinks in leveling bed of cement grout.
E. Install water-supply piping with stop on each supply to each sink faucet.
    1. Exception: Use ball, or gate valves if supply stops are not specified with sink.
    2. Install stops in locations where they can be easily reached for operation.
F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.
B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed sinks and fittings.
D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224223
COMMERCIAL SHOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Shower faucets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers and basins.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. LEED Submittals:
   1. Product Data for Prerequisite WE 1, Credit WE2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
   2. Product Data for Credit WE 2 and Credit WE 3.1: Documentation indicating compliance with requirements.

PART 2 - PRODUCTS

2.1 SHOWER FAUCETS

A. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.

B. Shower Faucets SH-1:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Chicago Faucets.
      b. Lawler Manufacturing Co., Inc.
      c. Leonard Valve Company.
      d. Powers; a division of Watts Water Technologies, Inc.
      e. Zurn LLC.
   2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; shower head, flexible metal hose and mounting bar.
   3. Faucet:
      a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
      b. Body Material: Solid brass.
      c. Finish: Polished chrome plate.
      d. Maximum Flow Rate: 1.6 gpm unless otherwise indicated.
      e. Mounting: Exposed.

f. Operation: Single-handle, twist or rotate control.
g. Antiscald Device: Integral with mixing valve.
h. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

4. Supply Connections: NPS 1/2.
5. Shower Head:
   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Shower Head Material: Metallic with chrome-plated finish.
   c. Spray Pattern: Fixed.
   d. Integral Volume Control: Required.
   e. Temperature Indicator: Integral with faucet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.
B. Examine walls and floors for suitable conditions where showers will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Shower enclosure by general contractor.
B. Assemble shower components according to manufacturers' written instructions.
C. Install showers level and plumb according to roughing-in drawings.
D. Install water-supply piping with stop on each supply to each shower faucet.
   1. Exception: Use ball, or gate valves if supply stops are not specified with shower.
   2. Install stops in locations where they can be easily reached for operation.
E. Install shower flow-control fittings with specified maximum flow rates in shower arms.
F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
G. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
B. Adjust water pressure at faucets to produce proper flow.

END OF SECTION

SECTION 224713
DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes drinking fountains and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include operating characteristics, and furnished specialties and accessories.

B. LEED Submittals:
   1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

A. Drinking Fountains DF-1: Stainless steel, recessed, two level, barrier-free with bottle fill.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Elkay Manufacturing Co.
      b. Halsey Taylor.
      c. Haws Corporation.
   2. Standard: Comply with NSF 61.
   3. Control: Push button.
   4. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap, complying with ASME A112.18.2/CSA B125.2.
   5. Supply: NPS 3 with shutoff valve.
   6. Support: Mounting frame or brackets for attaching to substrate.
   7. Options:
      a. Include optional access panels, above and below.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
B. Examine walls and floors for suitable conditions where fixtures will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
B. Set pedestal drinking fountains on floor.
C. Install recessed drinking fountains secured to wood blocking in wall construction.
D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.
F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.
D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
C. Provide protective covering for installed fixtures.
D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 230517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Grout.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
C. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   2. Concrete Slabs above Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   3. Interior Partitions:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

END OF SECTION

SECTION 230518
ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
C. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
C. Install floor plates for piping penetrations of equipment-room floors.
D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.

END OF SECTION

SECTION 230519
METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Filled-system thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Test-plug kits.

B. Related Sections:
   1. Section 231123 "Facility Natural-Gas Piping" for gas meters.
   2. Section 232216 "Steam and Condensate Piping Specialties" for steam and condensate meters.

1.3 ACTION SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
      a. Trerice, H. O. Co.

b. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel; 5-inch nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus 1 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:
1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
    a. Trerice, H. O. Co.
    b. Weiss Instruments, Inc.
    c. WIKA Instrument Corporation.
2. Standard: ASME B40.100.
3. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
B. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads. All gages shall be provided with ball valve shut-off in tee connection.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
   1. Trerice, H. O. Co.
   2. Weiss Instruments, Inc.
B. Description: Test-station fitting made for insertion into piping tee fitting.
C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.6 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
   1. Trerice, H. O. Co.
   2. Weiss Instruments, Inc.
B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
F. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
G. Install ball-valve shut-off prior to pressure gages.
H. Install valve and snubber in piping for each pressure gage for fluids (except steam).
I. Install test plugs in piping tees.
J. Install flow indicators in piping systems in accessible positions for easy viewing.
K. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
L. Install permanent indicators on walls or brackets in accessible and readable positions.
M. Install connection fittings in accessible locations for attachment to portable indicators.
N. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic boiler.
   2. Two inlets and two outlets of each chiller.
   3. Inlet and outlet of each hydronic coil in air-handling units.
   4. Inlet and outlet of each thermal-storage tank.
O. Install pressure gages in the following locations:
   1. Inlet and outlet of each chiller chilled-water and condenser-water connection.
   2. Suction and discharge of each pump.
P. Install thermometers and gages also as detailed and noted on drawings.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
B. Connect flowmeter-system elements to meters.
C. Connect flowmeter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.
B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic boiler shall be the following:
   1. Direct-mounted, metal-case, vapor-actuated type.
B. Thermometers at inlets and outlets of each chiller shall be the following:
   1. Direct-mounted, metal-case, vapor-actuated type.
C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:
   1. Direct-mounted, metal-case, vapor-actuated type.
D. Thermometers at inlet and outlet of each thermal-storage tank shall be the following:
   1. Direct-mounted, metal-case, vapor-actuated type.
E. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.
B. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F and 0 to plus 115 deg C.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be the following:
   1. Sealed, direct-mounted, metal case.
B. Pressure gages at suction and discharge of each pump shall be the following:
   1. Sealed, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi and 0 to 600 kPa.
B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi and 0 to 600 kPa.

END OF SECTION

SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Bronze lift check valves.
   3. Bronze swing check valves.
   4. Iron swing check valves.

B. Related Sections:
   1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set ball and plug valves open to minimize exposure of functional surfaces.
   4. Set butterfly valves closed or slightly open.
   5. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Handlever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Grooved: With grooves according to AWWA C606.
   3. Solder Joint: With sockets according to ASME B16.18.
   4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Conbraco Industries, Inc.
      b. Crane; Crane Energy Flow Solutions.
      c. Hammond Valve.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Watts; a Watts Water Technologies company.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Stainless steel.
      i. Ball: Stainless steel, vented.
      j. Port: Full.

2.3 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:

a. Hammond Valve.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Watts; a Watts Water Technologies company.

2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: NBR, PTFE, or TFE.

2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
a. Crane; Crane Energy Flow Solutions.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
a. Crane; Crane Energy Flow Solutions.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.
2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.5 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
a. Crane; Crane Energy Flow Solutions.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install check valves for proper direction of flow and as follows:
    1. Swing Check Valves: In horizontal position with hinge pin level.
    2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
    1. Shutoff Service: Ball, valves.
    2. Throttling Service except Steam: ball valves.
    3. Pump-Discharge Check Valves:
        a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
        b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.
B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
C. Select valves, except wafer types, with the following end connections:
    1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
    2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
    3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
    4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
    5. For Steel Piping, NPS 5 and Larger: Flanged ends.
    6. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
    1. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
    2. Bronze Swing Check Valves: Class 125, nonmetallic disc.
B. Pipe NPS 2-1/2 and Larger:
    1. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
    2. Iron Swing Check Valves: Class 125, metal seats.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
    1. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
    2. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   2. Iron Swing Check Valves: Class 125, metal seats.

END OF SECTION

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.

B. Related Sections:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
   3. Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
   4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from galvanized structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   2. Standard: MFMA-4.
   3. Channels: Continuous slotted steel channel with inturned lips.
   4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
   6. Metallic Coating: Hot-dipped galvanized.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Use thermal-hanger shield insert with clamp sized to match OD of insert.
      b. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
D. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
E. Use padded hangers for piping that is subject to scratching.
F. Use thermal-hanger shield inserts for insulated piping and tubing.
G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.

K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

L. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 230548.13
VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Elastomeric isolation pads.
   2. Open-spring isolators.
   3. Pipe-riser resilient supports.
   4. Spring hangers.
   5. Vibration isolation equipment bases.

B. Related Requirements:
   1. Section 210548.13 "Vibration Controls for Fire Suppression" for devices for fire-suppression equipment and systems.
   2. Section 220548.13 "Vibration Controls for Plumbing" for devices for plumbing equipment and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
      a. Kinetics Noise Control, Inc.
      b. Mason Industries, Inc.
   2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.

3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth pattern.
6. Infused nonwoven cotton or synthetic fibers.

2.2 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
      a. Kinetics Noise Control, Inc.
      b. Mason Industries, Inc.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
   7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.3 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene
   1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
   2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.4 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
      a. Kinetics Noise Control, Inc.
      b. Mason Industries, Inc
   2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.5 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Kinetics Noise Control, Inc.
   2. Mason Industries, Inc.
B. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.3 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

END OF SECTION

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Valve tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Valve numbering scheme.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: Black.
   3. Background Color: White.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
   7. Fasteners: Stainless-steel rivets or self-tapping screws.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
   1. Brady Corporation.
   2. Kolbi Pipe Marker Co.
   3. Marking Sevices Inc.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link chain or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:
   1. Chilled-Water Piping: White letters on a safety-green background.

2. Heating Water Piping: White letters on a safety-green background.
3. Refrigerant Piping: White letters on a safety-purple background.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
   a. Chilled Water: 1-1/2 inches, round.
   b. Hot Water: 1-1/2 inches, square.
   c. Gas: 2 inches, round.
2. Valve-Tag Colors:
   a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
   b. Flammable Fluids: Black letters on a safety-yellow background.
   c. Combustible Fluids: White letters on a safety-brown background.
   d. Potable and Other Water: White letters on a safety-green background.
   e. Compressed Air: White letters on a safety-blue background.
   f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

END OF SECTION

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Variable-flow hydronic systems.

1.3 DEFINITIONS

A. NEBB: National Environmental Balancing Bureau.
B. TAB: Testing, adjusting, and balancing.
C. TABB: Testing, Adjusting, and Balancing Bureau.

1.4 ACTION SUBMITTALS

A. LEED Submittals:
   1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
   2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

1.6 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by NEBB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with General Contractor on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Coordination and cooperation of trades and subcontractors.
      d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts"

and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:
   1. Permanent electrical-power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 PRE-BALANCE CONFERENCE

A. 90 days prior to beginning testing, adjusting and balancing, schedule and conduct a conference with the Architect/Engineer, Owner's Project Representative and the mechanical system and temperature control system installing Contractors. Provide AE and Commissioning Provider (CxP) with a complete copy of the TAB plan for the project. The objective is final coordination and verification of system operation and readiness for testing, adjusting and balancing procedures and scheduling procedures with the above mentioned parties. Indicate work required to be completed prior to testing, adjusting, and balancing and identify the party responsible for completion of that work. TAB Plan at minimum shall consist of:
   1. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch/sub-main proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using airflow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the waterside.
   2. List of all airflow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
   3. Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, SA, RA) pitot traverse, SA or RA flow stations.

4. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
5. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.

3.4 COMMISSIONING TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing Contractor days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.7 AIR TERMINAL UNIT BALANCING

A. Air Valve VAV Air-handling System(s):

1.

2. Operate randomly selected VAVs at 100% design flow. Leave all balancing dampers 100% open at this point.
    a. Due to design diversity, typically only 80% of boxes will add up to the AHU design flow. Designer provides guidance on diversity in design. These are referred to as active boxes.
    b. Select as many boxes to add up to 100% AHU design flow.
    c. Boxes with dampers widest open are critical boxes.
3. Adjust Static pressure to allow design flow in critical boxes at 100% open damper.
4. Allow design flow in boxes that were not active (due to diversity) and reduce flow in formerly active boxes for total flow approximate AHU design flow.
    a. Verify these boxes are able to achieve design flow. If not, increase static pressure.
5. The final pressure is the actual maximum pressure and will be reported to Controls Contractor to set as maximum pressure for static pressure reset. The minimum pressure typically will be set at 25% of that.
6. Balance each multi-diffuser system downstream of VAV.
    a. Single diffusers should not have balancing damper or damper be wide open.
    b. With all dampers wide open, measure all diffuser flow and determine critical diffuser.
    c. Leave critical diffuser 100% open and adjust remaining dampers to balance flow.

B. Outside and Exhaust Air (Minimum Damper Position):
1. Measure intake flow at various AHU operating flows and conduct further measurements at AHU speed approved by the engineer.
2. b. Measure flow of intake air and adjust intake damper until minimum flow is met. Note damper position (this will be minimum damper position).
3. c. Measure flow of intake air and adjust intake damper until maximum flow is met. Note damper position (this will be maximum damper position).

C. Space Differential Pressure Adjustment:
1. Airflow to or from spaces that need to maintain positive or negative pressure to adjacent spaces will be adjusted to maintain a specified pressure differential.
2. Engineer will give direction on what dampers/VFD need to be adjusted.

D. VAV Supply and Exhaust Duct System Static Pressure Set Point Calibration:
1. For VAV supply and exhaust systems with VAV air terminal devices, determine the minimum required duct static pressure at the DDC static pressure sensor location(s) needed to insure that all VAV air terminals are operating at their design airflows with the most demanding VAV terminal wide open. Provide these static pressure numbers to the DDC temperature controls contractor and record them in the T&B report for each system.

E. Measure airflow at return / transfer air openings in enclosed areas (offices, conference rooms) with the door(s) open, and with the doors closed. Record information and note deviation of greater than 10% from inlet airflows.

3.8 WATER FLOW BALANCING AND MEASUREMENTS

A. Balance after system has been cleaned, flushed and all strainers and dirt separators are cleaned and all flow restrictions removed.

B. Account for Viscosity differences of different fluids. For most air this is negligible and requirement can be waived by engineer. For Water and Glycol systems viscosity needs to be accounted for.

C. Measure flow of coils, boilers, and other devices with pressure drop over device. Contractor shall install standard 1/4” pressure taps as required.

D. Total system flow cannot be measured by pressure gain over pumps unless pump curve is very steep.

E. Permanently mark equipment settings, including damper positions, control settings, and similar devices allowing settings to be restored. Set and lock memory stops.

F. Variable Flow with Pressure Independent Control Valves:
1. Operate Pump to maintain 50% of design pressure.
2. Open all control valves 100%.
    a. Open only valves that are open during design condition – take into account diversity.
    b. Designer will provide information on diversity.
3. Measure all device flows with 100% open valves. Tabulate design flow vs. actual flow and determine the 5 critical zones that are at lowest % of design flow.
    a. If all flows are at design flow, repeat above with lower pressure / pump speed.
4. Verify flow in critical zones is not deficient for other reasons (i.e. dirty strainer, wrong pressure-independent device installed).

5. Gradually increase pressure and pump speed and re-measure flow in the above 5 critical zones until design flow is achieved within the limits of measuring and the accuracy of PICV (within 10% of design flow).
6. If some valves stayed closed or partially open (see b.), open those to 100% while closing other valves and verify design flow is met with the determined pressure. Adjust pressure as needed.
7. The final pressure is the actual maximum pressure and will be reported to Controls Contractor to set as maximum pressure for static pressure reset. The minimum pressure typically will be set at 25% of that.

G. Hydronic System Differential Pressure Control Set Point:
1. For hydronic systems with variable speed pumping, determine the minimum required system differential pressure set point needed to insure that all terminal devices are operating at their design water flows with the most demanding terminals device control valve wide open. Provide the differential control setting set point to the DDC temperature control contractor and record them in the T&B report for each system.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.12 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.13 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.
B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.14 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Voltage and amperage input of each phase at full load and at each incremental stage.
   5. Calculated kilowatt at full load.
   6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Airflow.
   3. Air pressure drop.
   4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.15 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
   2. Air Outlets and Inlets: Plus or minus 5 percent.
   3. Heating-Water Flow Rate: Plus or minus 5 percent.
   4. Cooling-Water Flow Rate: Plus or minus 5 percent.
   5. Return Air Inlets: Plus or minus 10 percent.

3.16 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.17 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.

2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
    a. Total air flow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Preheat-coil static-pressure differential in inches wg.

g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:
1. Coil Data:
a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per incho.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
a. Total air flow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.

j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.

g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.
2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

M. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.18 INSPECTIONS

A. Initial Inspection:
1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
a. Measure airflow of at least 20 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.

c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by General Contractor.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of General Contractor.
3. General Contractor shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 230713
DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Related Sections:
   1. Section 230716 "HVAC Equipment Insulation."
   2. Section 230719 "HVAC Piping Insulation."
   3. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
      a. CertainTeed Corporation; SoftTouch Duct Wrap.
      b. Johns Manville; a Berkshire Hathaway company; Microlite.
      c. Knauf Insulation; Atmosphere Duct Wrap with ECOSE Technology.
      d. Owens Corning; SOFTR All-Service Duct Wrap.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products; CP-127.
      b. Foster Brand; H. B. Fuller Construction Products; 85-60/85-70.
      c. Mon-Eco Industries, Inc; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
      a. Foster Brand; H. B. Fuller Construction Products; 30-80/30-90.
      b. Knauf Insulation;
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products; CP-10.
      b. Foster Brand; H. B. Fuller Construction Products; 46-50.
      c. Knauf Insulation;
      d. Mon-Eco Industries, Inc; 55-50.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inchdry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.
   5. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products; CP-76.
      b. Foster Brand; H. B. Fuller Construction Products; 95-44.
      c. Mon-Eco Industries, Inc; 44-05.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.
   6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Knauf Insulation; EXPERT Tapes - FSK Tape.
      b. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.7 SECUREMENTS

A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inchgalvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
c. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
D. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:
   1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not over-compress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
   5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
   6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed outdoor air.
   3. Indoor, concealed return located in unconditioned space.

4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:
1. Indoor supply and return ducts exposed to conditioned air.
2. Factory-insulated flexible ducts.
3. Flexible connectors.
4. Factory-insulated access panels and doors.

3.7 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, return-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Concealed, rectangular, supply-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

D. Concealed, rectangular, return-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

E. Concealed, rectangular, outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

F. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

G. Concealed, supply-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

H. Concealed, return-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

I. Concealed, outdoor-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

J. Exposed (to conditioned air), round and flat-oval, supply-air duct insulation shall be the following:
1. None.

K. Exposed (to conditioned air), round and flat-oval, return-air duct insulation shall be the following:
1. None.

L. Exposed (to conditioned air), rectangular, supply-air duct insulation shall be the following:
1. None.

M. Exposed (to conditioned air), rectangular, return-air duct insulation shall be the following:
1. None.

N. Exposed, rectangular, outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

O. Exposed, rectangular, exhaust-air duct insulation between the outdoor air intake and the air handling unit shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

P. Exposed, rectangular, exhaust-air duct insulation between the air handling unit and the exhaust point of capture shall be the following:
1. None.

Q. Attic area, supply-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.

R. Attic area, return-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.

S. Attic area, outdoor-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.

T. Attic area, exhaust-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.

END OF SECTION

SECTION 230716
HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:
   1. Chilled-water pumps.
   2. Heating, hot-water pumps.
   3. Air separators.
   4. Thermal storage tanks.

B. Related Sections:
   1. Section 230713 "Duct Insulation."
   2. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.
B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
F. Calcium Silicate:
   1. Products: Subject to compliance with requirements, provide the following:
      a. Industrial Insulation Group, LLC (IIG-LLC).
   2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Pittsburgh Corning Corporation.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
   5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.
      b. Armacell LLC.
      c. K-Flex USA.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corporation.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Owens Corning.

J. Phenolic:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Kingspan Tarec Industrial Insulation NV.
      b. Resolco International BV.
   2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
   3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
   4. Factory-Applied Jacket: ASJ. Requirements are specified in "Factory-Applied Jackets" Article.

K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Armacell LLC.
      b. Nomaco Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
   1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. For indoor applications, 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. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mildry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inchdry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.6 SEALANTS

A. Joint Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
2. Color: Color-coded by system.
3. Factory-fabricated tank heads and tank side panels.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 6.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:
   1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
   2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
   3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:
   1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inchgalvanized carbon-steel washer.
   3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
      a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
      c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
      a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
      b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
      c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
D. Wire: 0.062-inchsoft-annealed, stainless steel.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Keep insulation materials dry during application and finishing.
G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.4 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Boiler Breechings:
   1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
   2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
   3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inchoverlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.6 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Chilled-water pump insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Phenolic: 1 inch thick.
   3. Polyolefin: 1 inch thick.

D. Heating-hot-water pump insulation shall be one of the following:
   1. Calcium Silicate: 3 inches thick.
   2. Cellular Glass: 3 inches thick.
   3. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

E. Chilled-water air-separator insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Phenolic: 1 inch thick.
   3. Polyolefin: 1 inch thick.

F. Thermal storage tank (brine, water, ice) insulation shall be one of the following:
   1. Flexible Elastomeric: 2 inch thick.
   2. Phenolic: 2 inch thick.
   3. Polyolefin: 2 inch thick.

3.7 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. PVC, Color-Coded by System: 30 mils thick.

END OF SECTION

SECTION 230719
HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Condensate drain piping, indoors.
   2. Chilled-water and brine piping, indoors.
   3. Heating hot-water piping, indoors.
   4. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:
   1. Section 230713 "Duct Insulation."
   2. Section 230716 "HVAC Equipment Insulation."
   3. Section 232113.13 "Underground Hydronic Piping" for loose-fill pipe insulation in underground piping outside the building.
   4. Section 336313 "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
   a. Armacell LLC.
   b. K-Flex USA.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
   a. Johns Manville; a Berkshire Hathaway company.
   b. Knauf Insulation.
   c. Owens Corning.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Phenolic:
1. Products: Subject to compliance with requirements, provide product by one of the following:
   a. Kingspan Tarec Industrial Insulation NV.
   b. Resolco International BV.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

   a. Preformed Pipe Insulation: ASJ.

I. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
   a. Duna USA Inc.
   b. Dyplast Products.
   c. ITW Insulation Systems; Illinois Tool Works, Inc.
2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
3. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to 1 inch as tested by ASTM E 84.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
   a. Pipe Applications: None.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
B. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
F. PVC Jacket Adhesive: Compatible with PVC jacket.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. Color: White.
C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inchdry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: 60 percent by volume and 66 percent by weight.
   4. Color: White.

2.5 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products; CP-76.
      b. Foster Brand; H. B. Fuller Construction Products; 30-45.
      c. Mon-Eco Industries, Inc; 44-05.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 100 to plus 300 deg F.
   5. Color: White or gray.
B. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: Aluminum.
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: White.
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Color: Color-code jackets based on system. Color as selected by Architect.
   3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:
   1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
      a. Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.
         8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches.
   2. Thickness: 3.7 mils.
   3. Adhesion: 100 ounces force/inch in width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:
   1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
   2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches**][**4 inches**] o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF POLYISOCYANURATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of polyisocyanurate insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.11 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Do not field paint aluminum or stainless-steel jackets.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4 inch thick.
B. Chilled Water and Brine, above 40 Deg F:
   1. NPS 12 and Smaller: Insulation shall be the following:
      a. Flexible elastomeric: 1 inch thick.
      b. Phenolic: 1 inch thick.
C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
   1. NPS 2 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.
D. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
   1. NPS 2-1/2 and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.
E. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Polyisocyanurate: 1 inch thick.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Piping, Concealed:
   1. None.
D. Piping, Exposed:
   1. PVC, Color-Coded by System: 20 mils thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Piping, Concealed:
   1. None.
D. Piping, Exposed:
   1. Aluminum, Stucco Embossed: 0.024 inch thick.

END OF SECTION

SECTION 230900
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, and service necessary for a complete operating BAS, utilizing DDC as shown on the diagrammatic drawings and as described in Sequence of Operation. Provide Integration of system into existing WEBs supervisor per owner instructions.

B. Acronyms used in this specification are as follows:

1. BAS Building Automation System
2. DDC Direct Digital Controls
3. GUI Graphical User Interface
4. IBC Interoperable BACnet Controller
5. IDC Interoperable Digital Controller
6. LAN Local Area Network
7. NAC Network Area Controller
8. OOT Object Oriented Technology
9. PICS Product Interoperability Compliance Statement
10. PMI Power Measurement Interface
11. POT Portable Operator's Terminal
12. WAN Wide Area Network
13. WBI Web Browser Interface

1.2 REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract. Examples of related sections include, but are not limited to:

1. Division 26 - Electrical.
2. Section 230913.33 - Control Valves.
3. Section 230913.43 - Control Dampers.

1.3 SUBMITTALS

A. Complete wiring and schematic diagrams, software descriptions, sequences of operation, protocol documentation, point lists, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function. Terminal identification for all control wiring shall be

shown on the shop drawings. Include a trunk cable schematic diagram depicting control panel locations and a description of the communication type, media, and protocol.

B. Wiring: Load and voltage drop calculations including proposed wiring lengths and sizes. Provide transformer and fuse box data.

C. Include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation.

D. Complete set of electronic 'as-built' drawings and application software. Drawings shall be provided as dwg and Visio™ files.

1.4 QUALITY ASSURANCE

A. Basis-of-design: Honeywell WEBs-AX™ based on a hierarchical architecture incorporating the Niagara AX Framework™.

B. Contractor shall be certified and trained by BAS manufacturer and shall be ACI (Authorized Controls Integrator) Honeywell Contractor. The firm must be specializing and experienced in DDC control system installation for no less than 10 years.

C. All engineering and commissioning work shall be done by qualified employees of this contractor, or qualified employees of an Authorized Representative of that manufacturer. Installation of electrical components and wiring can be done by this contractor or contractor meeting requirements of Division 26.

D. The contractor must have a service office within 20 miles of the building location. This requirement applies to the actual office location the individuals working on controls work out of. Response Time During warrantee period must be four (4) hours or less.

E. All products of the BAS shall have the following agency approvals:

1. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
2. CSA (LR95329-3) Listed.
3. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
4. Meets Canadian standard C108.8 (radiated emissions).
5. Conforms to the following requirements per European Consortium standards:
   a. EN 61000-6-1; 2001 (EU Immunity).
   b. EN 61000-6-3; 2001 (EU Emissions).

F. Equipment must be capable of operation within expected conditions of the environment it is located in.

1.5 PERFORMANCE REQUIREMENTS

A. BAS shall be comprised of:

1. NAC within each facility shall connect to the owner's LAN network. Access to the system shall be via standard Web browsers and secure password.
2. Peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet™, LonWorks™ technology, MODBUS ™, OPC, and other open and proprietary communication protocols into one open, interoperable system.
3. Platform shall be designed specifically to control HVAC Equipment and if available be specific to that type of equipment. The controller shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the "Sequence of Operation". Standard controller is Honeywell Spyder or most current model capable of providing required control sequences and points.

B. Speed: A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data. Maximum acceptable response time from any alarm occurrence (at the point of origin) shall not exceed 5 seconds.

C. Alarms:

1. Alarm annunciation and acknowledgement shall indicate: in alarm, Return to normal, Fault condition.
2. Allow a minimum of eight alarm classes for the purpose of routing types and/or classes of alarms, i.e.: fire, HVAC.
3. Provide timed (schedule) routing of alarms by class, object, group, or node.
4. Provide alarms from "runtime" and/or event counts for equipment maintenance.
5. Controller and network failures shall be treated as alarms and annunciated.
6. Show acknowledge time, date, and user who issued acknowledgement.
7. Number of occurrences since last acknowledgement.
8. Provide a "query" feature to allow review of specific alarms by user defined parameters.

9. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided.
10. Users shall have the ability to inhibit alarm reporting for each point. User shall also be able to define conditions under which point changes need to be acknowledged by an operator and/or logged for analysis at a later date.
11. Provide the ability to route and email alarms based on Day of week, Time of day, Recipient. Show Graphic with flashing alarm object(s), Location (building, floor, zone, office number, etc.), Equipment (air handler #, access way, etc.).

D. Logging and backup capability:
1. All log data shall be available as HTML, XML, Plain Text., Comma or tab separated values, PDF.
2. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) for review by the user.
3. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
4. Archive log data locally and/or on server frequently and automatically.
5. An Audit Log that tracks all activities performed on the NAC. For each log entry, provide the Time and date, User ID and Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
6. The database shall be backed up frequently. Copies of the current database and, at the most recently saved database shall be stored in the NAC.

E. Trending:
1. Measured and calculated analog and binary data shall be assignable to user definable trends for the purpose of collecting operator specified performance data over extended periods of time.
2. Sample intervals of 1 minute to 24 hours shall be provided. Data shall be stored at the supervisory controller and frequently up-loaded to the server.

F. Graphics: The graphic shall provide a geographical overview of the multiple-site buildings.
1. All points shall be displayed including but not limited to the actual value, set-value and alarms.
2. Log of each value shall be accessible from the read value on display. All values shall be logged.
3. The graphic shall provide an accurate dimensional layout of the building floor(s); including all rooms, room numbers, walls, elevators, doors, entrances, hallways, and stairwells. Room numbering and naming conventions shall be provided by the Architect/Engineer.
4. Display and animate systems as 3-D objects including all sensors, heat exchangers, heating and cooling coils, dampers, piping and pumps, humidifiers, flow directions, safety devices, and limit devices with fan, pump, damper, and valves.
5. For each device and zone the set point and actual value shall be displayed.
6. The desired mode (i.e. winter occupied) shall be displayed.
7. Temporary Override shall have a drop-down menu and provide timed override to allow automatic fall-back of overridden value. Time intervals shall be 1-hour (default), 2 hours, 4-hours, 24 hours, 48 hours, and permanent.

G. Energy Management:
1. Current electric power draw of devices shall be totaled and displayed including data of sub-meters, VFD-data and other device-data. Categorize in system types (i.e. chiller system). In addition, display:
   a. Peak demand, with date and time stamp.
   b. 24-hour demand log.
   c. Accumulated KWH and therms for day.
   d. Sunday through Saturday KWH and therm usage.
   e. Demand KW annual history for past 12 periods.
   f. KWH and therm annual history for past periods.
2. Heating degree days and heating fuel consumption comparison will be logged and a relationship developed. Based on this, an indication in if the building performs as expected will be derived.
3. If shown elsewhere contractor shall arrange with the project electric utility for providing an isolation relay at the service meter to allow independent pulse signals to be monitored by the DDC control system for electric utility KWH power usage, natural gas usage, and peak KW demand. Owner will pay for utility fee, contractor shall pay for isolation relay and associated wiring and provide power to meter as required.

H. The Owner shall be the named license holder of all software associated with any and all incremental work. In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, BAS, and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

I. POINTS:

1. Analog Points shall allow linear input and output of 2-10V. 0-5 VDC, or 4-20 mA acceptable if 2-10V not available.
2. Digital Points shall allow 24VAC input and output.

PART 2 - PRODUCTS

2.1 TEMPERATURE SENSORS

A. Space temperature wall module: Temperature sensing modules mounted on the wall in occupied spaces.

1. Manufacturers: Honeywell.
2. User Adjustable: TR 71.
3. Not adjustable in finished spaces: TR23.
4. Not adjustable unfinished spaces: C7772.
5. Wall module shall have a thermistor temperature sensor with operating range of 25 to 99 °F designed for mounting on a standard electrical switch box. Accuracy shall be +/- 0.5 °F at 77 °F.
6. Where specified, wall module shall also have an after-hours override pushbutton and LED override indicator.

B. Duct mount, pipe mount, and outside air temperature sensors:

1. Manufacturers: Alerton, ACI, Honeywell, Johnson Controls, Novar, Siemens Building Technologies, Trend.
2. Outside air sensors shall include an integral sun shield.
3. Temperature sensors shall have an accuracy of plus or minus 1.0 °F over operating range.
4. Duct sensors shall have sensor approximately in center of the duct, and shall have selectable lengths.
5. Pipe mount sensors shall have separable well per piping specifications.

C. Temperature limit switches:

1. Manufacturers: Honeywell, Johnson Controls, Siemens Building Technologies, TAC
2. Safety low limit shall be manual reset twenty foot limited fill type responsive to the coolest section of its length.
   a. Low Limit Setpoint shall be adjustable between 20 and 60 °F. (-5 and 15 °C.)
   b. Ambient Temperature range -20 to 125 °F. (-11 to 52 °C.)
3. Safety high limit (fire stats) shall be manual reset type.
   a. High Limit Setpoint shall be adjustable between 100 and 240 °F. (38 and 116 °C.)
   b. Ambient Temperature range -20 to 190 °F. (-28 to 88 °C.) at case, and 350 °F (177 °C.) at the sensor.

2.2 PRESSURE SENSORS AND SWITCHES

A. Manufacturers: ACI, Honeywell, RIB, Inc., Veris Industries.

B. Sensing range: 2 times of expected pressure.

C. Operating Temperature 5-104 °F (-15 – 40 °C), Operating Humidity 0-95% non-condensing.

D. Pressure switches: Operates when the pressure exceeds the adjustable trip point. Integral LED for trip indication.

E. Pressure sensors: Solid state, split core linear current sensors shall be provided where specified.

1. Scale sensors so that average operating current is between 20-80% full scale.
2. Accuracy plus or minus 1.0% (5-100% full scale).

2.3 CURRENT SENSORS AND SWITCHES

A. Manufacturers: ACI, Honeywell, RIB, Inc., Veris Industries.

B. Sensing range: 2 times of expected current.

C. Operating Temperature 5-104 °F (-15 – 40 °C), Operating Humidity 0-95% non-condensing.

D. Current switches: operates when the current exceeds the adjustable trip point. Integral LED for trip indication.
E. Current sensors: Solid state, split core linear current sensors shall be provided where specified.
1. Scale sensors so that average operating current is between 20-80% full scale.
2. Accuracy plus or minus 1.0% (5-100% full scale).

2.4 FLOW MEASURING DEVICES

A. Air flow: Thermal dispersion air flow stations mounted in duct per manufacturer recommendations:
1. Manufacturers: Air Monitor Corporation, Ebtron, Ruskin.
2. Probe Sensor Density per manufacturer recommendation.
3. Airflow Sensor Accuracy: ±2% of reading.
4. Calibrated Range: 0-5000 FPM for duct applications.
5. Temperature Sensor Accuracy: ±0.15°F.
6. Temperature: -20°F to +140°F.
7. Relative Humidity: 0 to 95% (non-condensing).
8. Provide access panels for cleaning of screen and probe.

B. Water flow:
1. Manufacturer: Onicon.
2. Hot-swap with ballvalve and hot-tap installation kit.
3. Calibrate for expected design flow.
4. Pipe sizes <= 2":
a. Ultrasonic type F4600 series.
b. Accuracy 2% at 100:1 turndown.
c. Install flanged shut-off valves for replacement.
5. Pipe size >= 3":
a. Electromagnetic Type F3500 series.
b. Accuracy 1% at 2-20 ft/s.
c. Minimums Flow: 0.1 ft/s.
6. Install in design pipe size (no transition to smaller pipe excepted). Install in vertical or horizontal straight pipe with 20 pipe diameters straight pipe upstream and 5 pipe diameters downstream.

2.5 GAS SENSORS

A. Manufacturers: Honeywell, TelAire, Vaisala.
B. Sensor shall have an LCD display that displays the sensor reading and status.
C. Drift: <5% per year.
D. Sensor Lifespan: > 4 years.
E. Temperature Range: -4° - 122°F.
F. Co2 Sensors:
1. Carbon Dioxide sensors shall, with employ corrosion free gold-plated non-dispersive infrared sensing, designed for duct or wall mounting. Utilize non-dispersive infrared (NDIR) technology.
2. Internal diagnostics for power, sensor, analog output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-2000 PPM with +/- 25 PPM accuracy at full scale.

2.6 MOTION, DOOR AND WINDOW SENSORS

A. Motion Sensors:
1. Manufacturers: WattStopper.
2. Adjustable time-delay (standard set to 30 seconds).
3. Finished spaces, ceiling mount: CI-200.
4. Wall-mount, where called for on plan: CX-100.
5. Isolated relay rating 1A @ 24VDC, 0.5A @ 120V.
6. Warranty 5 years.

2.7 ACTUATORS

A. Manufacturers: Belimo, Honeywell.
B. Size to operate loads with sufficient reserve power to provide smooth modulating or two-position action and tight close-off.
C. On/Off actuators shall include 2 end-switches.

D. Modulating Actuators shall provide feedback and allow automatic calibration. Floating control is not acceptable.
E. Field-reversible spring return shall be provided on actuators scheduled to fail on open or closed position.
F. Manual power-off positioning lever for manual positioning during power loss or system malfunctions, including a gear-train lock to prevent spring action. Upon power restoration after gear lock, normal operation shall automatically recur.
G. Clutch shall enable operation of controlled device without actuator activation.

2.8 VARIABLE FREQUENCY DRIVES

A. Manufacturer: Danfoss FC 100 series or other Danfoss product if required for the application.
B. VFD shall include built-in disconnect and fuses.
C. Motor protection:
   1. If lead lengths exceed 500', an LC filter shall be included.
   2. If peak voltages are expected to exceed 1,000 V or rise times will be less than 2 microseconds, a dV/dt filter shall be included.
D. VFD shall measure motor torque and shall detect failures of belt or other parts downstream of VFD.
E. VFD shall communicate via BACNet or LONWorks all measured values to BAS.
F. The unit shall be U.L. listed, solid state, microprocessor-based with a pulse width modulated (PWM) output wave form. The VFD shall employ a full wave bridge rectifier, to prevent line notching, with DC output bus choke, capacitors to minimize the ripple of the rectified voltage to maintain near constant DC voltage. Insulated gate bipolar transistors (IGBT's) shall be employed as the output switching device.
G. Performance:
   1. Minimum Efficiency: 92% @ 50%; 99% @ 100% speed.
   2. Power Factor: 0.95 through speed range.
   3. Power Line Noise: Voltage distortion factor of 5% or less and a line notch depth of 25% or less. FCC compliant.
   4. Ride through a momentary power outage of 15 cycles.
   5. Start into a rotating load without damage to drive components or motor.
   6. Capable of automatic restart into a rotating load after a preset, adjustable time delay following a power outage.
   7. Full load output current available from drive shall not be less than motor nameplate amperage as required by NEC.
H. Features:
   1. Run/stop selector switch, auto/manual selector switch, fault light, power on light, ready light.
   2. Automatic under voltage reset with adjustable time delay.
   3. Over temperature protection.
   4. Under voltage/over voltage protection.
   5. Local speed control at the VFD.
   6. Adjustable acceleration and deceleration rate to adjust time period from start to full speed and from full speed to stop.
   7. Illuminated display keypad, display.
I. Diagnostics: Provide an English character display (no error codes) with indicators for Phase loss, Ground fault, Overcurrent, Over-voltage, Under-voltage, Over temperature, Overload, DC bus status, Earth ground, Emergency stop, System (component failure), Under voltage, Heat sink under temperature, Heat sink over temperature, Motor stalled, Motor over temperature, Motor under load, Cooling fan failure, Inverter bridge over temperature, Analog input control under current, Keypad failure, Other product unique monitored conditions.

2.9 WIRING

A. Line Voltage Wiring shall comply with Electrical Specifications.
B. Transformers:
   1. Size transformers to not exceed capacity of connected devices design VA-rating
   2. Open type. Transformers shall be installed outside cabinet to limit heat generation in cabinet.
   3. Locate transformer near supplied controller or device. Electrical contractor shall provide line voltage to the required locations.
   4. Transformer shall have ambient temperature rating of at least 140°F
   5. Over current Protection: Circuit Breaker on Low-Voltage side, Fuse on Line Voltage Side sized to 200% of design Current.
   6. Dual Threaded Hub Mount to separate line and low-voltage.

7. Connected loads up to 100 VA: Use one 100 VA Class 2 transformer. Basis of Design RIB TR100VA002 (120 V primary) or RIB TR100VA004 (Multi primary voltage).
8. Connected loads over 100 VA: Use 300 VA Transformer and install fuse box on low voltage side with 4A fuses limiting each line to Class 2. Basis of Design RIB TR300VA002. Install in Box.

C. All BAS wiring in exposed locations shall be in the conduit types specified in the Project Electrical Specifications. Only wiring behind closed ceilings is allowed to be installed without conduit. Wire in plenums has to be plenum-rated. All conduit shall be factory-white. All box covers shall be white and labeled "BAS".

D. Labeling: All wiring and conduit shall be labeled to show points and device they are connected to.

E. Wire: use #18AWG or larger:

1. Size to provide at least 22V at device served under full design load unless devices require higher minimum voltage.
2. Limit distance from transformer to controller to 30 feet (60 'total circuit length) on loads not exceeding 100 VA. If longer distances are required, lower connected load and/or increase wire size to meet above voltage drop requirement.
3. Size wire from controller to field devices (actuators/ sensors etc.) to limit full load voltage drop to values acceptable by manufacturer of such device. Take into account lower voltage at controller from upstream voltage drop.

F. Data wiring: Use manufacturer's most strict recommendations for data and signal wiring. Typically use twisted pair and shielded wire. Meet the requirements of the bus-standards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels.

B. Network infrastructure shall conform to published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. Number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system expansion with minimal infrastructure modifications.

C. Install all sensors and devices in dustproof and moisture-proof enclosures.

3.2 ACCEPTANCE TESTING

A. Perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. Upon successful completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner.

3.3 COMMISSIONING TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.4 OPERATOR INSTRUCTION, TRAINING

A. Operator training of the systems shall include, but not be limited to:
   1. Overall operation program, equipment functions, commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.
   2. A review of the as-built drawings and O&M manuals, a walk-through of the facility to identify control panels and device locations.
   3. Every screen shall be completely discussed, allowing time for questions.
   4. The trainings will be tailored to the needs and skill-level of the trainees.

B. First Training shall take place after commissioning and startups are successfully completed and the system operates as specified.

C. Deferred On-Site Training will be conducted on-site 6 months after occupancy and consist addressing specific topics that trainees need to discuss and to answer questions concerning operation of the systems. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

3.5 CONTROL SEQUENCES

A. Detailed points, schematics and sequences are given elsewhere in addition to these guidelines.

B. All control points and sequences describe the overall functionality. It is the contractor's responsibility to know what equipment is required. Contractor shall coordinate with the equipment manufacturers and other contractors what options the equipment need to be ordered with. This applies to and is not limited to required Modbus, BACNET or Lon cards, and controllers that may be required to perform the appropriate control and monitoring functions.

C. Optimized start/stop: Provide a start-stop time optimization to provide capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Stop equipment before the scheduled un-occupancy time just far enough ahead to take advantage of the building's thermal capacity.
   1. Average zone temperature may be 1°F outside deadband.
   2. Actual OAT is taken into account.
   3. Past days' performance is taken into account.
   4. No ventilation during morning warmup or cool-down.

D. Anti-cycling: Prevent frequent cycling of equipment while maintaining reasonable conditions. Prevent excessive demand situations during start-ups by automatically introducing time delays between successive start commands to electrical loads.

E. Deadbands: shall prevent hunting of output signals and simultaneous or alternating heating and cooling.

F. Loops: employing PID loops and other techniques equipment shall ramp up and down to prevent over-and undershoot, cycling, discomfort and excessive wear.

G. Minimum speed: Motors and other equipment shall operate at manufacturer-provided minimum speed. For example, pump minimum speed may be 25% (15Hz) and fan speed may be 20% (12 Hz) depending on manufacturer.

H. Lead/lag: Equipment to lead/lag shall switch lead device once a month on a Tuesday or Wednesday morning. Upon failure of lead equipment or it not being able to achieve a given setpoint for a period of time, the lag equipment shall be activated automatically. Time settings to fail over shall be set to avoid lag equipment operation if lead equipment is functional.

I. Interlocks: Equipment requiring action of another equipment before activation shall be interlocked to prevent such device to operate before that required device operates. Examples include fans requiring dampers to open.

J. Scheduling: Per Owner, provide adjustable schedule for equipment and systems to schedule setpoints, equipment operation etc. Typically, there will be occupied and unoccupied setpoints and ventilation only during occupied time.

K. Filter alarm: Measure pressure drop over filter, display dP, and allow user to set an alarm threshold.

L. Load shedding: If shown elsewhere, provide a demand-limiting object that is capable of controlling demand for any selected energy type. Monitor a demand value and predict the demand at the end of the user defined interval period. Upon a prediction that demand will exceed the demand limit, issue shed commands to either turn off user specified loads or modify equipment set points to shed load. Equipment will be shut off or limited based on priority list. Allow selection of priorities, rotation, and maximum/minimum shed times. Upon suitable demand reduction, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed.

M. Constant speed motors: Energize motor upon demand and measure current. Provide alarm when motor current is outside user adjustable parameter for minimum and maximum current.

N. Variable speed motor: Enable and adjust speed to meet the setpoint via VFD (AC) or inverter (DC). Read out and display all available data including but not limited to current, torque, speed, failure, status etc.
O. Analog actuator: modulate to meet setpoint. Provide alarm when feedback signal deviates by a user-adjustable %.
P. Digital actuator: Activate to open of close and provide alarm when end switch doesn't activate as required.

3.6 BUILDING AUTOMATION SYSTEM (BAS) POINTS LIST

A. The following represent minimum required points to be incorporated into the building automation system, and displayed therein. Additional points required to implement sequences shall be provided as necessary. Refer to plans for sequences. Refer to electrical plans for related information.
1. Building Utility Meters:
a. Building metering shall be monitored and recorded through the BAS.
1) Whole building electric meter.
2) Whole building gas meter.
2. Sump pits SP-1 and SP-2:
a. Sump pits shall be provided with integral controls and control panel, and shall not be operated through the BAS. The BAS shall monitor and display, only. (Controls contractor shall coordinate with plumbing contractor, prior to equipment submittal phase.)
b. SP-1 on/off status – DI
c. SP-1 alarm status – DI
d. SP-2 on/off status – DI
e. SP-2 alarm status – DI
3. Domestic hot water circulation pump:
a. The domestic water circulation pump operates based on a local thermometer and controller, and shall not be operated through the BAS. The BAS shall monitor and display, only. (Controls contractor shall coordinate with plumbing contractor, prior to equipment submittal phase.)
b. P-4 on/off status – DI
c. P-4 return water temperature – AI
4. Fire / smoke dampers:
a. Status (open/closed) – DI
5. Air handling units AHU-1 through AHU-4:
a. Refer to sequences and schematic on plan.
b. Outdoor airflow – AI
c. Outdoor air temperature – AI
d. Exhaust air damper – AO, AI
e. Exhaust airflow – AI
f. Exhaust temperature sensor – AI
g. Exhaust air filter differential pressure - AI
h. Electric preheat – AO
i. Airflow proving on/ off switch – DI
j. Preheat outdoor temperature sensor – AI
k. Outdoor damper – AO, AI
l. Outdoor filter differential pressure sensor – AI
m. Exhaust VFD on/off –DO
n. Exhaust VFD motor current status monitor - DI
o. Exhaust speed monitor –AI
p. Wheel differential pressure sensor – AI
q. Outdoor air bypass – AO, AI
r. Energy recovery wheel VFD on/off –DO
s. Energy recovery wheel VFD motor current status monitor - DI
t. Energy recovery wheel speed monitor –AI
u. Exhaust bypass – AO, AI
v. Post-wheel temperature sensor – AI
w. Pre-exhaust temperature – AI
x. Outdoor cool valve – AO, AI
y. Cold water return temperature sensor – AI
z. Cold water supply temperature sensor – AI
aa. Pre-cool air temperature sensor – AI

bb. Recirculation differential pressure – AI
cc. Recirculation motorized damper AO, AI
dd. Return VFD on/off –DO
ee. Return VFD motor current status monitor - DI
ff. Return speed monitor –AI
gg. Return filter differential pressure – AI
hh. Mixed air temperature sensor – AI
ii. Relief airflow rate - AI
jj. Return airflow rate – AI
kk. Return air temperature sensor – AI
ll. Return CO_2 sensor – AI
mm. Primary cool valve – AO, AI
nn. Cold water supply temperature sensor – AI
oo. Cold water return temperature sensor – AI
pp. Supply VFD on/off –DO
qq. Supply VFD motor current status monitor - DI
rr. Supply speed monitor –AI
ss. Supply airflow rate – AI
tt. Supply air temperature senor – AI
uu. High pressure limit sensor – AI
vv. Duct differential pressure sensor – AI

6. Chilled water plant:
   a. Refer to sequences and schematic on plan. Chiller shall be provided with a manufacturer-furnished controller. Coordinate points to be received from or sent to the chiller / condenser controller with the manufacturer to ensure compatibility and availability. (Controls contractor shall coordinate with mechanical contractor, prior to equipment submittal phase.)
   b. Primary P2A VFD on/off –DO
   c. Primary P2A VFD motor current status monitor -DI
   d. Primary P2A speed monitor –AI
   e. Primary P2B VFD on/off –DO
   f. Primary P2B VFD motor current status monitor -DI
   g. Primary P2B speed monitor –AI
   h. Primary P2C VFD on/off –DO
   i. Primary P2C VFD motor current status monitor -DI
   j. Primary P2C speed monitor –AI
   k. Secondary P3A VFD on/off –DO
   l. Secondary P3A VFD motor current status monitor -DI
   m. Secondary P3A speed monitor –AI
   n. Secondary P3B VFD on/off –DO
   o. Secondary P3B VFD motor current status monitor -DI
   p. Secondary P3B speed monitor –AI
   q. Chiller 1A supply water temperature – AI
   r. Chiller 1B supply water temperature – AI
   s. Chiller 1C supply water temperature - AI
   t. Chilled water return temperature sensor– AI
   u. Chilled water flow rate - AI
   v. Chilled water supply temperature sensor – AI
   w. Cold water supply/return by-pass valve –AO, AI
   x. Differential pressure sensor – AI
   y. Condenser status – DI
   z. Condenser alarm – DI
   aa. Chiller (3 thus) expansion valve (% open) – AI
   bb. Chiller (3 thus) requested stage – AI
   cc. Chiller (3 thus) flow on/ off switch – DI
   dd. Chiller (3 thus) inlet temperature sensor – AI
   ee. Chiller (3 thus) outlet temperature sensor – AI
   ff. Chiller (3 thus) status – DI
   gg. Chiller (3 thus) alarm – DI
   hh. Chiller (3 thus) enable – DO
   ii. Chilled water setpoint - AO
   jj. Outdoor air temperature sensor - AO

7. Hot water plant:
   a. Refer to sequences and schematic on plan. Boiler shall be provided with a manufacturer-furnished controller. Coordinate points to be received from or sent to the boiler controller with the manufacturer to ensure compatibility and availability. (Controls contractor shall coordinate with mechanical contractor, prior to equipment submittal phase.)
   b. Fire rate input – AI
   c. Fire rate output – AI
   d. Inlet temperature sensor – AI
   e. Outlet temperature sensor – AI
   f. Boiler status – DI
   g. Boiler alarm – DI
   h. Boiler enable - DO
   i. Hot water setpoint – AO
   j. Outdoor air temperature sensor – AO
   k. Hot water supply/return boiler flowrate
   l. Boiler-1 hot water supply temperature sensor – AI
   m. Boiler-1 isolation valve position – DO, DI
   n. Boiler-2 hot water supply temperature sensor – AI
   o. Boiler-2 isolation valve position – DO, DI
   p. Supply VFD on/off –DO
   q. Supply VFD motor current status monitor -DI
   r. Supply speed monitor –AI
   s. Supply VFD on/off –DO
   t. Supply VFD motor current status monitor -DI
   u. Supply speed monitor –AI
   v. Hot water supply system temperature sensor – AI
   w. Hot water supply or return by-pass valve – AO
   x. Hot water supply or return system differential pressure - AO
   y. System return temperature sensor – AI
   z. Boiler Return temperature sensor - AI
8. Air valves:
   a. Refer to sequences and schematic on plan.
   b. Damper position – AI, AO
   c. Discharge air temperature – AI
   d. Airflow rate - AI
9. Split system cooling units:
   a. Refer to sequences and schematic on plan. Unit shall be provided with a manufacturer-furnished controller. Coordinate points to be received from or sent to the unit controller with the manufacturer to ensure compatibility and availability. (Controls contractor shall coordinate with mechanical contractor, prior to equipment submittal phase.)
   b. Room temperature setpoint – AO
   c. Room temperature – AI
   d. On/off status - DI
10. Heat-only fan coil units:
   a. Refer to sequences and schematic on plan.
   b. Room temperature setpoint – AO
   c. Room temperature – AI
   d. On/off status - DI
11. Radiation elements (hot water radiators):
   a. Refer to sequences and schematics on plan. Radiation can be stand-alone, or integrated with other temperature control devices (e.g. variable air systems). Regardless, radiation shall include the following points.
   b. Valve position – AI, AO
12. Local / room sensors:
   a. Refer to sequences, schematics, and floor plans. Not all sensor types are required in all areas. Where shown on plan, the following items shall be provided with the associated signal.
13. Room temperature sensor, adjustable:
   a. Room temperature setpoint – AO
   b. Room temperature – AI
   c. Sensor adjustment – AI

d. Local override – DI

14. Room temperature sensor, not adjustable:
    a. Room temperature setpoint – AO
    b. Room temperature - AI
15. Room CO2 sensor:
    a. Room CO2 concentration – AI
16. Room occupancy sensor:
    a. Room occupancy - DI

END OF SECTION

SECTION 230913.33
CONTROL VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section includes information common to Control Valves and applies to all sections in this Division.

1.2 REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract. Examples of related sections include, but are not limited to:
   1. Section 230900 – Instrumentation and Control for HVAC.
   2. Section 232113 – Hydronic Piping.

1.3 SUBMITTALS

A. Valve Schedule: Valve sizing shall be performed, and a schedule created by the valve manufacturer. Include Valve Identification Tag, Location, Valve Type, Valve Size, Pipe Size, Configuration, Flow Characteristics, Capacity, Valve CV, Calculated CV, Design Pressure Drop, Actual Pressure Drop, Fail Position, Close off Pressure, Actuator Identification Tag, and Actuator Type.

1.4 QUALITY ASSURANCE

A. Manufacturer: Honeywell, Belimo.
B. Valves shall be line size unless noted otherwise.
C. Valves shall have stainless-steel stems and spring loaded Teflon packing with replaceable discs.
D. Piping and valves shall be properly insulated to prevent formation of ice on moving parts.
E. Valves shall be tagged with Cv rating and model number.

PART 2 - PRODUCTS

2.1 PRESSURE INDEPENDENT CONTROL VALVES

A. Basis of design: Honeywell, VRN2 (NPT) and VRW2 (flanged); and Belimo P2 series.
B. Chose type with lowest design pressure drop for design flowrate. Below table indicates available pressure drops. As manufacturers expand options, adjust selection criteria for approval by design engineer.

Design Flowrate	Valve Type	Design Pressure drop
1-5 gpm	0.5” Honeywell	3 psi
6-7 gpm	0.75” Honeywell	3 psi
8-9 gpm	0.75” Belimo P2	5 psi
10 gpm	1” Honeywell	3 psi
11-14 gpm	1” Belimo P2	5 psi
15 gpm	1” Honeywell	3 psi
16-19 gpm	1” Belimo P2	5 psi
20 gpm	1.25” Honeywell	4 psi

Design Flowrate	Valve Type	Design Pressure drop
21-24 gpm	1.25” Belimo	5 psi
25 gpm	2” Honeywell	4 psi
26-33 gpm	1.5” Belimo	5 psi
35 gpm	2” Honeywell	4 psi
36 – 100 gpm	2” Belimo	5 psi

1 **PART 3 - NOT USED**

2 **END OF SECTION**

SECTION 230913.43
CONTROL DAMPERS

PART 1 - GENERAL

1.1 SCOPE

A. This section includes information common to control dampers and applies to all sections in this Division.

1.2 REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract. Examples of related sections include, but are not limited to:
   1. Section 230900 - Instrumentation and Control for HVAC.
   2. Section 233100 - HVAC Duct and Casings.
   3. Section 233300 - Air Duct Accessories.

1.3 SUBMITTALS

A. Damper schedule: Damper and actuator sizing shall be performed, and a schedule created by the manufacturer. Include Damper Identification Tag, Location, Damper Type, Damper Size, Duct Size, Arrangement, Blade Type, Velocity, Pressure Drop, Fail Position, Actuator Identification Tag, Actuator Type, and Mounting.

1.4 QUALITY ASSURANCE

A. Provide all automatic control dampers in equipment (i.e. AHU) to meet these requirements.

PART 2 - PRODUCTS

2.1 CONTROL DAMPERS

A. Manufacturers: Greenheck, Honeywell, Ruskin, Tamco:
   1. Made of extruded aluminum.
   2. Testing and ratings to be in accordance with AMCA Standard 500.
   3. Blade and frame seals are extruded silicone, for reduced air leakage at colder temperatures. Blade and frame seals are secured in an integral slot within the aluminum extrusions and are mechanically fastened to prevent shrinkage and movement over the life of the damper.
   4. Bearings are 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.
   5. Adjustable 7 /16" hexagonal drive rod, U-bolt fastener, and hexagonal retaining nuts are zinc-plated steel. These provide a positive connection to blades and linkage.
   6. Aluminum and corrosion-resistant zinc-plated steel linkage hardware is installed in the frame side, complete with cup-point trunnion screws for a slip-proof grip.
   7. Rated for operation -40°F – 212°F. Use higher rated version for high-temp applications
   8. All control dampers shall be leakage Class 1A.
   9. Testing and ratings to be in accordance with AMCA Standard 500.
   10. Shaft shall be hexagonal or other shape preventing actuator-slip. Round shaft shall not be acceptable.
   11. Maintenance free (except cleaning).
   12. Produced to exact size without blank-off.

B. Basis of design:
   1. Insulated Dampers: Tamco 9000 BF-ECT series (thermally broken frame and silicone seal); flanged installation.
   2. Non-insulated Control Dampers: Tamco Series 1500.

C. Dampers used for directed mixing of airstreams, i.e. outside air and return air, to be parallel blade type and blades shall be arranged so that the air streams are directed at one another to facilitate mixing.

D. Dampers used for throttling or modulating applications other than air stream mixing to be opposed blade type. Two position dampers shall be parallel blade type and shall be located far enough from coils to allow proper flow development over entire coil surface.

E. Dampers used for isolation on the discharge of centrifugal fans shall have damper blades perpendicular to the fan shaft to minimize system effect. Dampers mounted with blades vertically shall be designed for vertical blade orientation.

F. Provide adequate operating clearance and access to the operator. Install an access door adjacent to each control damper for inspection and maintenance.

PART 3 - NOT USED

END OF SECTION

SECTION 231123
FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Service meters.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.
   2. Service Regulators: 65 psig minimum unless otherwise indicated.
   3. Minimum Operating Pressure of Service Meter: 5 psig.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping specialties.
   2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   3. Pressure regulators. Indicate pressure ratings and capacities.
   4. Dielectric fittings.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
   1. Notify General Contractor no fewer than two days in advance of proposed interruption of natural-gas service.
   2. Do not proceed with interruption of natural-gas service without General Contractor's written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   a. Material Group: 1.1.
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
   e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
   1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
   2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
   3. Corrugated stainless-steel tubing with polymer coating.
   4. Operating-Pressure Rating: 0.5 psig.
   5. End Fittings: Zinc-coated steel.
   6. Threaded Ends: Comply with ASME B1.20.1.
   7. Maximum Length: 72 inches.

B. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig.
   2. Threaded Ends: Comply with ASME B1.20.1.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Body: Bronze, complying with ASTM B 584.
   2. Ball: Chrome-plated bronze.
   3. Stem: Bronze; blowout proof.
   4. Seats: Reinforced TFE; blowout proof.
   5. Packing: Threaded-body packnut design with adjustable-stem packing.
   6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   7. CWP Rating: 600 psig.
   8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:
   1. Single stage and suitable for natural gas.
   2. Steel jacket and corrosion-resistant components.
   3. Elevation compensator.
   4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Appliance Pressure Regulators: Comply with ANSI Z21.18.
   1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
      a. Eaton.
      b. Maxitrol Company.
   2. Body and Diaphragm Case: Die-cast aluminum.
   3. Springs: Zinc-plated steel; interchangeable.
   4. Diaphragm Plate: Zinc-plated steel.
   5. Seat Disc: Nitrile rubber.
   6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
   7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
   8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
   9. Maximum Inlet Pressure: 2 psig.

2.6 SERVICE METERS

A. Service Meters: Comply with ANSI B109.1; to be provided by utility company. Contractor shall coordinate all work, connect to meter, and place into operation.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Description:
      a. Standard: ASSE 1079.
      b. Pressure Rating: 125 psig minimum at 180 deg F.
      c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Description:
      a. Standard: ASSE 1079.
      b. Factory-fabricated, bolted, companion-flange assembly.
      c. Pressure Rating: 125 psig minimum at 180 deg F.
      d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

P. Connect branch piping from top or side of horizontal piping.

Q. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

R. Do not use natural-gas piping as grounding electrode.

S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

T. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 SERVICE-METER ASSEMBLY INSTALLATION

A. Service meter to be installed by Utility. Mechanical contractor is responsible for coordination and final operation.

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

C. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
1. Alkyd System: MPI EXT 5.1D.
   a. Prime Coat: Alkyd anticorrosive metal primer.
   b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
   c. Topcoat: Exterior alkyd enamel (gloss).
   d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
1. Alkyd System: MPI INT 5.1E.
   a. Prime Coat: Alkyd anticorrosive metal primer.
   b. Intermediate Coat: Interior alkyd matching topcoat.
   c. Topcoat: Interior alkyd (gloss).
   d. Color: Safety yellow.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIGAND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
B. Aboveground, distribution piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with steel welding fittings and welded joints.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
C. Valves in branch piping for single appliance shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION

SECTION 232113
HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Condensate-drain piping.
   4. Air-vent piping.
   5. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:
   1. Section 232123 "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Hot-Water Heating Piping: 60 psig at 200 deg F.
   2. Chilled-Water Piping: 60 psig at 200 deg F.
   3. Condensate-Drain Piping: 150 deg F.
   4. Air-Vent Piping: 200 deg F.
   5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air control devices.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

E. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

C. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

D. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

E. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 VALVES

A. Automatic Flow-Control Valves:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   a. Flow Design Inc.
   b. Griswold Controls.
4. Body: Brass or ferrous metal.
5. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
6. Combination Assemblies: Include bonze or brass-alloy ball valve.
7. Identification Tag: Marked with zone identification, valve number, and flow rate.
8. Size: Same as pipe in which installed.
9. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
10. Minimum CWP Rating: 175 psig.
11. Maximum Operating Temperature: 200 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

F. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
   2. Outlet: Type K A, annealed-temper copper tubing with soldered or flared joints.

G. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install throttling-duty valves at each branch connection to return main.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.
K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS ¾ threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
P. Install valves according to Section 230523.
Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
T. Identify piping as specified in Section 230553 "Identification for HVAC Piping and Equipment."
U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
E. Support vertical runs at roof, at each floor, and at 10-footintervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
B. Install control valves in accessible locations close to connected equipment.
C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Section 230519 "Meters and Gages for HVAC Piping."

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
    1. Leave joints, including welds, uninsulated and exposed for examination during test.
    2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
    3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
    4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
    5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
B. Perform the following tests on hydronic piping:
    1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
    2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
    3. Isolate expansion tanks and determine that hydronic system is full of water.
    4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
    5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
    6. Prepare written report of testing.
C. Perform the following before operating the system:
    1. Open manual valves fully.
    2. Inspect pumps for proper rotation.
    3. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
    4. Set temperature controls so all coils are calling for full flow.

5. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
6. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 232116
HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes special-duty valves and specialties for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Makeup-water piping.
   4. Condensate-drain piping.
   5. Air-vent piping.
   6. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air-control devices.
   3. Hydronic specialties.

1.4 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Hot-Water Heating Piping: 100 pgig at 200 deg F.
   2. Chilled-Water Piping: 100 psig at 200 deg F.
   3. Makeup-Water Piping: 80 psig at 150 deg F.
   4. Condensate-Drain Piping: 150 deg F.
   5. Air-Vent Piping: 200 deg F.
   6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

A. Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping." Section 15112 "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC." Section 15900 "HVAC Instrumentation and Controls."

C. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Flow Design, Inc.
   b. Griswold Controls.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
4. Sight glass.

D. Tangential-Type Air / Dirt Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

2.4 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM B 62, bronze with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 40 -mesh strainer, or perforated stainless-steel basket.

4. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install throttling-duty valves at each branch connection to return main.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

END OF SECTION

SECTION 232123
HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.
B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. ITT Corporation.
   2. Grundfos Pumps Corporation, USA.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

2.2 CLOSE-COUPLED IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. ITT Corporation.
2. Grundfos Pumps Corporation, USA.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed and rigidly mounted to pump casing.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   a. Enclosure: Open, dripproof.
   b. Enclosure Materials: Cast iron.
   c. Motor Bearings: Permanently lubricated ball bearings.

2.3 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.

1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

A. Perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check and shut-off valve on discharge side of pump.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

I. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.

b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

END OF SECTION

SECTION 232300
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig.
   2. Suction Lines for Heat-Pump Applications: 535 psig.
   3. Hot-Gas and Liquid Lines: 535 psig.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.5 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.6 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L.
B. Copper Tube: ASTM B 280, Type ACR.

C. Wrought-Copper Fittings: ASME B16.22.
D. Wrought-Copper Unions: ASME B16.22.
E. Brazing Filler Metals: AWS A5.8.
F. Flexible Connectors:
1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.
B. Packed-Angle Valves:
1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.
C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.
D. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.
E. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.
F. Moisture/Liquid Indicators:
1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.

6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

G. Receivers: Comply with ARI 495.
1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

H. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR or L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Safety-Relief-Valve Discharge Piping: Copper, Type ACR or L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

D. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

E. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
1. Compressor.

F. Install receivers sized to accommodate pump-down charge.

G. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
M. Install refrigerant piping in protective conduit where installed belowground.
N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
O. Slope refrigerant piping as follows:
    1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
    2. Install horizontal suction lines with a uniform slope downward to compressor.
    3. Install traps and double risers to entrain oil in vertical runs.
    4. Liquid lines may be installed level.
P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
    1. Shot blast the interior of piping.
    2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
    3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
    4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
    5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
    6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
S. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
    1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
    2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
B. Install the following pipe attachments:
    1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
    2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
    3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
    4. Spring hangers to support vertical runs.
    5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
    1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
    2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
    3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
3. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.

E. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
a. Fill system with nitrogen to the required test pressure.
b. System shall maintain test pressure at the manifold gage throughout duration of test.
c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

END OF SECTION

SECTION 232513
WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following water treatment for closed-loop hydronic systems:
   1. Manual chemical-feed equipment.
   2. Chemicals.

B. Related Requirements:
   1. Section 232533 "HVAC Makeup-Water Filtration Equipment" for water softeners, RO equipment, and filtration equipment.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

B. RO: Reverse osmosis.

C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
   1. Bypass feeders.
   2. Chemical material safety data sheets.

1.5 INFORMATIONAL SUBMITTALS

A. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

B. Other Informational Submittals:
   1. Water Analysis: Illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating and chilled water, shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TSS: Maintain a maximum value of 10 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:
    a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
    c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
    d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
    e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Domed Bottom Bypass Feeder: Provide the quantity and capacity of feeder as shown on the construction drawings.

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

1. Griswold
2. Wessels

C. The feeder shall be constructed of steel and have the following characteristics:

1. Capacity 5 gallon.
2. The feeder will be rated for a minimum of 350 psig at 250 degrees F.
3. Tank shall be provided with a wide mouth of not less than 4” inside diameter so that chemicals can be introduced without the need of a funnel.
4. Four ¾” access ports for flow, vent, and drain.
5. The enclosure shall be a grooved end cap. The retaining bolts are removable by a small adjustable wrench. Rotating cap closures or closures requiring special wrenches shall not be considered equal.
6. The feeder will include heavy legs, minimum 3/16” thick, welded to the sides of the vessel, with holes in the feet to allow floor mounting with anchor bolts.
7. OPTIONS
    a. Stainless steel basket with 1/8” perforations to hold solid chemicals or optional filter bag.
    b. Cartridge Filter Kit with 25 micron element rated for the specified maximum temperature of 170 F.
    c. Plastic filling funnel kit with valve for introduction of liquid agents without opening the lid to the feeder. Valve in kit will include an integral vent valve to bleed off air or release pressure.

2.3 CHEMICALS

A. Chilled water and heating hot water systems shall be straight water, without anti-freeze.

B. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
B. Install water testing equipment on wall near water chemical application equipment.
C. Install interconnecting control wiring for chemical treatment controls and sensors.
D. Mount sensors and injectors in piping circuits.
E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and chilled water, and equipped with the following:
    1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
    2. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
    3. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
    4. Install a swing check on the inlet after the isolation valve.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.
B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."
C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."
D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.
E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
    1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
    2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
    3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
    4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
    5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
    6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
    7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
    8. Repair leaks and defects with new materials and retest piping until no leaks exist.
B. Equipment will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

D. At eight-months following Substantial Completion, perform a final water analysis on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.

E. Comply with ASTM D 3370 and with the following standards:
   1. Silica: ASTM D 859.
   2. Acidity and Alkalinity: ASTM D 1067.
   3. Iron: ASTM D 1068.
   4. Water Hardness: ASTM D 1126.

END OF SECTION

SECTION 233113
METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Leakage tests.
7. Duct cleaning.

B. Related Sections:
1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For sealants.
B. LEED Submittals:
   1. Product Data for IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
   2. Product Data for MR 5: For recycled content.
   3. Product Data for MR 5: For materials extracted, harvested or recovered, as well as manufactured within the region.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
   3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   1. General: Single-component, acid-curing, silicone, elastomeric.
   2. Type: S.
   3. Grade: NS.
   4. Class: 25.
   5. Use: O.
   6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

F. All duct that is to be exposed (and uninsulated) shall be prepped and primed to receive paint (by general contractor).

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections. All such connections shall be high-efficiency type.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. All duct that is to be exposed (and uninsulated) shall be prepped and primed to receive paint (by general contractor).

3.7 FIELD QUALITY CONTROL

A. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
   a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
   b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
   c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
   d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
   e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
   a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.
B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.
C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   6. Supply-air ducts, dampers, actuators, and turning vanes.
   7. Dedicated exhaust and ventilation components and makeup air systems.
E. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
   5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   6. Provide drainage and cleanup for wash-down procedures.
   7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.
B. Supply Ducts:
   1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
      a. Pressure Class: Positive 1-inch wg.
      b. Minimum SMACNA Seal Class: A.
   2. Ducts Connected to Variable-Air-Volume Air-Handling Units:
      a. Pressure Class: Positive 4-inch wg.
      b. Minimum SMACNA Seal Class: A.
C. Return Ducts:
   1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
      a. Pressure Class: Positive or negative 1-inch wg.

b. Minimum SMACNA Seal Class: A.
2. Ducts Connected to Air-Handling Units:
a. Pressure Class: Positive or negative 3-inch wg.
b. Minimum SMACNA Seal Class: A.

D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
a. Pressure Class: Negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
2. Ducts Connected to Air-Handling Units:
a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Air-Handling Units:
a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.

F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

G. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Velocity 1000 fpm or Lower:
1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.
b. Velocity 1000 to 1500 fpm:
1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
c. Velocity 1500 fpm or Higher:
1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.
b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 233300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Manual volume dampers.
2. Control dampers.
3. Fire dampers.
4. Combination fire and smoke dampers.
5. Duct silencers.
6. Turning vanes.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Flexible ducts.
10. Duct accessory hardware.

B. Related Requirements:
1. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
3. Section 283112 "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. LEED Submittals:
1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

1.4 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.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Exposed-Surface Finish: Mill phosphatized.
B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Low-Leakage, Steel, Manual Volume Dampers:
   1. Comply with AMCA 500-D testing for damper rating.
   2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Hat shaped.
      b. 0.094-inch-thick, galvanized sheet steel.
      c. Mitered and welded corners.
      d. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized, roll-formed steel, 0.064 inch thick.
   6. Blade Axles: Galvanized steel.
   7. Bearings:
      a. Oil-impregnated bronze.
      b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   8. Blade Seals: Neoprene.
   9. Jamb Seals: Cambered stainless steel.
   10. Tie Bars and Brackets: Galvanized steel.
   11. Accessories:
      a. Include locking device to hold single-blade dampers in a fixed position without vibration.
B. Jackshaft:
   1. Size: 0.5-inch diameter.
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
C. Damper Hardware:
   1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.

2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
   1. Greenheck Fan Corporation.
   2. Nailor Industries Inc.
   3. Pottorff.
   4. Ruskin Company.
B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
D. Fire Rating: 1-1/2 and 3 hours.
E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.05 thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
G. Mounting Orientation: Vertical or horizontal as indicated.
H. Blades: Roll-formed, interlocking, 0.024-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
K. Heat-Responsive Device: Electric, replaceable link and switch package, factory installed, 165 deg F rated.

2.5 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
   1. Greenheck Fan Corporation.
   2. Nailor Industries Inc.
   3. Pottorff.
   4. Ruskin Company.
B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
D. Fire Rating: 1-1/2 and 3 hours.
E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded, interlocking, gusseted, or mechanically attached corners and mounting flange.
F. Heat-Responsive Device: Replaceable, 165 deg F rated,
G. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.
H. Smoke Detector: Integral, factory wired for single-point connection.
I. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- thick, galvanized sheet steel.
J. Leakage: Class I.
K. Mounting Sleeve: Factory-installed, 0.05-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
L. Master control panel for use in dynamic smoke-management systems.
M. Damper Motors: two-position action.
N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or

adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

O. Accessories:
1. Auxiliary switches for signaling or position indication.
2. Test and reset switches, remote mounted.

2.6 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Dynasonics.
2. Vibro-Acoustics.
3. Price Industries.

B. General Requirements:
1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Shape:
1. Rectangular straight with splitters or baffles.
2. Rectangular elbow with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.034 inch thick.

E. Inner Casing and Baffles: ASTM A 653/A 653M, G90 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.

F. Connection Sizes: Match connecting ductwork unless otherwise indicated.

G. Principal Sound-Absorbing Mechanism:
1. Film-lined type with fill material.
a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression.
b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
1. Joints: Lock formed and sealed, continuously welded, or flanged connections.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

I. Source Quality Control: Test according to ASTM E 477.
1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.7 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

C. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 7-2M, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:
    a. Double wall, rectangular.
    b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    c. Vision panel.
    d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
    a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.
    d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.9 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.
B. Coatings and Adhesives: Comply with UL 181, Class 1.
C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
    1. Minimum Weight: 26 oz./sq. yd..
    2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
    3. Service Temperature: Minus 40 to plus 200 deg F.

2.10 FLEXIBLE DUCTS

A. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
    1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
    2. Maximum Air Velocity: 4000 fpm.
    3. Temperature Range: Minus 20 to plus 175 deg F.
    4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.
B. Flexible Duct Connectors:
    1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
    1. Install steel volume dampers in steel ducts.
    2. Install aluminum volume dampers in aluminum ducts.
D. Set dampers to fully open position before testing, adjusting, and balancing.
E. Install fire dampers according to UL listing.
F. Connect ducts to duct silencers rigidly.
G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
    1. On both sides of duct coils.
    2. Upstream and downstream from duct filters.
    3. At outdoor-air intakes and mixed-air plenums.

4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
2. Head and Hand Access: 18 by 10 inches.

J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect flexible ducts to metal ducts with draw bands. Do not exceed 3 feet for flexible connection.

3.2 MOCK UP

A. Contractor shall provide a mock-up of the fire damper assembly through deck for room 260
1. Assembly shall include all elements shown in detail 7/M450 (“Fire Damper Detail”); including, but not limited to: fire damper, linear slot diffuser, primary ductwork, including elbow and access door, Young’s regulator, and damper.
2. Mock-up shall also include blank-off linear slot diffusers on either side of active diffuser.
3. Assembly shall be through existing deck of room 260, where final installation is to take place.
4. Exact location of mock-up installation shall be coordinated with general contractor and architect.
5. Coordinate schedule of mock-up with general contractor.Mock-up shall be used as final installation, upon acceptance.

END OF SECTION

SECTION 233423
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on [**actual Project site elevations**][**sea level**].
B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Fan speed controllers.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.
B. Coordinate sizes and locations of concrete bases with actual equipment provided.
C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Acme Engineering & Manufacturing Corp.
   2. Greenheck Fan Corporation.
   3. PennBarry.

B. Housing: Split, Galvanized steel, outlet duct collar with integral backdraft damper and field-rotatable discharge.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

D. Fan Wheels: Polypropylene wheel.

E. Accessories:

   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Companion Flanges: For inlet and outlet duct connections.
   3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch. Vibration-control devices are specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

B. Replace fan and motor pulleys as required to achieve design airflow.

C. Lubricate bearings.

END OF SECTION

SECTION 233600
AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Single-duct Airflow Control Valves.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Air terminal units.
   2. Liners and adhesives.
   3. Sealants and gaskets.

B. LEED Submittals:
   1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   2. Product Data for IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
   3. Product Data for MR 5: For recycled content.
   4. Product Data for MR 5: For materials extracted, harvested or recovered, as well as manufactured within the region.

1.4 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SINGLE-DUCT AIRFLOW CONTROL VALVES

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:

1. AccuValve.
2. Prior approved equal.

B. The Airflow Control Valve shall consist of a compression section, two airflow control surfaces, factory-mounted digital vortex airflow measuring device factory-mounted standard speed electric actuator and integral access panel.

C. The compression section shall divide the airstream into at least two separate airstreams. Each airstream shall be approximately equal in size and the total open area shall be approximately 50% of the duct open area. The divided sections shall cause compression therefore creating a more laminar flow for better airflow measurement and turndown. The compression section shall be of an aerodynamic shape with a static regain section to insure minimal pressure drop. The valve shall not require any duct straight runs either upstream or downstream of the airflow valve to achieve required specified performance.

D. Airflow control valves shall be a linear type and shall operate with a minimum turndown ratio of 8 to 1. Accuracy of the airflow valve shall be 5% of reading in the 8 to 1 range of the damper.

E. The airflow control valve shall be capable of being mounted in any position (360º mounting plane) in ductwork without the need for recalibration. It shall not be required to specify mounting plane when ordering valve. Airflow valves that must be ordered and mounted in either a vertical or horizontal plane will not be acceptable.

F. Valve body material for non-corrosive service such as for Supply and Return or Exhaust shall be 18 gauge aluminum for body and 16 gauge for blades. Unit shall be factory-insulated. Valve shaft material shall be 416SS.

G. Airflow control valves shall operate without linkages, springs, levers, or bearings, in the airstream due to the effect of exhaust air on those materials, and shall exhibit no deadband or hysteresis. Airflow control valves shall be provided as “fail last position”.

H. All critical components of the airflow control valve shall be easily accessable from one side of the valve. All linkages shall be out of the airstream to avoid possible corrosion and loss of accuracy. Airflow valves that cannot be mounted with accessible control components (i.e. pivot arm/actuator) in the 4-8 o’clock orientation will not be acceptable.

I. Airflow control valves shall be of a low pressure drop design for energy efficiency. Valves shall not require greater pressure drop than listed at Max CFM (Max L/s or CMH) on project valve schedule or 0.3” wc (75Pa), whichever is less. Airflow control valves that require higher pressures to operate shall not be acceptable. The provision of a larger airflow control valve that is scheduled to accommodate the lower scheduled pressure drop will not be acceptable. Airflow control valves that require higher pressures to operate will not be acceptable.

J. The airflow valve shall be complete with a digital vortex type airflow sensing device providing true airflow feedback for the system. Airflow valves using mechanical means for creating pressure independence will not be acceptable. Airflow valves incorporating pitot, orifice, venturi airflow or thermal airflow measurement will not be acceptable.

K. Demand Based Static Pressure Reset Control (DBSPRC) – Valve must be capable of being utilized with a demand based static pressure reset control scheme as described in ASHRAE Standard 90.1-6.5.3.2.3.

1. DBSPRC offers considerable savings in operating cost by minimizing the static pressure in the duct thereby allowing the supply and exhaust fans to operate at lower brakehorsepower. To utilize DBSPRC the airflow valve must incorporate airflow measurement and closed loop control. Through the measurement of true airflow, the valve will modulate to the proper airflow volume. This will occur regardless of the static pressure in the duct. Information on the valve postion will then be communicated to the BMS which will use that information to reset the static pressure in the duct to the minimum setpoint possible to maximize energy savings.
2. An open loop venturi valve shall not be acceptable because it relies on a calibrated spring and plunger which only drives to a specific valve position and relies on the spring to compensate for pressure changes. Therefore valve position is not indicative of required static pressure in the system and a venturi valve cannot be used for DBSPRC.
3. A mechanical based aiflow control valve such as a venturi valve that cannot meet the demand based static pressure reset control scheme as described in ASHRAE Standard 90.1-6.5.3.2.3 shall not be acceptable.
4. Should a venturi valve be offered as a substitute for a low pressure drop closed loop control valve the contractor offering the valve must provide <u>each</u> venturi valve with a static pressure reset kit which requires duct straight runs of 3x Duct Diameter (upstream of venturi valve) and 4x Duct Diameter (downstream of venturi valve) ensuring that the pressure pickups are located such that they will not be susceptible to clogging or condensation within the tubes. The contractor substituting the venturi valve shall also be responsible for associated design

change and field duct changes to accompany the requirement of straight duct run upstream and downstream of the venturi valve (see above).

5. In addition to the above (Item 3) requirement, the contractor offering the substituted venturi valve must provide the owner the loss in operating savings without DBSPRC of $50,000.00 per 10,000 CFM of exhaust which represents the extra energy cost to the owner over the life of the building.

L. Airflow measuring devices shall be of the Vortex Shedding type, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume. Pitot, Orifice Venturi or Thermal Airflow sensors shall not be acceptable due to their susceptibility to coating and plugging of the sensors which could cause serious errors in readings and resultant safety issues in the room.

M. Individual airflow sensors shall be of rugged construction, and shall not require special handling during installation. Sensors shall be mounted on support bars. Standard materials shall be manufactured of corrosion resistant plastic.

N. Individual velocity sensors shall not be affected by dust, temperature, pressure, or humidity. The sensors shall be passive in nature, with no active parts within the air stream. The output from individual sensors shall be linear with respect to airflow velocity and shall be capable of sensing airflow in one direction only. The velocity sensors shall not require calibration.

O. Velocity sensing methods other than those specified shall not be acceptable. For another velocity sensing method to be considered it must provide the basic requirements for linear electronic output, turndown, accuracy, materials of construction, and output signal. If differential pressure devices are to be considered (such as pitot and venturi), dual differential pressure transmitters, the span of the lower transmitter being one tenth the span of the higher, with an accuracy not less than +/- 0.5%, shall be utilized to provide the required turndown. Orifice type devices shall have a Beta ratio of 0.7 or less, and shall be installed in accordance with ASME MFC-3M guidelines for up and downstream conditions.

P. The airflow sensors shall be easily accessible in the valve for inspection without removing valve from the duct. Airflow control valves provided without built in inspection ports will not be acceptable.

Q. Use of valve or damper position for calculation of airflow volume is not acceptable. Direct airflow measurements must be taken.

R. Sensing methods employing thermal devices in the airstream shall not be acceptable due to their susceptibility to dust and dirt buildup in and exhaust airstream which could cause serious errors in readings and resultant safety issues in the room.

S. Airflow control valves shall have an integral closed-loop feedback controller. Airflow measurement through the vortex airflow sensor shall send the digital signal to the controller which modulates the standard speed electric actuator to maintain desired airflow setpoint. The airflow setpoint shall have the capability of being provided through analog input, digital input, and communications over BACnet MS/TP or AVC internal program memory. Analog output signal shall be provided for airflow and alarm outputs must be provided to indicate abnormal airflow conditions.

1. Airflow Control Valve integral controller shall provide an EIA-485 port supporting BACnet MS/TP as a Full Master Node state machine. Field programming shall be accomplished through an intuitive PC based UI (User Interface) tool. Connection between the integral controller and the computer shall be provided through a USB port located on the AVC control module.
2. Power requirement for each airflow valve with integral controller shall not exceed 10VA for all round, 12”x18” and 12”x24” valves; 16VA for 12”x36” and 12”x48” valves.

T. Airflow control valves provided without the integral closed-loop feedback controller (Model H-AV3000) shall have factory installed standard speed electric actuator specifically adapted to the stroke of the valve which shall operate on 24VAC. Power requirement for each airflow valve actuator shall not exceed 6VA.

2.3 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Steel Cables: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Connect ducts to air terminal units according to Section 233113 "Metal Ducts." Manufacturer-furnished draw-band connections are allowed.

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

SECTION 233713
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Rectangular and square ceiling diffusers.
   2. Linear bar diffusers.
   3. Linear slot diffusers.
   4. Adjustable bar registers and grilles.
   5. Linear bar grilles.

B. Related Sections:
   1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:
   1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Price Industries.
      b. Titus.
   2. Material: Steel.
   3. Finish: Baked enamel, color selected by Architect.
   4. Face Size: 24 by 24 inches.
   5. Face Style: Plaque.
   6. Dampers: Combination damper and grid.

2.2 LINEAR SLOT OUTLETS

A. Linear Bar Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Price Industries.
   b. Titus.
2. Material: Aluminum, final selection by Architect
3. Finish: Anodized aluminum, final selection by Architect
4. Pencil-Proof Core Spacing Arrangement: 3/16-inch thick blades spaced 7/16 inch apart, zero-degree deflection.
5. Frame: 1 inch wide; heavy duty for floor installation.

B. Linear Slot Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Price Industries.
   b. Titus.
2. Material - Shell: Aluminum, insulated.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Anodized aluminum, final selection by Architect.
5. Finish - Pattern Controller: Baked enamel, black, final selection by Architect.

2.3 REGISTERS AND GRILLES

A. Adjustable Bar Register:
1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Price Industries.
   b. Titus.
2. Material: Steel.
3. Finish: Baked enamel, color selected by Architect.
4. Face Blade Arrangement: Horizontal spaced 3/4-inch apart.
5. Frame: 1-1/4 inches wide.
6. Damper Type: Adjustable opposed blade.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.
B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 233723
HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Louvered-penthouse ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
   1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
   2. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

C. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1-2004.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. For louvered-penthouse ventilators specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. LEED Submittal:
   1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.6 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90zinc coating, mill phosphatized.
D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
E. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
D. Fabricate supports, anchorages, and accessories required for complete assembly.
E. Perform shop welding by AWS-certified procedures and personnel.

2.3 LOUVERED-PENTHOUSE VENTILATORS

A. Manufacturers: Subject to compliance with requirements, product indicated on Drawings or comparable product by one of the following:
   1. Aerovent; a division of Twin City Fan Companies, Ltd.
   2. Greenheck Fan Corporation.
B. Construction: All-welded assembly with 4-inch-deep louvers, mitered corners, and aluminum sheet roof with mineral-fiber insulation and vapor barrier.
C. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and0.060 inch for blades.
   1. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
   2. Exterior Corners: Prefabricated corner units with mitered blades with concealed close-fitting splices and with semirecessed mullions at corners.
D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
   1. Configuration: Built-in raised cant and mounting flange.
   2. Overall Height: 12 inches.
E. Bird Screening: Galvanized-steel, 1/2-inch-square mesh, 0.041-inch wire.
F. Galvanized-Steel Sheet Finish:
   1. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
      a. Color and Gloss: As selected by Architect from manufacturer's full range.
G. Accessories:
   1. Dampers:
      a. Location: Penthouse neck.
      b. Control: Motorized.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Install gravity ventilators with clearances for service and maintenance.

C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.

E. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

F. 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.

G. 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.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION

SECTION 235216
CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, factory fabricated and assembled, gas-fired, fire-tube condensing boilers, trim and accessories for generating hot water.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
   1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.

B. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 50% and 7% input firing rates at incoming water temperatures ranging from 80°F to 160°F.

C. Pressure Drop Curve. Submit pressure drop curve for full range of flows:
   1. If submitted material is different from that of the design basis, boiler manufacture shall incur all costs associated with reselection of necessary pumps. Possible differences include, but are not limited to, the pump type, pump pad size, electrical characteristics and piping changes.

D. Shop Drawings: For boilers, boiler trim and accessories include:
   1. Plans, elevations, sections, details and attachments to other work; for installation, not required for submittal.
   2. Wiring Diagrams for power, signal and control wiring; for submittal.

E. Source Quality Control Test Reports: Reports shall be included in submittals.

F. Field Quality Control Test Reports: Reports shall be included in submittals.

G. Operation and Maintenance Data: Data to be included in boiler emergency, operation and maintenance manuals.

H. Warranty: Standard warranty specified in this Section.

I. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. I=B=R Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.

C. ASME Compliance: Condensing boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV “Heating Boilers”.

D. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

E. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

F. UL Compliance: Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

G. NOx Emission Standards: When installed and operated in accordance with manufacturer’s instructions, condensing boilers shall comply with NOx emissions of less than 20 ppm, corrected to 3% oxygen at all firing rates. Certificate or report of compliance is to be supplied upon request.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.

1.6 WARRANTY

A. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:
   a. The pressure vessel/heat exchanger shall carry a 10 year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
   b. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from shipment.
   c. All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 18 months from shipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings or a comparable product by one of the following:
   1. AERCO International (BMK Series).
   2. Lochinvar (Knight Series).

B. Substitutions: Other Manufacturers will be considered for prior approval subject to compliance with the requirements in this specification. Please submit your request along with a chart comparing the following items against the basis of design. Furthermore, it shall be the responsibility of the contactor to insure that any substituted equipment is equivalent in fit, form and function to the specified equipment. The cost of any additional work caused by the substitution shall be the responsibility of the contractor.
   1. Heat Exchanger Type and Material.
   2. Firing Rate Turndown.
   3. AHRI Combustion Efficiency.
   4. AHRI Thermal Efficiency.
   5. O2 @ 5% Firing Rate.
   6. O2 @ 100% Firing Rate.

7. Unit Dimensions.
8. Unit Weight (Shipping & Operating).
9. Combustion Air & Exhaust Vent Sizes.
10. Warranty.

2.2 CONSTRUCTION

A. Description: Boiler shall be natural gas fired, fully condensing, fire tube design. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory fabricated, factory assembled and factory tested, fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return and condensate drain connections, and controls.

B. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 5/8" OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal.

C. Pressure Vessel: The pressure vessel shall have a maximum water volume of 44 gallons. The boiler water pressure drop shall not exceed 3 PSIG at 170 gpm. The boiler water connections shall be 4 inch flanged 150 pound, ANSI rated. The pressure vessel shall be constructed of SA53 carbon steel, with a minimum of 0.25 inch thick wall and 0.50-inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

D. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of a 20 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. Boilers with less turndown are not acceptable. The burner shall produce less than 20 ppm of NOx corrected to 3% excess oxygen. The burner shall be metal fiber mesh covering a stainless steel body with pilot ignition system and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable frequency drive (VFD), controlled cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner. A washable & reusable combustion air filter made of multi layers of oiled cotton fabric shall be provided to help keep the burner and air/fuel valve clean.

E. Minimum boiler efficiencies shall be as follows as tested by AHRI: combustion: 95.1%, thermal: 94.6%.

F. Exhaust Manifold: The exhaust manifold shall be of corrosion resistant cast aluminum or 316 stainless steel. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

G. Blower: The boiler shall include a VFD controlled fan to operate during the burner firing sequence and pre-purge the combustion chamber.

1. Motors: Blower motors shall comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.

H. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

I. The boiler shall be designed such that the combustion air is drawn from the inside of the boiler enclosure, decoupling it from the combustion air supply and preheating the air to increase efficiency.

J. The sheet metal enclosure shall be fully removable, allowing for easy access during servicing.

K. Boiler width shall be no greater than 28".

L. Boiler shall be manufactured in the USA.

2.3 CONTROLS

A. Refer to Division 23, Section "Instrumentation and Control of HVAC" and or plans.

B. The boiler control system shall be segregated into three components: "C-More" Control Panel, Power Box and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized.

C. The control panel shall consist of six individual circuit boards using state of the art surface mount technology in a single enclosure. These circuit boards shall include:

1. A display board incorporating LED display to indicate temperature and a vacuum fluorescent display module for all message enunciation.
2. A CPU board housing all control functions.
3. An electric low water cutoff board with test and manual reset functions.
4. A power supply board.
5. An ignition /stepper board incorporating flame safeguard control.
6. A connector board.
7. Each board shall be individually field replaceable.

D. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification type flame sensor.

E. The control panel hardware shall support both RS-232 and RS-485 remote communications.

F. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of eight separate status messages and 34 separate fault messages.

G. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:

1. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.
2. Setpoint Low Limit: Allow for a selectable minimum operating temperature.
3. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired.

H. The boiler control system shall incorporate the following additional features for enhanced external system interface:

1. System start temperature feature.
2. Pump delay timer.
3. Auxiliary start delay timer.
4. Auxiliary temperature sensor.
5. Analog output feature to enable simple monitoring of temperature setpoint, outlet temperature or fire rate.
6. Remote interlock circuit.
7. Delayed interlock circuit.
8. Fault relay for remote fault alarm.

I. Each boiler shall include an electric, single seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over temperature protection with manual reset, in accordance with ASME Section IV and CSD 1.

J. Each boiler shall have an oxygen monitoring system that will measure the oxygen content of the exhaust gasses in real time. Output of O2 information shall be displayed on the C-More control panel.

K. Each boiler shall have integrated Boiler Sequencing Technology (BST), capable of multi-unit sequencing with lead-lag functionality and parallel operation. The system will incorporate the following capabilities:

1. Efficiently sequence 2-to-8 units on the same system to meet load requirement.
2. Integrated control and wiring for seamless installation of optional isolation valve. When valves are utilized, the system shall operate one motorized valve per unit as an element of load sequencing. Valves shall close with decreased load as units turn off, minimum of one must always stay open for recirculation.
3. Automatically rotate lead/lag amongst the units on the chain and monitor run hours per unit and balance load in an effort to equalize unit run hours.
4. Designated master control, used to display and adjust key system parameters.
5. Automatic bump-less transfer of master function to next unit on the chain in case of designated master unit failure; master/slave status should be shown on the individual unit displays.
6. Designated master control, used to display and adjust key system parameters.

2.4 BAS COMMUNICATION

A. Accepts enable/disable signal from BAS.

B. Accepts 4-20mA signal from BAS for temperature setpoint.

C. Contacts for BAS to Monitor:

1. Refer to plans.

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.

B. Single Point Field Power Connection: Factory installed and factory wired switches, motor controllers, transformers and other electrical devices shall provide a single point field power connection to the boiler.

C. Electrical Characteristics: 120V single phase, 16 FLA.

2.6 OPTIONS

A. Boiler system shall be supplied with a gateway for communicating with BAS BacNet.

B. Boiler manufacturer shall supply each boiler with a motorized two-way isolation valve shipped loose for field installation.

1. This valve shall be connected to the factory supplied boiler wiring harness and shall require no other wiring for control or power.
2. This valve shall be controlled by the boiler controller and shall include logic to open all valve when all boilers are off.

C. Boiler shall be furnished with a condensation neutralization system, for installation by the contractor.

2.7 VENTING

A. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with operating temperatures up to 230°F, Venting shall be Heatfab Al 29-4C stainless steel (double or single wall) or polypropylene. Boiler vender must supply Exhaust Venting.

B. Combustion-Air Intake shall be a metal or PVC duct connected between the boiler and the outdoors. This duct shall be insulated in the field by contractor.

C. Common vent and common combustion air must be an available option for boiler installation. Consult manufacturer for common vent and combustion air sizing.

D. Follow guidelines specified in manufacturer's venting guide.

2.8 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.

B. Test and inspect factory assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

1. If boilers are not factory assembled and fire tested, the local vendor is responsible for all field assembly and testing.

C. Allow Owner access to source quality control testing of boilers. Notify Architect fourteen days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations and piping and electrical connections to verify actual locations, sizes and other conditions affecting boiler performance, maintenance and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Install gas fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
B. Install piping adjacent to boiler to permit service and maintenance.
C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
D. Install condensate piping from the drain on the exhaust manifold to the factory supplied condensate trap and optional condensate neutralizer and then pipe to a floor drain. The piping should be either PVC or Polypropylene; copper should not be used.
E. Connect gas piping to boiler gas train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
F. Connect hot water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.
G. Install piping from safety relief valves to nearest floor drain.
H. Boiler Venting:
    1. Install flue venting kit and combustion-air intake.
    2. Connect venting full size to boiler connections.
I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
K. Install condensate neutralization system according to manufacturer recommendations and pipe to nearest floor drain.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
    1. Manufacturer's Field Service: Engage a factory authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
B. Tests and Inspections
    1. Perform installation and startup checks according to manufacturer's written instructions.
    2. Perform hydrostatic test. Repair leaks and retest until no leaks exist.
    3. Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
    4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
        a. Check and adjust initial operating set points and high and low limit safety set points of fuel supply, water level and water temperature.
        b. Set field adjustable switches and circuit breaker trip ranges as indicated.
C. Remove and replace malfunctioning units and retest as specified above.
D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide onsite assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
E. Performance Tests:
    1. Engage a factory authorized service representative to inspect component as assemblies and equipment installations, including connections, and to conduct performance testing.
    2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
    3. Perform field performance tests to determine capacity and efficiency of boilers.
        a. Test for full capacity.
        b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40 and 20 percent of full capacity. Determine efficiency at each test point.
    4. Repeat tests until results comply with requirements indicated.
    5. Provide analysis equipment required to determine performance.
    6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
    7. Notify Architect in advance of test dates.
    8. Document test results in a report and submit to Architect.
F. Demonstration and training:
    1. Engage a factory authorized service representative to train owner’s maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION

SECTION 236313
AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

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

1.2 SYSTEM DESCRIPTON

A. Outdoor-mounted, air-cooled condenser suitable for refrigerant R-410A or R-134a on the ground or rooftop installation. The 09DPS unit shall have one refrigeration circuit and the 09DPM unit shall have two independent refrigeration circuits capable of field conversion to single circuit. Unit shall have air-cooled coils, propeller-type condenser fans, a control box, and shall discharge condenser air vertically upward as shown on certified drawings. Unit shall be used in refrigeration circuit with 30MPA or 30HXA air-cooled condenserless chillers.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-cooled refrigerant condenser. Include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. LEED Submittals:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1.
2. Product Data for Credit EA 4: Documentation indicating that air-cooled refrigerant condensers and refrigerants comply.

1.4 QUALITY ASSURANCE

A. Unit construction shall comply with latest edition of ASHRAE 15 Safety Code, UL 1995, and ASME applicable codes (U.S.A. codes).

B. Unit shall be manufactured in a facility registered to ISO 9001 Manufacturing Quality Standard.

C. Base unit shall be constructed in accordance with UL standards and CSA.

D. Unit cabinet shall be capable of withstanding 500-hour salt-spray exposure per ASTM B117 (scribed specimen).

E. Design pressure shall be 650 psig.

F. Unit shall be functional checked at the factory.

G. Unit shall be rated using refrigerants R-410A and R-134a. Ratings shall be listed at minimum (5° F subcooling) and maximum (15° F subcooling) refrigerant charge.

H. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

B. Coordinate location of refrigerant piping and electrical rough-ins.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be shipped as single package and shall be stored and handled per unit manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Carrier Corporation; a unit of United Technologies Corp.

2.2 EQUIPMENT

A. General:

1. Factory assembled, single-piece, air-cooled remote condenser. Contained within the unit enclosure shall be all factory wiring, piping, controls, nitrogen holding charge, and special features required prior to field start-up.

B. Unit Cabinet:

1. Cabinet shall be galvanized steel casing with a baked enamel powder or pre-painted finish.
2. Cabinet shall be capable of withstanding 500-hr salt spray test in accordance with ASTM (U.S.A.) B-117 standard.
3. Control box access panels shall be removable for service access.
4. Lifting holes shall be provided to facilitate rigging.

C. Fans:

1. Condenser fans shall be direct-drive propeller type, discharging air vertically upward.
2. All condenser fan motors shall be totally enclosed 3-phase type with permanently lubricated ball bearings, class F insulation and internal, automatic-reset thermal overload protection.
3. Shafts shall have inherent corrosion resistance.
4. Fan blades shall be statically and dynamically balanced.
5. Condenser-fan openings shall be equipped with PVC-coated steel wire safety guards.

D. Condenser Coils:

1. Coil shall be air-cooled microchannel heat exchanger (MCHX) and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Microchannel coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for the fins, tubes and manifolds in combination with a corrosion-resistant coating on the tubes.
2. Tubes shall be cleaned, dehydrated, and sealed.
3. Assembled condenser coils shall be leak tested and pressure tested at 650 psig.

E. Refrigeration Components:

1. Refrigeration circuit components shall include liquid line temperature relief device and nitrogen holding charge.

F. Controls and Safeties:

1. Unit controls shall include:
   a. Unit shall have a temperature fusible plug for safety on each refrigerant circuit.
   b. Self-contained low voltage control circuit.
   c. Cycle condenser fans to maintain proper head pressure control.

G. Operating Characteristics:

1. Unit shall be capable of rejecting the required heat at the required cfm and be capable of operating down to moderate ambient temperatures with standard factory supplied fan cycling.
2. Head pressure fan cycling control utilizes temperature switches for 09DP018-035 and 065 units.
3. Head pressure fan cycling control utilizes temperature and pressure switches for 09DP040-060 and 075-130 units.
4. Operation to –20 F shall be possible with Motormaster® head pressure control.

H. Electrical Requirements:
1. A dual power supply of the correct voltage shall be required for each series unit. A 3-phase power circuit voltage and a 24 volt single-phase control circuit shall be required.
2. The number of control circuits shall depend on the unit application, whether it is matched with one unit or two units.
3. Power supplies for all units shall enter the control box through factory-punched entrance holes in the control box shelf.
4. Terminal blocks shall be supplied for field wiring connections.
5. Units shall utilize electromechanical fan cycling head pressure controls to control proper head pressure.

I. Special Features:
1. Low Ambient Control:
   a. Control shall regulate fan motor speed in response to the saturated condensing temperature of the unit. The control shall be capable of operating with outdoor temperatures at –20 F.
   b. Motormaster® low ambient control shall be available as a factory-installed option or field-installed accessory for all units.
2. Optional E-Coated MCHX Condenser Coil:
   a. E-coated aluminum microchannel coils shall have a flexible epoxy polymer coating uniformly applied to all coil external surface areas without material bridging between fins or louvers. Coating process shall ensure complete coil encapsulation, including all exposed fin edges. E-coat thickness of 0.8 to 1.2 mil with top coat having a uniform dry film thickness from 1.0 to 2.0 mil on all external coil surface areas, including fin edges, shall be provided. E-coated coils shall have superior hardness characteristics of 2H per ASTM D3363-00 and cross-hatch adhesion of 4B-5B per ASTM D3359-02. E-coated products shall have superior impact resistance with no cracking, chipping or peeling per NSF/ANSI 51-2002 Method 10.2 (U.S.A. Standards). E-coated aluminum microchannel coils shall be capable of withstanding an 8,000-hour salt spray test in accordance with the ASTM (American Society for Testing and Materials) (U.S.A.) B-117 Standard.
3. Sound Reduction:
   a. Low sound fan for sound reduction is available as a factory-installed option or field-installed accessory for all units.
   b. Low sound fans shall be direct driven, 9-blade, airfoil cross-section type with reinforced polymer construction and shrouded axial fan. Fan shall be statically and dynamically balanced with inherent corrosion resistance.
4. Non-Fused Disconnect:
   a. A non-fused disconnect is available as a factory- installed option for all units having single point power connection units.
5. High Short Circuit Current Rating (SCCR):
   a. The optional high SCCR interrupt capability shall allow the unit to tolerate a 65 kA (208/230v, 380v and 460-v units) or 25 kA (575-v units) short circuit current for a brief period of time while protecting downstream components. The high SCCR option shall provide a higher level of protection than the standard unit (option for 60 Hz only). High interrupt shall be available as factory-installed option on all units.
6. Security Grilles/Hail Guards:
   a. Units shall be supplied with factory-installed or field-installed louvered, sheet metal panels which securely fasten to the unit to provide condenser coil protection against hail and physical damage.
7. Vibration Isolation Pads:
   a. Neoprene vibration isolation pads (24 in. x 3 in. x 1/4 in.) shall be available for field installation to reduce vibration transmission from the compressor through the floor and into the conditioned space.
8. Wind Baffle Kit:
   a. Field-installed accessory kit shall provide wind baffles for use with low ambient temperature operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of air-cooled refrigerant condensers.
B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
C. Examine walls, floors, and roofs for suitable conditions where air-cooled condensers will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
B. Equipment Mounting:
    1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
C. Maintain manufacturer's recommended clearances for service and maintenance.
D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
    1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
B. Tests and Inspections:
    1. Perform electrical test and visual and mechanical inspection.
    2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
    4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    5. Verify proper airflow over coils.
C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
D. Air-cooled refrigerant condensers will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
    1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
        a. Inspect for physical damage to unit casing.
        b. Verify that access doors move freely and are weathertight.
        c. Clean units and inspect for construction debris.
        d. Verify that all bolts and screws are tight.
        e. Adjust vibration isolation and flexible connections.
        f. Verify that controls are connected and operational.
    2. Lubricate bearings on fan motors.

3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
4. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
5. Measure and record airflow and air temperature rise over coils.
6. Verify proper operation of capacity control device.
7. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
8. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-cooled refrigerant condensers.

END OF SECTION

SECTION 236423
SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SYSTEM DESCRIPTION

A. Microprocessor controlled liquid-cooled condenserless liquid chiller utilizing scroll type compressors.

1.3 ACTION SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
   1. Performance at ARI standard conditions and at conditions indicated.
   2. Performance at ARI standard unloading conditions.
   3. Minimum evaporator flow rate.
   4. Refrigerant capacity of water chiller.
   5. Oil capacity of water chiller.
   6. Fluid capacity of evaporator.
   7. Characteristics of safety relief valves.

1.4 QUALITY ASSURANCE

A. Unit performance shall be rated per AHRI (Air-Conditioning, Heating and Refrigeration Institute) Standard 550/590 and 551/591, latest edition (U.S.A.) at standard rating conditions.

B. All units shall be ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) 90.1 compliant.

C. Unit construction shall comply with ANSI (American National Standards Institute)/ASHRAE 15 Safety Standard (latest revision) and NEC (National Electrical Code).

D. Unit shall be certified in accordance with ISO (International Organization for Standardization) 9001 manufacturing quality standard.

E. Unit shall be ETL and ETL, Canada certified.

1.5 DELIVERY, STORAGE AND HANDLING

A. Unit shall be shipped factory-assembled with all piping and wiring, pre-charged with a holding charge of nitrogen and shall be stored and handled according to manufacturer's recommendations.

B. Unit controls shall be capable of withstanding 150 F storage temperatures in the control compartment.

C. Chiller and starter should be stored indoors, protected from construction dirt and moisture. An inspection should be conducted under shipping tarps, bags, or crates to be sure water has not

collected during transit. Protective shipping covers should be kept in place until machine is ready for installation. The inside of the protective cover should meet the following criteria:

1. Temperature is between 40 F and 120 F.
2. Relative humidity is between 10% and 80% (non-condensing).

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Carrier Corporation; a unit of United Technologies Corp.

2.2 EQUIPMENT

A. General:
   1. Single-piece liquid chiller consisting of compressor(s), BPHE (brazed-plate heat exchanger) evaporator, controls, safeties, and any hardware required before start-up.

B. Unit Cabinet:
   1. Frame shall be of heavy-gage galvanized steel with an electrostatically applied baked enamel finish.
   2. The unit shall pass through a standard 36-inch door and shall not exceed 57 inches in length.

C. Compressor:
   1. Fully hermetic scroll type compressors.
   2. Direct drive, 3500 rpm, protected by line break device, suction gas cooled motor.
   3. External vibration isolation - rubber in shear.
   4. Staging of compressors shall provide unloading capability. Digital compressor unloading shall be provided for further staging capacity..

D. Evaporator:
   1. Evaporator shall be rated for a maximum refrigerant pressure of 505 psig for sizes 015 and 020, 565 psig for sizes 030 to 045, and 653 psig for sizes 050 to 071, and shall be tested for a maximum water-side pressure of 300 psig.
   2. Shall be single-pass, ANSI type 316 stainless steel, brazed plate construction.
   3. Shall be insulated with 3/4-inch closed-cell, polyvinyl-chloride foam with a maximum K factor of 0.28.
   4. Unit shall be provided with a factory-installed flow switch.
   5. Unit shall be provided with entering and leaving chilled water temperature sensors and water pressure access port.
   6. A strainer with a minimum of 40 mesh must be installed within 10 ft of the heat exchanger fluid inlet to prevent debris from clogging the heat exchanger. This strainer shall be required and shall be available as an accessory.

E. Refrigerant Components:
   1. Each chiller shall contain the following: sight glass; filter drier; liquid line isolation valve; expansion valve; and charging port.
   2. Expansion valve TXV thermostatic expansion valve shall be located within 12 inches of the evaporator with no bend between expansion valve and evaporator in accordance with evaporator manufacturer recommendation.

F. Controls, Safeties and Diagnostics:
   1. Controls:
      a. Unit controls shall include the following minimum components:
         1) Microprocessor.
         2) Power and control circuit terminal blocks.
         3) ON/OFF control switch.
         4) Thermistor is installed to measure evaporator entering and leaving fluid temperatures.
         5) Terminal block for temporary and/or permanent interface to the Carrier Comfort Network® or similar building system control.
      b. Microprocessor with non-volatile memory. Battery backup system shall not be accepted.

c. Control transformer to serve all controllers, contactors, relays, and control components.
d. Replaceable solid-state relay panels and controllers.
e. Pressure transducers (used to calculate saturated suction temperature and saturated condensing temperature).
f. Provision for field installation of accessory sensor to measure compressor return gas temperature (suction gas thermistor).
g. Terminals shall be provided in the control box for wiring of accessory field-installed condenser temperature sensors.
h. Unit controls shall be capable of performing the following functions:
1) Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature.
2) Limiting of the chilled fluid temperature pulldown rate at start-up to 1° F per minute to prevent excessive demand spikes (charges) at start-up.
3) Seven-day time schedule.
4) Leaving chilled fluid temperature reset from return fluid.
5) Dual chiller control for parallel chiller applications (common leaving chilled water sensor required).
6) Timed maintenance scheduling to signal maintenance activities.

2. Diagnostics:
a. The control panel shall include, as standard, a scrolling marquee display capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display.
b. Information included for display shall be:
1) Compressor lockout.
2) Loss of charge.
3) Low fluid flow.
4) Evaporator freeze protection.
5) Thermistor malfunction.
6) Entering and leaving-fluid temperature.
7) Circuit suction and discharge pressure.
8) Time of day.
c. Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, and compressors before chiller is started.
d. Diagnostics shall include the ability to review a list of the 20 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
e. An alarm history buffer shall allow the user to store no less than 20 alarm events with clear language descriptions, time and date stamp event entry.
f. The chiller controller shall include a connection port for communicating with the local equipment network and the Carrier Comfort Network (CCN) system.
g. The control system shall allow software upgrade without the need for new hardware modules.

3. Safeties:
a. Unit shall be equipped with sensors and all necessary components in conjunction with the control system to provide the unit with the following protections:
1) Loss of refrigerant charge protection.
2) Low fluid flow detection.
3) Low chilled fluid temperature protection.
4) Low control voltage (to unit) protection.
5) High-pressure switch.
6) Reverse rotation.
7) Overcurrent protection.
8) Loss of phase.
b. Compressors shall be equipped with the following protections:
1) High discharge temperature protection.
2) Electrical overload through the use of definite-purpose contactors and motor overload protection through internal compressor overload or external current overload.
3) Circuit breakers shall open all 3 phases in the event of an overload in any one phase (single-phasing condition).
4) Circuit breakers for short circuit protection.

G. Operating Characteristics:
   1. Unit shall be capable of starting with up to 95 F fluid temperature entering the evaporator.
   2. Unit shall be capable of operating with variable evaporator fluid flow, up to 10% change in flow rate per minute.

H. Electrical Requirements:
   1. Single-point electrical power connection with compressors factory-wired to a terminal block in the control panel. Compressor sensors and system pressure transducers shall be factory-wired to the unit controller.
   2. Control interface shall be accessed through low voltage terminal strip or terminal strip.

I. Chilled Water Circuit:
   1. Chilled water circuit shall be rated for 300 psig.
   2. Solid-state flow switch with integral relay shall be factory installed and wired.

J. Special Features:
      a. Sound Enclosure Panels:
      b. This acoustic package shall be either factory-installed or field-installed and shall entirely enclose the compressor section to further reduce radiated sound.
      c. Vibration Isolators (Springs):
      d. Vibration isolators shall be field-installed before the unit is set into its final location and shall reduce vibration transmission through the mounting area of the chiller.
   2. Non-Fused Disconnect:
      a. The non-fused disconnect shall be factory installed and shall disconnect all power to the unit (including control circuit power).
      b. Strainer:
      c. A Y strainer shall be available in sizes 1.5 to 6 in. with a minimum of 40 mesh for field installation.
   3. Remote Enhanced Display:
      a. Unit shall be supplied with indoor-mounted, remote, 40-character per line, 16-line display panel for field installation.
   4. Energy Management Module (EMM):
      a. A factory or field-installed module shall provide the following energy management capabilities: 4 to 20 mA signals for leaving fluid temperature reset, cooling set point or demand limit control; 2-point demand limit control (from 15% to 100%) activated by a remote contact closure; and discrete input for “Ice Done” indication for ice storage system interface. EMM shall be capable of:
         1) Leaving temperature reset from space temperature, outdoor temperature, or 4 to 20 mA signal.
         2) Demand limit or load shed via field-supplied 4 to 20 mA signal or 2-step discrete contact closure.
   5. BACnet Translator Control:
      a. Unit shall be supplied with field-installed interface between the chiller and a BACnet Local Area Network (LAN, i.e., MS/TP EIA-485).
      b. Digital Compressor Option:
      c. Shall provide factory-installed digital compressor to provide additional steps of capacity (not available on sizes 015, 050-071).
   6. Compressor Insulation:
      a. Compressor insulation is designed to insulate scroll compressors and prevent water vapor from condensing on the colder compressor surface.
      b. Compressor Sound Blankets:
      c. Units can be ordered with acoustically insulated sound blankets installed around the compressors to reduce radiated sound levels.
   7. Water Manifold Piping Option:
      a. Shall provide piping that allows more than one chiller module to be piped together in parallel. Combination valves shall also be provided.
   8. BACnet Communication Option:
      a. Shall provide factory-installed communication capability with a BACnet MS/TP network. Allows integration with i-Vu® Open control system or a BACnet building automation system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
   1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

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

3.2 WATER CHILLER INSTALLATION

A. Install water chillers on support structure indicated.

B. Equipment Mounting:
   1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

E. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to chiller to allow service and maintenance.

D. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. Make connections to water chiller with a union, flange, or mechanical coupling.

E. Refrigerant Pressure Relief Valve Connections: For water chillers installed indoors, extend vent piping to the outside without valves or restrictions. Comply with ASHRAE 15.

F. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
   2. Verify that pumps are installed and functional.
   3. Verify that thermometers and gages are installed.
   4. Operate water chiller for run-in period.
   5. Check bearing lubrication and oil levels.
   6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
   7. Verify proper motor rotation.
   8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
   9. Verify and record performance of water chiller protection devices.
   10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Prepare a written startup report that records results of tests and inspections.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

END OF SECTION

SECTION 237313
MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Variable-air-volume, single-zone air-handling units.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.
1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
a. Certified fan-performance curves with system operating conditions indicated.
b. Certified fan-sound power ratings.

c. Fan construction and accessories.
d. Motor ratings, electrical characteristics, and motor accessories.
4. Certified coil-performance ratings with system operating conditions indicated.
5. Filters with performance characteristics.

B. LEED Submittals:
1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
3. Product Data for MR 5: For recycled content.
4. Product Data for MR 5: For materials extracted, harvested or recovered, as well as manufactured within the region.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Filters: One set(s) for each air-handling unit.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
F. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.
B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The following manufacturers are approved for use.
1. Daikin Applied 'Vision' Air Handler shall be the basis of design.
2. Trane shall be allowed as equal, if compliant with requirements of plan and specification.

2.2 GENERAL DESCRIPTION

A. Configuration: Fabricate as detailed on drawings.
B. Performance: Conform to AHRI 430. See schedules on prints. (NOTE: above does not apply to fan array).

C. Acoustics: Sound power levels (dB) for the unit shall not exceed the specified levels shown on the unit schedule. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

2.3 UNIT CONSTRUCTION

A. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.

B. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
   1. The inner liner shall be constructed of G90 galvanized steel.
   2. The outer panel shall be constructed of G60 painted galvanized steel.
   3. The floor plate shall be constructed as specified for the inner liner.
   4. Unit will be furnished with solid inner liners.

C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.

D. The casing leakage rate shall not exceed .5 cfm per square foot of cabinet area at 5 inches of positive static pressure or 6 inches of negative static pressure (.0025 m3/s per square meter of cabinet area at 1.24 kPa static pressure).

E. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.

F. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size turnable door handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.

G. A 6-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping. The base rail shall be constructed with 12-gauge nominal for unit sizes 003 - 035 and 10-gauge nominal for unit sizes 040 - 090. The following calculation shall determine the required height of the baserail to allow for adequate drainage. Use the largest pressure to determine base rail height. [(Negative)(Positive) static pressure (in)] (2) + 4” = required baserail height. Should the unit baserail not be factory supplied at this height, the contractor is required to supply a concrete housekeeping pad to make up the difference.

H. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3’’ above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2’’ thickness of insulation under drain pan.

2.4 FAN ASSEMBLIES

A. Acceptable fan assembly shall be a single width, single inlet, class II, direct-drive type plenum fan dynamically balanced as an assembly, as shown in schedule. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes. Provide access to motor and fan assembly through hinged access door.

B. Fan and motor shall be mounted internally on a steel base. Factory mount motor on slide base that can be slid out the side of the unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry. Motor shall be TEFC type.

2.5 BEARINGS, SHAFTS, AND DRIVES

A. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be provided on the motor with the fan wheel mounted directly on the motor shaft, AMCA arrangement 4.

B. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.

C. The fan wheel shall be direct coupled to the motor shaft. The wheel width shall be determined by motor speed and fan performance characteristics.

2.6 ELECTRICAL

A. Fan motors shall be manufacturer provided and installed, Totally Enclosed, premium efficiency (meets or exceeds EPAct requirements), 1750 RPM, single speed, 460V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.

B. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.

C. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.

D. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.

E. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.

F. Air handler manufacturer shall provide and mount conduit and wiring from each fan motor terminated at an external junction box.

2.7 COOLING COILS

A. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.

B. Water cooling coils shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.

1. Headers shall consist of stainless steel. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
3. [Removed].
4. Coil tubes shall be 5/8 inch OD seamless copper, 0.025 inch nominal tube wall thickness, expanded into fins, brazed at joints.

5. Coil connections shall be carbon steel, NPT threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
6. Coil casing shall be a formed channel frame of galvanized steel.

2.8 FILTERS

A. Furnish filter sections with 4-inch pleated filter racks as shown on plan. Provide filter media as noted on plan.
B. Filter media shall be UL 900 listed, Class I or Class II.
C. Filter Magnehelic gauge(s) shall be furnished and installed at the factory.

2.9 ADDITIONAL SECTIONS

A. Access section shall be provided for access between components.
B. Plenum section shall be provided and properly sized for inlet and/or discharge air flow (between 600 and 1500 feet per minute). The plenum shall provide single or multiple openings as shown on drawings and project schedule.
C. Mixing box section shall be provided with end outside air opening and no return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Connecting linkage and ABS plastic end caps shall be provided when return and outside air dampers are each sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.
D. Energy recovery wheel shall be constructed of corrugated synthetic fibrous media, with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Wheel shall be segmented for breakdown, and washable. Rotors with desiccants coated bonded, or synthesized onto the media are not acceptable due to delaminating or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. Coated aluminum is not acceptable. Face flatness of the wheel shall be maximized in order to minimize wear on inner seal surfaces and to minimize cross leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers should be uniform in construction forming uniform aperture sizes for airflow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by airflow are unacceptable due to the possibility of channeling and performance degradation. The minimum acceptable performance shall be as specified in the unit schedule.
Desiccant Material: The desiccant material shall be a molecular sieve, and specifically a 4A or smaller molecular sieve to minimize cross contamination. Wheel Media Support System: The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction should allow for post fabrication wheel alignment. Wheel Seals: The wheel seals shall be full contact nylon brush seals or equivalent. Seals should be easily adjustable. Wheel cassette: Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box tubing. Cassettes shall have a built in adjustable purge section minimizing cross contamination of supply air as shown on unit schedule. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged or pillow block bearings. Drive systems shall consist of fractional horsepower AC drive mo-

tors with multi-link drive belts. Face and bypass dampers shall be furnished as shown on unit schedule and drawings. Certification: The wheel shall be AHRI certified by the energy recovery wheel supplier to AHRI Standard 1060 and must bear the AHRI certification stamp. Private independent testing performed "in accordance with" various standards is not a substitute for AHRI certification and shall not be accepted. The wheel shall be listed or recognized by UL or equivalent.

2.10 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Units shall be shipped to site broken down. Contractor shall provide for factory-authorized personnel to arrive on site and assist in assembly.

B. Equipment Mounting:

1. Where so noted on plan, install air-handling units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Arrange installation of units to provide access space around air-handling units for service and maintenance.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties. "Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Field Service: inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Comb coil fins for parallel orientation.
7. Verify that proper thermal-overload protection is installed for electric coils.
8. Install new, clean filters.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.

3.6 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

1 **END OF SECTION**

SECTION 238126
SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Compressor: One year(s) from date of Substantial Completion.
   b. For Parts: One year(s) from date of Substantial Completion.
   c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Carrier Corporation; a unit of United Technologies Corp.
2. Mitsubishi Electric & Electronics USA, Inc.

2.2 INDOOR UNITS 5 TONS (18 kW) OR LESS

A. Wall-Mounted, Evaporator-Fan Components:
   1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
   2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
   3. Fan: Direct drive, centrifugal.
   4. Fan Motors:
      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
      c. Enclosure Type: Totally enclosed, fan cooled.
      d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
      e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
      f. Mount unit-mounted disconnect switches on exterior of unit.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   6. Condensate Drain Pans:
      a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
         1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
         2) Depth: A minimum of 1 inch deep.
      b. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
      c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
         1) Minimum Connection Size: NPS 1.
   7. Air Filtration Section:
      a. General Requirements for Air Filtration Section:
         1) Comply with NFPA 90A.
         2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
         3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
      b. Disposable Panel Filters:
         1) Factory-fabricated, viscous-coated, flat-panel type.
         2) Thickness: 1 inch.
         3) Merv according to ASHRAE 52.2: 5.
         4) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
         5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Factory-furnished options shall include any items required to operate equipment down to -20F ambient.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Section 07720 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC." Section 15068 "Vibration Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Connect hydronic piping to supply and return connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 238216.11
HYDRONIC AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hydronic heating and cooling air coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
   2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.2 COILS

A. Manufacturers: Subject to compliance with requirements, product indicated on Drawings or comparable products by one of the following:
   1. Carrier Corporation; a unit of United Technologies Corp.
   2. Dunham-Bush, Inc.
   3. Greenheck Fan Corporation.
   4. Heatcraft Worldwide Refrigeration.
   5. Trane.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum 0.035 inch thick.

F. Fins: Aluminum, minimum 0.006 inch thick.

G. Stainless steel headers with drain and air vent tappings.

H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for slip-in mounting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

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

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Straighten bent fins on air coils.

D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230923.11 "Control Valves," and other piping specialties are specified in Section 232116 "Hydronic Piping Specialties."

END OF SECTION

SECTION 238216.14
ELECTRIC RESISTANCE AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes electric resistance air coils.
B. Related Requirements:
   1. Section 238216.11 "Hydronic Air Coils."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
   2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.2 COILS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by one of the following:
   1. Chromalox, Inc.
   2. INDEECO.
   3. Trane.
B. Testing Agency Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Coil Assembly: Comply with UL 1995.
D. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, and fastened to supporting brackets.
E. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.
   1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
F. Frames: Galvanized-steel channel frame, minimum 0.064 inch thick for slip-in mounting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

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

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

END OF SECTION

SECTION 238219
FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Ductless fan coil units and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. LEED Submittals:
   1. Product Data for IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
   2. Product Data for MR 5: For recycled content.
   3. Product Data for MR 5: For materials extracted, harvested or recovered, as well as manufactured within the region.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTED OR DUCTLESS FAN COIL UNITS

A. Manufacturers: Subject to compliance with requirements, product indicated on Drawings or comparable product by one of the following:
   1. Airtherm; a Mestek company.
   2. Carrier Corporation; a unit of United Technologies Corp.
   3. ENVIRO-TEC; by Johnson Controls, Inc.
   4. Greenheck Fan Corporation.
   5. Titus.
   6. Trane Inc.
   7. YORK; a Johnson Controls company.

B. Coil Section Insulation: 1/2-inch-thick, matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
   1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
   2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Chassis: Galvanized steel where exposed to moisture, with powder-coat finish and removable access panel. Floor-mounting units shall have leveling screws.

D. Cabinet: Steel with factory prime coating, ready for field painting.
   1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.
   2. Steel recessing flanges for recessing fan coil units into ceiling or wall.

E. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
   1. Pleated Cotton-Polyester Media: 90 percent arrestance and MERV 7.

F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

G. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: Electrically commutated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
   3. Wiring Termination: Connect motor to chassis wiring with plug connection.

H. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

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

3.2 INSTALLATION

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 60 inches above finished floor.

E. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.
    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 ADJUSTING

A. Adjust initial temperature and humidity set points.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION

SECTION 238229
RADIATORS

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

A. Section includes flat-pipe steel radiators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Color Samples for Initial Selection: For radiators with factory-applied color finishes.

PART 2 - PRODUCTS

2.1 FLAT-PIPE STEEL RADIATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Runtal North America, Inc.
   2. Sterling.
B. Heating Elements: Steel, welded and formed into flat, square, steel header with minimum thickness of 0.109 inch. Include threaded piping and air-vent connections.
   1. Working Pressure: 85 psig; 0.058 inch.
C. Mounting: Wall brackets or floor pedestals, as indicated on drawings and required by location, with maximum spacing of 36 inches.
D. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
E. Accessories:
   1. Steel piping covers finished to match radiator finish.
   2. Flexible Expansion Compensation Hoses: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F.
      a. Length: 24 inches.
      b. Minimum Diameter: Equal to connection size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive radiators for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of radiators.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb.
B. Install expansion compensation hoses.
C. Install piping covers.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect radiators and components to piping according to Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."
    1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.
C. Install control valves as required by Section 230923.11 "Control Valves."
D. Install piping adjacent to radiators to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:
    1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
B. Units will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

END OF SECTION

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2 and Type XHHW-2.

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.
B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.
C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway.
D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway.
F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.
G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
C. 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.
D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

A. 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. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
    1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.
        a. Transformers
        b. Panelboards
        c. Distribution Panels.
    2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger.

Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.

2.3 CONNECTORS

A. Listed and labeled by an NRTL 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: Copper or copper alloy.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
   1. Bury at least 24 inches below grade.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install 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.

C. Water Heater, Heat-Tracing, and Antifrost 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.

D. 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.

3.4 INSTALLATION

A. 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.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
   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 three 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.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   2. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by 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. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

END OF SECTION

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 CONNECTION TO SUPPORTING SYSTEMS

A. The architectural drawings include support rails at the open area ceilings between acoustical panel zones for equipment support. It is preferable to use these supports whenever practical. These support rails are galvanized.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   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:
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

PART 3 - EXECUTION

3.1 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 scheduled in NECA 1, where it's Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC 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 (90 kg).

3.3 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 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.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Surface raceways.
   4. Boxes, enclosures, and cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For floor boxes and poke through.

1.4 DEFINITIONS

A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. EMT: Comply with ANSI C80.3 and UL 797.
C. FMC: Comply with UL 1; zinc-coated steel or aluminum.
D. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: die cast.
      b. Type: Setscrew.
   3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

F. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
C. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
C. Metal Floor Boxes:
    1. Manufacturers: Legrand Wiremold or Hubbell.
    2. Shape: Rectangular.
    3. Covers shall be metallic blank cover or furniture feed covers as indicated on the drawings.
    4. Cover finish shall be selected by the architect. In areas with carpet or wood floor finish an equivalent inlaid material shall be available for the cover.
    5. Type: Fully adjustable.
    6. Boxes shall be intended for shallow applications.
    7. Boxes shall have a gang configuration adequate for the power and communications devices indicated on the drawings.
    8. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    9. Wiremold RFB series or equal.
D. Poke Thru Devices:
    1. Manufacturers: Legrand Wiremold, Hubbell.
    2. Shape: round, 6” or 10”.
    3. Covers shall be metallic blank cover or furniture feed covers as indicated on the drawings.
    4. Cover Finish: to be selected by the architect.
    5. Boxes shall have a gang configuration adequate for the power and communications devices indicated on the drawings.
    6. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    7. Wiremold Evolution Series or equal.
E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
H. Gangable boxes are allowed.
I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 (indoor) or Type 3R (outdoor) with continuous-hinge cover with flush latch unless otherwise indicated.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
    1. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
    2. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
B. Indoors: Apply raceway products as specified below unless otherwise indicated:
    1. Exposed, Not Subject to Physical Damage: EMT.

2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
4. Boxes and Enclosures: NEMA 250, Type 1.

C. Minimum Raceway Size: 1/2-inch.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, cast-metal fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to, GRC, or IMC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

R. Surface Raceways:
   1. Install surface raceway with a minimum 2-inch radius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

X. 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. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Locate boxes so that cover or plate will not span different building finishes.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

BB. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Section 312000 "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
   4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
   5. Install 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 coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION

SECTION 260544
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For sleeves penetrating fire rated assemblies.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:
   1. Material: Galvanized sheet steel.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Identification of power and control cables.
2. Identification for conductors.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Equipment identification labels.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.
B. Comply with NFPA 70.
C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
D. Comply with ANSI Z535.4 for safety signs and labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
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

2.1 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2.2 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag:
   1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   2. Thickness: 4 mils.
   3. Weight: 18.5 lb/1000 sq. ft.
   4. 3-inch tensile according to ASTM D 882: 30 lbf, and 2500 psi.

2.4 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. 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 INCHES."

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.1 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. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding 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-footmaximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

H. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
    a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    b. Colors for 203/110-V Circuits:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.
    c. Colors for 403/117-V Circuits:
        1) Phase A: Brown.
        2) Phase B: Orange.
        3) Phase C: Yellow.
    d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

B. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

C. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    a. Power transfer switches.
    b. Controls with external control power connections.

END OF SECTION

SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Standalone daylight-harvesting switching controls.
   2. Indoor occupancy sensors.
   3. Emergency shunt relays.

B. Related Requirements:
   1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring.
   2. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or products by the following:
   1. Wattstopper DLM series

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).

b. When significant daylight is present.
2. System programming is done with two hand-held, remote-control tools.
a. Initial setup tool.
b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Wattstopper

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
a. Sensor: Suitable for mounting in any position on a standard outlet box.
b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
9. Include relay for plug load control where indicated on the drawings.
10. HVAC control shall be performed by a separate sensor provided by the mechanical contractor.

C. Dual-Technology Type: Ceiling mounted, unless noted otherwise; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

D. Passive Infrared (PIR) Type: Ceiling mounted, unless noted otherwise; detect occupants in coverage area using PIR detection methods.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.3 CONTROL STATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Wattstopper DLM series
B. Install in a standard gangable box.
C. On/off, dimming, scene control as indicated on the drawings.

2.4 EMERGENCY SHUNT RELAY

A. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
   1. Coil Rating: Match the circuit voltage.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
B. Sensors, wall control stations, and relay packs shall be interconnected with category 5 cable.

2.6 TIME CLOCK

A. Manufacturer: Tork or Intermatic
B. Function: The time clock shall be an astronomical, fully programmable, time clock with capability of different settings based on day of the week and holiday schedule.
C. Outputs: a minimum of 4 independent form C contacts

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
   1. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
B. Lighting control devices will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
   2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
   3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 262200
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
   2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Siemens.
   2. Square D.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Transformers Rated 15 kVA and Larger: Comply with DOE energy-efficiency levels as verified by testing according to DOE.
D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
E. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.

2. Coil Material: Aluminum.

F. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated.

1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

F. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.

G. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

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

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
C. 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.
D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION

SECTION 262413
SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Accessory components and features.
5. Identification.

1.3 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Detail utility company's metering provisions with indication of approval by utility company.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Routine maintenance requirements for switchboards and all installed components.
      b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 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.
   1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
C. Handle and prepare switchboards for installation according to NECA 400 and NEMA PB 2.1.

1.8 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
B. Environmental Limitations:
   1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

1.9 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Siemens
   2. Square D

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 2.

E. Comply with NFPA 70.

F. Comply with UL 891.

G. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Sections rear aligned.

H. Indoor Enclosures: Steel, NEMA 250, Type 1.

I. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

J. Barriers: Between adjacent switchboard sections.

K. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

L. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

M. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

N. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

O. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

P. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Q. Pull Box on Top of Switchboard:
   1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
   2. Set back from front to clear circuit-breaker removal mechanism.
   3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
   4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
   5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

R. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
   2. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
   3. Tin-plated aluminum feeder circuit-breaker line connections.
   4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   5. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
   6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

7. Disconnect Links:
   a. Isolate neutral bus from incoming neutral conductors.
   b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
8. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

S. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Siemens
   2. Square D

B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.

C. SPDs with the following features and accessories:
   1. Integral disconnect switch.
   2. Indicator light display for protection status.
   3. Surge counter.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. SCCR: Equal or exceed 100 kA.

F. Nominal Rating: 20 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. MCCB Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.5 IDENTIFICATION

A. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

B. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400 and NEMA PB 2.1.
   1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
   2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
   3. Protect from moisture, dust, dirt, and debris during storage and installation.
   4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NECA 400 and NEMA PB 2.1.
B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
   1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to switchboards.
   6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
E. Install filler plates in unused spaces of panel-mounted sections.
F. Install overcurrent protective devices, surge protection devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.
G. Install spare-fuse cabinet.
H. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.
C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.
D. Support and secure conductors within the switchboard according to NFPA 70.
E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
B. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 262416
PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   7. Include wiring diagrams for power, signal, and control wiring.
   8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 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.
   1. Keys: Two spares for each type of panelboard cabinet lock.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

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

2. Square D

B. Enclosures: Surface-mounted cabinets.
1. Rated for environmental conditions at installed location.
a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Finishes:
a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.
4. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:
1. Material: Tin-plated aluminum.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

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

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker or lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
a. Standard frame sizes, trip ratings, and number of poles.

b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

F. Install filler plates in unused spaces.

G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:
1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 262713
ELECTRICITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes equipment for sub-metering of electricity.

1.3 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

B. PC: Personal computer.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.7 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR SUB-METERING ELECTRICITY

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. Electro Industries.
2. Emon Dmon.

B. Electronic Meters
1. Electronic meter with digital display, shall accept input from standard instrument transformers rated 5 amperes and 120 volts, 60 Hertz. Meter suitable for connection to a three phase, four wire wye system or a three phase, three wire delta system. Meter shall be capable of measuring and displaying volts (line-to-line and line-to-neutral), current (per phase), kilowatts, kilowatt demand, kilowatt-hours and power factor. Meter shall display actual numeric values without requiring the use of a multiplier.
2. Provide a BACnet communication interface to communicate with BAS to provide at a minimum the following information:
3. Current, per phase & three-phase total.
4. Voltage, per phase & three-phase total, phase-to-phase & phase-neutral.
5. Real Power (kW), per phase & three-phase total.
6. Reactive Power (kVAR), three phase total.
7. Apparent Power (kVA), three phase total.
8. Power Factor, per-phase & three-phase total.
9. Real Energy (kWh), three phase total.
10. Meter shall provide measurement for up to 6 feeders simultaneously.
11. Coordinate with the 23 0924 Contractor for the type of BACnet communication transport (MSTP or IP) to provide. The Electrical Contractor shall be responsible for providing all metering communication wiring between the meters and shall provide a single termination point for BAS communication bus.

C. BACNET Meter Interface
1. Manufacturers with meters with included BACnet communication interface: Veris H8163 series, Delta Controls DSM-PWR, or equal. For delta three phase feeders without a neutral leg, the Veris H8163 cannot be used. A gateway device such as the Delta Controls DSM-PWR or FieldServer gateway shall be supplied. All programming of the gateway device to provide the BACnet objects to the building automation system shall be included. Meter shall be provided with a LCD display and pushbuttons for local display of meter information. Meter shall be provided with a BACnet MSTP communication interface to provide at a minimum the following information through the communication interface:
2. Current, per phase & three-phase total.
3. Voltage, per phase & three-phase total, phase-to-phase & phase-neutral.
4. Real Power (kW), per phase & three-phase total.
5. Reactive Power (kVAR), three phase total.
6. Apparent Power (kVA), three phase total.
7. Power Factor, per-phase & three-phase total.
8. Real Energy (kWh), three phase total.

D. Current Transformers
1. Current Transformers: ANSI C57.13; 5 ampere secondary, with primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
2. Mount and brace transformers to withstand 100,000 amp short circuit current.

E. Potential Transformers
1. Potential Transformers: ANSI C57.13; 120 volt secondary, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
2. Potential transformers are required for metering on all electrical systems above 208/120 volts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Connect a load of known kilowatt rating, 1.5 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 eight hours 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.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 262726
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Snap switches and wall-box dimmers.
   3. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.
B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell
   2. Pass & Seymour
B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, Commercial Grade, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.4 GFCI RECEPTACLES

A. General Description:
   1. Straight blade, feed-through type.
   2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
   3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

2.5 TOGGLE SWITCHES

A. Commercial Grade
B. Comply with NEMA WD 1, UL 20, and FS W-S-896.
C. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Single Pole:
         1) Hubbell; HBL1221.
         2) Pass & Seymour; CSB20AC1.
      b. Three Way:
         1) Hubbell; HBL1223.
         2) Pass & Seymour; CSB20AC3.
      c. Four Way:
         1) Hubbell; HBL1224.
         2) Pass & Seymour; CSB20AC4.

2.6 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

2.7 FINISHES

A. Device Color:
   1. Wiring Devices Connected to Normal Power System: White with the exception of devices mounted on wood paneling, gray on wood paneling.
B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of 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 cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until right 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. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
   1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
   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 the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
   5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
   6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
   7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   8. Tighten unused terminal screws on the device.
   9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.
   2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device 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.

G. 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.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

END OF SECTION

SECTION 262813
FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600-V ac and less for use in, enclosed switches, switchboards, enclosed controllers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, and descriptions of individual components. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   3. Current-limitation curves for fuses with current-limiting characteristics.
   4. Coordination charts and tables and related data.
   5. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with NEMA FU 1 for cartridge fuses.
D. Comply with NFPA 70.
E. Comply with UL 248-11 for plug fuses.

1.5 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Motor Branch Circuits: Class RK1, time delay.
2. Other Branch Circuits: Class RK1, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

END OF SECTION

SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Enclosures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of NRTL listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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. Siemens.
   2. Square D.

B. Type HD, Heavy Duty, Single Throw, specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   2. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

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. Siemens.
   2. Square D.

B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 262913.03
MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Combination full-voltage magnetic motor controllers.
   2. Enclosures.
   3. Accessories.
   4. Identification.

1.3 DEFINITIONS

A. CPT: Control power transformer.
B. MCCB: Molded-case circuit breaker.
C. MCP: Motor circuit protector.
D. NC: Normally closed.
E. OCPD: Overcurrent protective device.
F. SCCR: Short-circuit current rating.
G. SCPD: Short-circuit protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For each type of magnetic controller.
   1. Include plans, elevations, sections, and mounting details.
   2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
   3. Wire Termination Diagrams and Schedules: Include diagrams for 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. Differentiate between manufacturer-installed and field-installed wiring.

4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:
1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
a. Listing document proving Type 2 coordination.
7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
a. Routine maintenance requirements for magnetic controllers and installed components.
b. Manufacturer's written instructions for setting field-adjustable overload relays.
c. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 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.
1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.2 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
B. 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. Siemens.
2. Square D.
C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Nonreversing.
E. Contactor Coils: Pressure-encapsulated type.
1. Operating Voltage: Manufacturer's standard, unless indicated.
F. Control Power:
1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
a. Spare CPT Capacity as Indicated on Drawings: 50 VA.
G. Overload Relays:
1. Solid-State Overload Relay:
a. Switch or dial selectable for motor-running overload protection.
b. Sensors in each phase.
c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
H. Fusible Disconnecting Means:
1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.3 ENCLOSURES

A. Comply with NEMA 250, indoor combination starters shall include a NEMA 1 enclosure.
B. The construction of the enclosures shall comply with NEMA ICS 6.

2.4 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
1. Pilot Lights, and Selector Switches: 30mm Heavy-duty or oil-tight
a. Selector Switches: Provide with a Hand-Off-Auto selector switch.
b. Pilot Lights: Provide with Green running pilot light. Pilot lights shall be LED, push-to-test type.
2. Auxiliary Contacts: Provide a minimum of two form C contacts
3. External overload reset mechanism

2.5 IDENTIFICATION

A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Comply with NECA 1.
B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
E. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
2. Visual and Mechanical Inspection:
    a. Compare equipment nameplate data with drawings and specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
    e. Inspect contactors:
        1) Verify mechanical operation.
        2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
    f. Motor-Running Protection:
        1) Verify overload element rating is correct for its application.
        2) If motor-running protection is provided by fuses, verify correct fuse rating.
    g. Inspect bolted electrical connections for high resistance using one of the two following methods:
        1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
    h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
    a. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
    b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
    c. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:
        1) Description of equipment to be tested.
        2) Discrepancies.
        3) Temperature difference between the area of concern and the reference area.
        4) Probable cause of temperature difference.
        5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
        6) Load conditions at time of inspection.
        7) Photographs and thermograms of the deficient area.
        8) Recommended action.
    d. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
    e. Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

C. Motor controller will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.
   1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
   2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
   3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controller will be considered defective if it does not pass the system function tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 263323
CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following central battery and power conversion equipment rated 600 V and less for emergency lighting:
   1. Interruptible (fast-transfer) central battery equipment.

1.3 DEFINITIONS

A. BAS: Building automation system.
B. IBC: International Building Code.
C. Interruptible: As used in the Section Text, an off-line, passive-standby or line-interactive, inverter-only unit, with an intentional interruption of power to the load until an internal transfer switch picks up and transfers the load to the unit's inverter and internal battery source on loss of the "normal" source, and then retransfers to the "normal" source when it is restored. Transfer time can be "slow" (up to approximately 1 second) or "fast" (2-4 ms or 40-50 ms, depending on manufacturer).
D. LED: Light-emitting diode.
E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
F. OCPD: Overcurrent protective device.
G. PC: Personal computer.
H. PWM: Pulse-width modulated.
I. VRLA: Valve-regulated lead acid.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of central battery equipment unit.
   1. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, shipping splits, and furnished options, specialties, and accessories.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Less than 0 deg for exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
3. Humidity: More than 95 percent (condensing).
4. Altitude: Exceeding 3300 feet.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace central battery equipment that fails in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:
   a. Central Battery Equipment (excluding Batteries): One year(s).
   b. Standard VRLA Batteries:
      1) Full Warranty: One year(s).
      2) Pro Rata: Nine years.

PART 2 - PRODUCTS

2.1 INTERRUPTIBLE (FAST-TRANSFER) CENTRAL BATTERY EQUIPMENT

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

1. Iota.
2. Lithonia.
3. Sure-Lites.
4. Dual Lite.

B. General Requirements for Interruptible (Fast-Transfer) Central Battery Equipment:

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924.
3. Comply with the IBC, NFPA 70, and NFPA 101.
4. Comply with NEMA PE 1.

C. ~~Performance Requirements:~~ Not used. (Addendum 5)

D. **Performance Requirements: (Addendum 5)**

1. Fast-Transfer Central Battery Equipment: Passive standby (off-line) system. Automatically sense loss of normal ac supply and use a solid-state static switch to transfer load. Transfer in 40-50 ms or less from normal supply to battery-inverter supply.
2. Automatic Operation:
   a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, bypassing inverter, with battery connected in parallel via rectifier/charger output.
   b. Abnormal Supply Conditions: If normal ac supply deviates from specified voltage, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
   c. If normal power fails, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
   d. If a fault occurs in system when being supplied by inverter and current flows in excess of the overload rating of inverter, inverter automatically protects itself against damage from overloads and short circuits by shutting down.

e. When normal ac power is restored at input supply terminals of unit, controls automatically retransfer the load back to the normal ac supply, with a momentary loss of power to the load. Rectifier/charger then recharges battery.
f. If normal power failure is prolonged (more than 90 minutes), integral low-voltage battery protective circuit disconnects battery and prevents battery from damage due to deep discharge.
g. If battery becomes discharged, and when normal ac supply is again available, rectifier/charger recharges battery. When battery is fully charged, rectifier/charger automatically shifts to float-charge mode.
h. If battery is disconnected, and normal ac power is available, central battery equipment continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

E. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.
2. Input Frequency Tolerance: Plus or minus 3 percent of central battery equipment frequency rating.
3. Synchronizing Slew Rate: 1 Hz per second, maximum.
4. Minimum Off-Line Efficiency: 95 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or operating condition.
6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F and not exceeding 86 deg F.
7. Humidity Rating: Less than 95 percent (noncondensing).
8. Altitude Rating: Not exceeding 3300 feet.
9. Off-Line Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

F. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.

G. Controls and Indication:
1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:
a. Normal power available.
b. Status of system.
c. Battery charging status.
d. On battery power.
e. System fault.
f. External fault.
2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
a. Keypad: In addition to required programming and control keys, include the following:
1) Keys for METER, CONTROL, PROGRAM, and CLEAR modes.
2) Security Access: Provide electronic security access to controls through identification and password with at least two levels of access: View only; and view, operate, and service.
3) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.
b. Digital Display: Plain-English language messages on a digital display; provide the following historical logging information and displays:
1) Real-time clock with current time and date.
2) Tests and Events Logs: Record and store up to 25 tests and events.
a) Dates.
b) Times.
c) Durations.
d) Output voltage and currents.
3) Alarm Logs: Record and store up to 25 alarms.
a) Dates.
b) Times.
c) Alarm type.
4) Metering Functions: Display central battery equipment metering parameters including, but not limited to, the following:

a) Input and output voltage (V ac) and output current (A ac).
b) Battery voltage (V dc) and current (A ac).
c) Fault or alarming status (code).
d) Power output (VA).
e) Inverter load (W).
f) Ambient temperature (deg F).
g) System run time (cumulative days).
h) Inverter run time (cumulative minutes).

5) Alarm Functions: Digital display mounted flush in unit door and connected to display central battery equipment parameters including, but not limited to, the following:
a) High/low battery charge voltage.
b) High/low input voltage.
c) Battery nearing low-voltage condition.
d) Battery low voltage.
e) High ambient temperature.
f) Inverter fault.
g) Output fault.
h) Output overload.

H. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.

I. Integral Input Disconnecting Means and OCPD: None.
1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: **as indicated on the drawings.**~~22 kA~~. (**Addendum 5)**

J. Inverter:
1. Description: Solid-state, high-frequency, PWM type, with the following operational features:
a. Automatically regulate output voltage to within plus or minus 3 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes.
b. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
c. Output Voltage Waveform: Sine wave with maximum 3 percent TDD throughout battery operating-voltage range, for 100 percent linear load.
d. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.
e. Load Power Factor: 0.5 lead to 0.5 lag.
f. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

K. Rectifier/Battery Charger:
1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.
2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.

L. Batteries:
1. Description: Standard VRLA batteries.
a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.
2. Battery Disconnect and OCPD: Manufacturer's standard.

M. Maintenance Bypass Systems:
1. Maintenance Bypass Mode: Internal; manual operation only; bypasses central battery equipment power circuits (inverter and static transfer switch); requires local operator selection at central battery equipment. Transfer and retransfer shall be break-before-make, with temporary disrupting power to the load.
2. Bypass Overload Capability: 1.5 times the base load current.

N. Integral Output Disconnecting Means and OCPD:
1. Single-Output OCPD: As scheduled on Drawings; manufacturer's standard ratings based on unit output ratings.

2.2 ENCLOSURES

A. Central Battery Equipment Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
   2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store central battery equipment according to NECA 411.
B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
C. Examine equipment before installation. Reject equipment that is wet, moisture damaged, or mold damaged.
D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Install central battery equipment and accessories according to NECA 411.
C. Wall-Mounted Central Battery Equipment: Install central battery equipment on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For units not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
D. Suspended-Mounted Central Battery Equipment: Suspend central battery equipment from structural ceiling components using hangers, clamps, and associated fittings, designed for types and sizes of units to be supported. Provide support devices complying with Section 260529 "Hangers and Supports for Electrical Systems."
E. Comply with NECA 1.
F. Wiring Method: Install cables in raceways except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
   3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 CONNECTIONS

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.
B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, and other adjustable parts.

C. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous-trip elements; install fuses if not factory installed.

D. Set the automatic system test parameters.

3.5 PROTECTION

A. Replace central battery equipment whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.

END OF SECTION

SECTION 265000
HISTORIC LIGHTING RESTORATION AND REPLICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Restoring existing historic luminaires
   2. Rehabilitating luminaires from existing historic and new components
   3. Replicating historic luminaires
   4. Retrofitting and repairing damaged electrical and lighting equipment

B. Related Sections:
   1. Section 260923 - Lighting Control Devices
   2. Section 265600 - Exterior Lighting
   3. Section 265100 - Interior Lighting

1.3 DEFINITIONS

A. Luminaire: A complete assembly of a light fixture, suspension system, pole, pole base, electrical components and lamps.

B. Restoration: Cleaning, repairing and finishing an existing luminaire.

C. Rehabilitation: Construction of a new luminaire utilizing restored and new luminaire components and pieces

D. Replication: Construction of a new luminaire in its entirety.

1.4 DESCRIPTION OF WORK

A. Provide lighting fixtures as shown on the Drawings and identified as “historic lighting” and herein specified or scheduled.

B. The work to be performed on this project shall include the restoration and rehabilitation of existing historic fixtures and the replication of new luminaires from both existing fixtures and from photographs, drawings, and historic information available.

C. For new replications of existing and non-existing lighting, work shall include complete studies of photographs, drawings, and available historic information allowing concise preparation and design of engineering drawings with complete bills of materials for the fabrication of each fixture. All

ornamental design, structural elements and component parts shall be fully detailed in addition to all anchoring support, wire-way, and joinery conditions.

D. Completed fixtures shall meet all applicable codes regarding materials and methods. All NEC guidelines and UL procedures shall be followed and each new fixture shall bear the proper UL label for its application

1.5 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and light source components. The light fixture submittal must be complete or the entire submittal will be rejected. A complete submittal includes the following:
   1. All light fixtures and lamp as specified in the Light Fixture Schedule and Lamp and Ballast Schedule..
   2. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
   3. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

B. Complete scaled drawings of replicated luminaires indicating all details of construction including lamping, wire-ways, lamp holders, diffuser assemblies, mounting accessories and hardware, finishes, weight, and a list of materials.

C. Complete scaled drawings of rehabilitated luminaires indicating all details of construction including lamping, wire-ways, lamp holders, diffuser assemblies, mounting accessories and hardware, finishes, weight, and a list of materials for each component. Drawing shall identify new and restored historic pieces.

D. Provide scaled drawings of luminaires to be restored indicating components to be replace, repaired and replicated. Include all electrical modifications and materials. Drawing to include photographs of all damaged structural and ornamental pieces requiring replacement.

E. Detailed assembly and installation instructions for each fixture and for custom fixture including color digital photos of each sub-assembly with cross references to the drawings. Lamp and ballast access points shall be noted along with detailed instructions for replacement.

F. Finish Samples: Samples of shades, diffuser material (glass, plastic, etc.), metals and metal finish samples shall be submitted for approval prior to the notice to proceed with mock-ups.

1.6 MANUFACTURERS SAMPLES AND MOCK-UPS

A. Provide one complete working sample of each custom or replicated historic lighting fixture type.

B. Approval of the sample by the Architect shall be required prior to commencement of each of the subject luminaire types.

C. Samples shall include diffusers and lamps to allow complete evaluation of luminaire design, construction finish and performance.

D. The sample, if approved, may be used as one of the required number of fixtures of it's type.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. New and restored historic luminaires and assembled components to be UL listed for location/moisture conditions specified.

D. The Manufacturer shall submit qualification data as listed below, in their response to the request for bids, along with an itemized unit price quotation.
   1. Data shall demonstrate manufacturer's capabilities, experience and financial stability.
   2. It shall include a history of the firm, number of employees, number of years the firm has restored, rehabilitated and replicated historic lighting.

1.8 PRODUCT HANDLING

A. All costs for removing historic fixtures from existing locations, disassembly, packing, crating, insurance and freight for luminaires from the job site to the Manufacturer shall be the responsibility of the Electrical Contractor.
   1. The Electrical Contractor shall coordinate the removal and re-installation with other project contractors.
   2. The Electrical Contractor shall coordinate the location of existing historic luminaire pieces with the Owner.

3. The Manufacturer shall be on-site during fixture removal to assist with the photo-documentation of the existing condition, location, tagging and supervising the proper handling, disassembly, packing and crating of the historic lighting fixtures.

B. Packaging, crating, insurance and shipping of restored, rehabilitated and replicated luminaires from the manufacturing facility to the Electrical Contractor for installation shall be the responsibility of the Manufacturer.

C. The Electrical contractor shall be responsible for receiving, storing, assembly and installation of restored, rehabilitated and replicated luminaires. The Electrical contractor shall be responsible for final lamping adjustment, luminaire adjustment and cleaning.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Electrical contractor shall be responsible for verify all ceiling and exterior mounting conditions and coordinating the mounting hardware with the manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Saint Louis Antique Lighting Company. St. Louis. MO

B. Gibson Lighting. Chula Vista, CA

C. Crenshaw Lighting. Floyd , VA

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

A. Utilize materials to match the original or with matching equivalent physical characteristics of strength, finish, resistance to corrosion.

B. Repair or replace any broken, missing, or damaged luminaire components matching original workmanship and fastenings.

1. Replace broken and missing glazing in kind and reinstall existing glazing with restored glazing clips and sealing compound as required, all glazing to be washed clean.
2. Inspect and recondition or replace all fastenings, fixture mounting, hinges, and latches to restore to original strength and function.
3. Repair or replace any historic parts that are missing, broken, or damaged. Replacement parts shall match the original parts in material, strength appearance, and detail.
4. Electrical renovation shall consist of the replacement of all electrical components and wiring.
5. Replaced electrical components shall comply with the Electrical Specifications.
6. The result shall be a restored, rehabilitated or replication of the original luminaire in size, material, appearance, detail and finish.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. Intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. Sheet metal shall be free of light leaks. Edges shall be finished so there are no sharp edges exposed. Miters shall be in accurate alignment with abutting intersecting members. Piecing of plates in individual runs in single planes and the use of spliced pieces or filler material to cover defective workmanship shall not be acceptable. Sheet metal work shall be properly fabricated and supported so that planes will not deform (i.e. become concave or convex, due to normal expected ambient and operating conditions).

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
   a. "USE ONLY" and include specific lamp type.
   b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) diameter and base type.
   c. CCT and CRI for all luminaires.

2.3 LUMINIARES

A. All replicated luminaires to match existing historic luminaires and historic drawings in size, shape, detail and materials. Variances will be considered only, if in the opinion of the architects, their consultants, and the project historians, they will achieve the desired appearance, quality of construction and performance.

B. Lamp holders shall hold lamps securely against vibrations, maintenance and handling. For enclosed incandescent standard base lamp holders, provide glazed porcelain, nickel-plated brass screw shell type lamp holders. Other lamp holders shall match the original or as specified. Decorative sleeves over lamp holders should match the original.

C. Luminaires shall be free of light leaks and shall be designed to provide sufficient ventilation of lamps, including vent holes where required.

D. Wiring shall meet the applicable U.L. Standard and all local codes and the National Electrical Code. Exposed wire shall be of similar color to existing finish and be installed in such a manner as to be as invisible as possible. Wires through or along-side chain shall be threaded or attached by means of wire ties in such a manner that chains hang plumb and straight without crimping the wire at any point. The manufacturer shall coordinate with Electrical Contractor for any special wiring or attachment considerations (plugs, quick-disconnects, extra length, sleeving, etc.)

E. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

F. Lamps shall be furnished by Electrical Contractor, as specified.
   1. Lamps shall be from the same manufacturer for each lamp type and shall be manufactured by GE, Osram-Sylvania or Philips, unless specified otherwise.
   2. Lamp performance requirements and color temperature are specified on the Lighting Fixture Schedule.
   3. Color Temperature of 3000Kfor interior luminaires as listed in the Luminaire Schedule in the Architectural Lighting plans. The color temperature of exterior LED luminaires should not exceed 3500K (nominal)
   4. Lamps shall have a minimum 20,000 hour rated lamp life.
   5. Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.
   6. Lamps shall be oriented to provide the best light distribution, free of shadows or “hot” spots.

G. Diffusers to match the existing in all aspects: size, thickness, material, color, surface texture design, etc.
   1. Manufacturer shall submit samples of diffusers or diffuser material after the Shop Drawings are approved.
   2. Shelf Stock: furnish additional diffusers for each fixture type, as specified.

H. Glare Control: Exterior luminaires shall meet DesignLights Consortium’s® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior luminaires

I. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

J. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

K. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

2.4 LUMINIARE STRUCTURAL MEMBERS

A. All new visible structural members to match existing historic members or historic drawings in material, size, shape, and detail.

B. Utilize gauges and thickness of all metals as required to provide the appropriate structural performance and durability and structural integrity.

C. All castings shall be free of pits, scratches, blemishes, parting lines, burrs and internal flaws.

D. Historic structural members to be restored shall be restored to the original condition.
   1. Fill pits, holes, chips and scratches with metal to match the original
   2. Fully chase all fills such that the repair is not visible.
   3. Remove all rust, marks and stains prior to finishing.

E. Assemblies of structural elements joined by soldering, brazing, or welding shall exhibit no external discoloration at the seams. All seams to be fully chased such that the solder, braze or weld is not visible.

F. External fasteners shall be finished to match the parts in which they are installed.

2.5 LUMINIARE ORNAMENTAL MEMBERS

A. All new ornamental pieces to match the size, shape and detail of the original piece.
B. Applied ornamental pieces shall be cast, spun, stamped or hand wrought of the same material to which they are to be attached.
C. All castings shall be free of pits, scratches, blemishes, parting lines, burrs and internal flaws.
D. Historic ornamental members to be restored shall be restored to the original condition.
    1. Fill pits, holes, chips and scratches with metal to match the original
    2. Fully chase all fills such that the repair is not visible.
    3. Remove all rust, marks and stains prior to finishing.
E. Applied ornamentation shall be attached using fasteners in discreet locations. Visible fasteners shall be finished to match the material into which they are set.

2.6 FINISHES

A. Where luminaires are scheduled for restoration, refinishing shall consist of the removal of the existing finish to bare metal using the least abrasives, metal surface preparation, polishing, staining, etching, patina application and coating, as specified.
B. Exterior Luminaires: Match original finish including two coats of rust inhibiting ferrous metal primer.
C. Interior Luminaires: Provide finish as detailed in the historic drawings and Light Fixture Schedule.
D. Where clear coating is required, clear coat with IncraLac (or equal, acrylic lacquer with U.V. inhibitor). Dip lacquer all small parts. Spray lacquer is permitted only on parts too large to be dipped.
E. Finish shall be uniform, free of runs, specs, smudges, “checking”, “rainbowing”, milkiness (caused by lacquering in too humid environment), etc. For exterior fixtures, three coats are required.
F. Manufacturer shall provide samples for approval of all finishes and materials to be used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Mark fixtures with a tag or identifying label to record the original location where installed; otherwise assume all risk for improper reinstallation.
B. Remove fixtures to shop and disassemble, exercising care to keep original parts together for reassembly.
C. Save original glazing for reinstallation after cleaning

3.2 INSTALLATION

A. Lighting fixtures:
    1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
    2. Install lamps in each luminaire.
B. Install mounting accessories as required for ceiling construction type indicated on the Drawings. Luminaire type designations do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed.
C. Install support for each luminaire. Verify weight and mounting method of luminaries and furnish and install suitable supports. It is the responsibility of the Electrical Contractor to coordinate with the Manufacturer for any special mounting requirements.
D.

3.3 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION

SECTION 265100
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Exit signs.
   3. Lighting fixture supports.

B. Related Sections:
   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

A. BF: Ballast factor.
B. CCT: Correlated color temperature.
C. CRI: Color-rendering index.
D. HID: High-intensity discharge.
E. LER: Luminaire efficacy rating.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting fixture, including ballast housing if provided.
H. LED: Light Emitting Diode

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and light source components. The light fixture submittal must be complete or the entire submittal will be rejected. A complete submittal includes the following:
   1. All light fixtures, ballasts, lamp, light emitting diode data, drivers, and power supplies as specified in the Luminaire Schedule.
   2. Physical description of lighting fixture including dimensions.
   3. Ballast, including BF.
   4. Energy-efficiency data.
   5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Action Submittals" Article in Section 233713 "Diffusers, Registers, and Grilles."
   6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Section 233713 "Diffusers, Registers, and Grilles."
   7. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
   8. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
      b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.5 PRIOR APPROVALS AND SUBSTITUTIONS

A. Refer to Exhibit N, Project Manual Volume 1 Section 01 25 13 "Product Substitution Procedures

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.7 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:
    a. "USE ONLY" and include specific lamp type.
    b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
    d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
    e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
    f. CCT and CRI for all luminaires.

2.2 LED LUMINAIRES

A. LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:

1. Minimum Light Output.
2. Zonal Lumen Requirements.
3. Minimum Luminaire Efficacy.
4. Minimum CRI.
5. L70 Lumen Maintenance.
6. Minimum Luminaire Warranty of 5 years (not pro-rated) to include LED driver and all LED components.
7. Additional requirements:
    a. Color Temperature of 3000K-4100K for interior luminaires as listed in the Luminaire Schedule in the Architectural Lighting plans. The color temperature of exterior LED luminaires should not exceed 4100K (nominal).
    b. Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior

luminaires. Exterior luminaires shall use a maximum 5-step MacAdam Ellipse binning process.

c. Glare Control: Exterior luminaires shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior luminaires.

d. Luminaire shall be mercury-free, lead-free, and RoHS compliant.

e. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.

f. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.

g. Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.

h. Driver shall have a rated life of 50,000 hours, minimum.

i. Lumen output shall not depreciate more than 20% after 10,000 hours of use.

j. Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.

k. Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.

8. LED luminaire shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).

9. LED driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.

10. Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.

11. Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.

12. Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.

13. All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

14. Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.

15. All luminaires shall be provided with knockouts for conduit connections.

16. The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).

17. Provide all of the following data on submittals:

a. Delivered lumens.

b. Input watts.

c. Efficacy.

d. Color rendering index.

2.3 Emergency LED Luminaire Compatibility with Inverters:

A. Emergency Inverters shall be sine-wave type, or have written confirmation from the luminaire manufacturer that the luminaire will function with a square-wave inverter.

2.4 Dimming:

A. LED drivers shall be provided with 0-10V dimming unless indicated otherwise.

B. LED driver indicated as line voltage dimming shall be compatible with dimming controls where dimming is indicated on the plans. Dimmable drivers shall use Dimming Constant Current (DCC) or Pulse Width Modulation (PWM) operation.

2.5 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.

2. Designed for type and quantity of lamps served.

3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.

4. Sound Rating: Class A.

5. Total Harmonic Distortion Rating: Less than 10 percent.

6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

7. Operating Frequency: 42 kHz or higher.

8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.88 or higher.
10. Power Factor: 0.98 or higher.
11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Electronic Programmed-Start Ballasts for T8 Lamps: Comply with ANSI C82.11 and the following:
1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.

D. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

E. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

2.6 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.7 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm),2950 initial lumens (minimum), CRI 75 (minimum), color temperature as indicated on the drawings, and average rated life 65,000 hours at 3 hour starts unless otherwise indicated.

2.8 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:
1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION

SECTION 265600
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Exterior luminaires with lamps and ballasts.
   2. Luminaire-mounted photoelectric relays.
   3. Poles and accessories.
   4. Luminaire lowering devices.

B. Related Sections:
   1. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color-rendering index.
C. HID: High-intensity discharge.
D. LER: Luminaire efficacy rating.
E. Luminaire: Complete lighting fixture, including ballast housing if provided.
F. Pole: Luminaire support structure, including tower used for large area illumination.
G. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.
C. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.
D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
   1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s).
      a. Wind Importance Factor: 1.0.
      b. Minimum Design Life: 25 years.
      c. Velocity Conversion Factors: 1.0.

1.5 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and light source components. The light fixture submittal must be complete or the entire submittal will be rejected. A complete submittal includes and the following:
   1. All light fixtures, ballasts, lamp, light emitting diode data, drivers, and power supplies as specified in the Luminaire Schedule.
   2. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   3. Details of attaching luminaires and accessories.
   4. Details of installation and construction.
   5. Luminaire materials.
   6. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
      a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

7. Photoelectric relays.
8. Ballasts, including energy-efficiency data.
9. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
10. Materials, dimensions, and finishes of poles.
11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
12. Anchor bolts for poles.
13. Manufactured pole foundations.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.

1.6 PRIOR APPROVALS AND SUBSTITUTIONS

A. Refer to Exhibit N, Project Manual Volume 1 Section 012513 "Product Substitution Procedures

1.7 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
   1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
   2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
   3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.3 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

END OF SECTION

SECTION 27 05 00
BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.

1.2 SCOPE OF WORK

A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the Communications Systems as shown on the drawings and specified herein.

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

C. Description of Systems include but are not limited to the following:

1. Complete Structured Cabling System including, but not limited to:

a. Voice and data backbone cabling and terminations.
b. Voice and data horizontal cabling and terminations.
c. Information outlets (IO's) including faceplates, jacks and labeling.
d. Equipment racks, cabinets, cable management and equipment.

e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
f. Cabling pathways.
g. Grounding and Bonding
h. Testing

2. Complete Audio/Visual Systems.

3. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.

4. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".

5. Firestopping of penetrations as described in 27 05 03.

1.3 OWNER FURNISHED PRODUCTS

A. Network switching gear shall be Owner Furnished and Contractor Installed.

B. A/V Head end and work area equipment shall be Owner Furnished and Owner Installed.

1.4 WORK SEQUENCE

A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.

B. The successful Bidders shall be responsible for scheduling overtime hours for the following work:

C. Successful Bidders shall itemize all work and list associated hours and pay scale for each item.

1.5 ALTERNATES

A. Except as listed in the General Technology Schedule, no alternates will be accepted without prior authorization from the OWNER.

1.6 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.

2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".

3. "Communications Contractor" as referred to herein refers to the Contractors listed in Division 27 of this Specification.

4. Low Voltage Communications Wiring: The wiring (less than 120VAC) associated with the Communications Systems, used for analog and/or digital signals between equipment.

5. Telecommunications Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation and mounting of the telecommunications information outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling. Where surface mounted backboxes are required, conduit shall be routed to above the lay-in ceiling.

C. General:

1. The purpose of these Specifications is to outline typical Electrical and Communications Contractor's work responsibilities as related to Communications Systems including Telecommunications rough-in, conduit, cable tray, power wiring and Low Voltage Communications Wiring. The prime contractor is responsible for all divisions of work.

2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Communications Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Communications Drawings but required for the successful operation of the systems shall be the responsibility of the Communications Contractor and included in the Contractor’s bid.

3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Communications systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Communications Contractor has convened to determine the exact location and requirements of the installation.

4. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Communications Wiring, the installation shall not begin until the Communications Contractor has completed a coordination review of the cable tray shop drawing.

5. This Contractor shall establish Electrical and Communications utility elevations prior to fabrication and installation. The Communications Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:

    a. Lighting Fixtures
    b. Gravity Flow Piping, including Steam and Condensate
    c. Sheet Metal
    d. Electrical Busduct
    e. Cable Trays, including 12” access space
    f. Sprinkler Piping and other Piping
    g. Conduit and Wireway
    h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the “Suggested Matrix of Scope Responsibility” to be provided by the Electrical Contractor.

2. Assumes all responsibility for providing and installing cable tray.

3. Responsible for Communications Systems grounding and bonding.

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

E. Communications Contractor's Responsibility:

1. Assumes all responsibility for the Low Voltage Communications Wiring of all systems, including cable support where open cable is specified.

2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."

3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).

4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of Communications equipment which is required to be bonded to the Communications ground system.

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

1.7 COORDINATION DRAWINGS

A. Definitions:

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

   a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

   b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

   c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

   d. Maintenance clearances and code-required dedicated space shall be included.

   e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

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

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.

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

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

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

C. Drawing Requirements:

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

a. Scale of drawings:

1) General plans: 1/4 Inch = 1 '-0" (minimum).

2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.

3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

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

2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.

8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

   a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.

   b. Potential layout changes shall be made to avoid additional access panels.

   c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

   d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

   e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.8 QUALITY ASSURANCE

A. Telecommunications Structured Cabling System Standards:

1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:

   a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling

   b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises

      1) C.1 - Commercial Building Telecommunications Standard

      2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard

      3) C.3 - Optical Fiber Cabling Components Standard

      4) C.4 - Broadband Coaxial Cabling and Components Standard

   c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces

   d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure

e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

f. ANSI/TIA-758-B - Customer-Owned Outside Plant Telecommunications Standard

g. ANSI/TIA-862-A - Building Automation Systems Cabling Standard

h. ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers

i. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling

j. ANSI/TIA-1179 Healthcare Facility Telecommunications Standard

k. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding

l. NFPA 70 (NEC) - National Electrical Code (Current Edition)

m. UL 444 - Standard for Safety for Communications Cable

B. Refer to individual sections for additional Quality Assurance requirements.

C. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.

2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Certification of Contractor shall have been in place for a minimum of one (1) year prior to bidding this project. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.

3. Specific manufacturers may require personnel to be present, onsite, during initial and/or subsequent installations in order to provide additional guidance and supervision of installation methods. Contractor shall coordinate installation with owner and manufacturer if required by manufacturer and/or if required to provide warranty as specified.

4. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.

5. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.

6. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.

7. The Contractor shall have certified BICSI installation technicians on staff to perform the following tasks on the project:

a. Act as the field superintendent or job foreman with the responsibility of monitoring the daily work of each technician.

b. Oversee all testing and termination of cabling.

8. A resume of qualification shall be submitted with the Contractor's bid indicating the following:

   a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.

   b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

   c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.

   d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.

   e. Resume and certification of the BICSI installation technician for the project.

D. Compliance with Codes, Laws, Ordinances:

1. This Contractor shall conform to all requirements of the City of Madison, WI Codes, Laws, Ordinances and other regulations having jurisdiction over this installation.

2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.

3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, the codes and regulations shall determine the method or equipment used.

4. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.

5. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

E. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.

3. Pay all applicable charges for such permits or licenses that may be required.

4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.

5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.

6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.

7. Pay any charges by the service provider related to the service or change in service to the project.

8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):

   a. Factory Mutual
   b. Underwriters' Laboratories, Inc.

F. Examination of Drawings:

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

2. Contractor shall determine the exact locations of equipment and the exact routing of cabling so as to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.

3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.

5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.

6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Autodesk Revit.

2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

3. Upon request for electronic media, the Contractor shall complete and return a signed “Electronic File Transmittal” form provided by KJWW.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.

5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.

6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

H. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long, that was not brought to the written attention of the Architect/Engineer will be borne entirely by the Contractor.

3. This Contractor shall provide the Architect/Engineer with written documentation of any cabling drops that will not be able to use the cable tray (where cable tray is available) due to the resulting cabling lengths. This documentation shall be submitted prior to installation and installation shall not commence until approved by the Architect/Engineer.

1.9 SUBMITTALS

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

1. Submittals list:

Referenced Specification Section	Submittal Item
27 05 03	Through Penetration Firestopping
27 05 26	Communications Bonding
27 05 28	Interior Communications Pathways
27 05 43	Exterior Communications Pathways
27 05 53	Identification and Administration
27 11 00	Communication Equipment Rooms
27 13 00	Backbone Cabling Requirements
27 15 00	Horizontal Cabling Requirements
27 17 10	Testing
27 41 00	Professional Audio Video System
27 51 19	Sound Masking System

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

a. Date
b. Project title and number
c. Contractor's name and address
d. Description of items submitted and relevant specification number
e. Notations of deviations from the contract documents
f. Other pertinent data

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

a. Date
b. Project title and number
c. Architect/Engineer
d. Contractor and subcontractors' names and addresses
e. Supplier and manufacturer's names and addresses
f. Description of item submitted (using project nomenclature) and relevant specification number
g. Notations of deviations from the contract documents

h. Other pertinent data
i. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor's review shall include, but not be limited to, verification of the following:

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

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

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

6. Submittal Identification and Markings:

   a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

   b. The Contractor shall clearly indicate the size, finish, material, etc.

   c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

   d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor’s responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer’s approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

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

   a. Submittal file name: 27 XX XX.description.YYYYMMDD
   b. Transmittal file name: 27 XX XX.description.YYYYMMDD

5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

D. Paper Copy Submittal Procedures:

1. Paper copies are acceptable where electronic copies are not provided.

2. The Contractor shall submit ten (10) paper copies of each shop drawing.

3. Each set shall be bound in a three-ring binder or presentation binder. Copies that are loose or in pocket folders are not acceptable.

1.10 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

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

C. Preparation:

1. Itemize the cost for each of the following:

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

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

    a. Contractor's own labor forces.
    b. All subcontractors.
    c. All major suppliers of products or equipment.

3. Break down all costs into:

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

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

    a. Structured Cabling
    b. Audio/Video Systems

D. Update Schedule of Values when:

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

1.11 CHANGE ORDERS

A. A detailed material and labor take-off shall be prepared for each change order along with labor rates and mark-up percentages. Change orders with inadequate breakdown will be rejected.

B. Change order work shall not proceed until authorized.

1.12 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:

1. Firestopping, including mechanical firestop systems.

1.13 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.

B. Store materials on the site so as to prevent damage.

C. Keep fixtures, equipment and materials clean, dry and free from deleterious conditions.

1.14 WARRANTY

A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.

B. Provide a structured cabling System Assurance Warranty as described herein.

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

D. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.15 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.16 MATERIAL

A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.

B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured **in writing** from the Architect/Engineer not later than ten (10) days prior to the bid opening date. The Contractor bears full responsibility for the unnamed manufacturer's equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.1 REFER TO INDIVIDUAL SECTIONS

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.

D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 27 sections for further requirements.

2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.

3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.

4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

5. All telecommunications tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.

2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."

3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.

2. Submitted bound copies of approved shop drawings.

3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.

4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.

5. Submitted testing reports for all systems requiring final testing as described herein.

6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.

7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; submit receipt to Architect/Engineer prior to final payment being approved.

8. Provide System Assurance Warranty certificate for the telecommunications system.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies shall be distributed as directed by the Architect/Engineer.

2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

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

    a. O&M file name: O&M.div27.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div27.contractor.YYYYMMDD

5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.

6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.

2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copy of final approved test and balance reports.

5. Copies of all factory inspections and/or equipment startup reports.

6. Copies of warranties.

7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

8. Dimensional drawings of equipment.

9. Capacities and utility consumption of equipment.

10. Detailed parts lists with lists of suppliers.

11. Operating procedures for each system.

12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

13. Repair procedures for major components.

14. List of lubricants in all equipment and recommended frequency of lubrication.

15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

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

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

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

D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.

E. Refer to the individual specification sections for minimum hours of instruction time for each system.

F. Operating Instructions:

1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.

2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM COMMISSIONING

A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to insure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

C. This Contractor shall maintain at the job site, a separate and complete set of Communications Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Communications Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.

E. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.

C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

3.10 CONSTRUCTION WASTE MANAGEMENT

A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).

1. This Contractor shall coordinate with the General Contractor to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.

2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor's scope of work. The Contractor shall provide this information to the General Contractor so that it can be incorporated with similar information from all other contractors for the project.

    a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the General Contractor to establish the preferred calculation method and report the results accordingly.

    b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.

END OF SECTION

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

In order to assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All telecommunications jacks are installed in the faceplates.
4. All telecommunications cabling is pulled and at least 75% of all jacks have been terminated at the jack and at the telecom room.
5. Telecommunications testing is in progress and at least 25% of testing has been completed.
6. Telecommunications labeling has been provided on at least 25% of each type of component requiring a label.
7. All telecommunications related grounding is complete.
8. All Audio/Visual components, cabling and control systems are installed, programmed and operational.
9. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
10. All access control system equipment, including card readers, conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational.

The project will be ready for final jobsite observation prior to the requested date of the observation, according to the above list of requirement.

Prime Contractor: _____ By: _____

Requested Observation Date _____ Today's Date: _____

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

Telecommunications – Proof of Certification

There are specific Contractor qualification requirements for this project as defined in Section 27 05 00, which may include Manufacturer Certification and RCDD credentials. This Proof of Certification document, and the supporting documentation require herein, is required to be submitted at the time of bid to show compliance with the requirements of 27 05 00.

Statement of Compliance:

The named Contractor's base bid is a structured cabling solution from the connectivity manufacturer _____. Named Contractor is trained and certified, under the named manufacturer's formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product, labor and system assurance warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the _____ day of _____, 20____.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name: _____

Authorized Representative: (print) _____

Date: _____ Manufacturer Certification Number (if any): _____

Submit the following with the bid:

- This form.
- Proof of Manufacturer Certification indicated above.

SECTION 27 05 03
THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

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

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

1.3 REFERENCES

A. UL 723 - Surface Burning Characteristics of Building Materials
B. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
C. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
D. Intertek / Warnock Hersey - Directory of Listed Products
E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
F. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
G. The Building Officials and Code Administrators National Building Code
H. Wisconsin Administrative Code
I. 2009 International Building Code
J. NFPA 5000 – Building Construction Safety Code

1.4 SUBMITTALS

A. Submit under provisions of Section 27 05 00.

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

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

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

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

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

F. Submit VOC rating of firestopping material in g/L (less water) with documentation that it meets the limits set forth in SCAQMD Rule 1168.

1.5 DELIVERY, STORAGE, AND HANDLING

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

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

1.6 PERFORMANCE REQUIREMENTS

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

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

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

1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings**:**

    a. Floor penetrations located outside wall cavities.
    b. Floor penetrations located outside fire-resistance-rated shaft enclosures.
    c. Wall penetrations above corridor ceilings which are not part of a fire-resistive assembly.
    d. Wall penetrations below any ceiling that are larger than 4" diameter or 16 square inches.

3. L-Rated Systems: Provide through-penetration firestop systems with L-ratings of not more than 5.0 cfm/sq.ft. (0.0254 cu. m/s x sq. m) at both ambient temperature and 400°F (204°C) for smoke barriers.

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

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

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

F. In accordance with LEED EQc4.1, Low-Emitting Materials - Adhesives and Sealants, all adhesives and sealants used on the interior of the building must comply with the following requirements:

1. Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.

2. Aerosol adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

1.7 MEETINGS

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

1. Review foreseeable methods related to firestopping work.

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

1.8 WARRANTY

A. Provide one year warranty on parts and labor.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. 3M; Fire Protection Produces Division.
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk.
4. Tremco; Sealant/Weatherproofing Division.
5. Johns-Manville.
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Wiremold/legrand: FlameStopper

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

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

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

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

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

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

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

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

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated
   F Rating = Floor/Wall Rating
   T Rating = Floor/Wall Rating

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

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated
   F Rating = Wall Rating
   T Rating = 0

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

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated
F Rating = Wall/Floor Rating
T Rating (Floors) = Floor Rating

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

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

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

3.2 INSTALLATION

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

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

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

3.3 CLEANING AND PROTECTING

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

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

3.4 IDENTIFICATION

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

1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."

2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

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

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

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

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

END OF SECTION

SECTION 27 05 05
TECHNOLOGY DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Technology demolition.

1.2 RELATED WORK

A. Section 27 05 00 - Basic Communications Systems Requirements.

1.3 REFERENCES

A. NFPA 70 – National Electrical Code.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for terminating, patching and cross connecting of existing telecommunications and security systems shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY OUTLET, BOX, CONDUIT, OR CABLE THAT MUST BE REMOVED.

B. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS AND SCOPE OF WORK.

C. Where walls, ceilings, structures, etc., are indicated as being renovated on general drawings, the Contractor shall be responsible for the removal of all technology equipment including but not limited to: copper, fiber and coaxial cable, faceplates and jacks, raceways, racking and equipment mounted to the racking, etc., from the renovated area.

D. Where ceilings, walls, structures, etc., are temporarily removed and replaced, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area.

F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and technology service to avoid conflicts.

3.2 PREPARATION

A. Not all services within the building will be inactive or abandoned. Verify abandonment status with the building owner, General Contractor and Architect/Engineer prior to demolition.

B. Prior to commencing with demolition, a proposed implementation narrative with schedule shall be submitted to the Architect/Engineer for approval.

C. The contractor shall provide proof that only qualified personnel with extensive telecommunications experience will perform the demolition. No laborers will be allowed in the cable removal process.

3.3 DEMOLITION AND EXTENSION OF EXISTING TECHNOLOGY WORK

A. Demolish and extend existing technology work under provisions of Division 1 of Architectural Specifications and this Section.

B. Contractor MUST verify that Existing Single-mode and Multi-mode fiber has been pulled back PRIOR to demolition or removal of any fiber connected devices.

C. Remove abandoned low voltage cabling and raceway to source of cabling according to the NEC. Refer to the NEC for definition of Abandoned Communications Cabling.

D. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is removed. Patch openings created from removal of devices to match surrounding finishes.

F. Disconnect and remove abandoned patch panels, blocks and other distribution equipment.

G. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.

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

I. Disconnect and remove anything remaining at time of demolition.

J. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

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

3.4 INSTALLATION

A. Install relocated materials and equipment under the provisions of applicable Division 27 specifications.

END OF SECTION

SECTION 27 05 26
COMMUNICATIONS BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Bonding Conductors
B. Bonding Connectors
C. Grounding Busbar (TMGB and TGB)
D. Rack-mount Telecommunications Grounding Busbar

1.2 RELATED WORK

A. Section 26 05 33 – Conduit
B. Section 26 05 36 – Cable Trays
C. Section 26 05 13 – Wire and Cable
D. Section 26 05 26 – Grounding and Bonding
E. Section 26 41 00 – Lightning Protection Systems
F. Section 27 05 00 – Basic Communications Systems Requirements
G. Section 27 05 03 – Through Penetration Firestopping
H. Section 27 11 00 – Communication Equipment Rooms
I. Section 27 05 28 – Interior Communication Pathways
J. Section 27 05 53 – Identification and Administration

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

B. Communications bonding system component, device, equipment, and material manufacturer(s) shall have a minimum of five (5) years documented experience in the manufacture of communications bonding products.

C. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be listed by Underwriters' Laboratories, Inc.

1.4 REFERENCES

A. ANSI/IEEE 1100 – Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems

B. ANSI/TIA/EIA 568-C – Commercial Building Telecommunications Cabling Standard

C. ANSI/TIA/EIA 569-A – Commercial Building Standard for Telecommunications Pathways and Spaces

D. ANSI/TIA/EIA 606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

E. ANSI/TIA/EIA 758 – Customer Owned Outside Plant

F. ANSI-J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

G. IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements

H. IEEE 837 – IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding

I. NFPA 70 – National Electrical Code

J. NFPA 780 – Standard for the Installation of Lightning Protection Systems

K. UL 96 – Lightning Protection Components

L. UL 96A – Installation Requirements for Lightning Protection Systems

M. UL 467 – Grounding and Bonding Equipment

1.5 SUBMITTALS

A. Submit product data and shop drawings under provisions of Section 27 05 00 and Division 1.

B. Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item, including construction, materials, ratings, and all other parameters identified in Part 2 - Products.

2. Manufacturer's installation instructions indicating 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. Provide CAD-generated, project-specific system shop drawings as follows:

1. Provide a system block diagram indicating system configuration, system components, interconnection between components, and conductor routing. The diagram shall clearly indicate all wiring and connections required in the system. When multiple devices or pieces of equipment are required in the exact same configuration (e.g., multiple identical equipment racks or sections of ladder tray), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where system equipment will be located.

2. Installation details for all system components.

D. Provide system checkout test procedure to be performed at acceptance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under the provisions of Section 27 05 00.

B. Store and protect products under the provisions of Section 27 05 00.

C. Contractor shall exercise care to prevent corrosion of any products prior to installation. Corroded products shall not be acceptable for use on this project.

1.7 SYSTEM DESCRIPTION

A. This section describes the requirements for the furnishing, installation, adjusting, and testing of a complete turnkey communications bonding system, including connection to the electrical ground grid.

B. Performance Statement: This specification section and the accompanying drawings are performance based, describing the minimum material quality, required features, operational requirements, and performance of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made, or every feature and function that must be configured. Based on the equipment constraints described and the performance required of the system as presented in these documents, the Contractor is solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.

C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor.

D. Basic System Requirements:

1. A complete communications bonding infrastructure is required for this project. Refer to the drawings and the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.

2. The bonding system shall include, but not be limited to, the following major components:

    a. Bonding Conductor for Telecommunications (BCT)
    b. Telecommunications Main Grounding Busbar (TMGB)
    c. Telecommunications Bonding Backbone (TBB)
    d. Telecommunications Grounding Busbar(s) (TGB)
    e. Rack mount Telecommunications Grounding Busbar(s)
    f. Bonding Conductor(s) (BC)
    g. Bonding Connectors
    h. Bonding system labeling and administration as defined in Section 27 05 53.

1.8 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 05 00.

B. Provide final system block diagram showing any deviations from approved shop drawing submittal.

C. Provide floor plans that document the following:

1. Actual locations of system components, devices, and equipment.
2. Actual conductor routing.
3. Actual system component, device, equipment, and conductor labels.

D. Provide statement that system checkout test, as outlined in the approved shop drawing submittal, is complete and test results were satisfactory.

E. Complete all operation and maintenance manuals as described below.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 27 05 00.

B. Submitted data shall include:

1. Approved shop drawings.

2. Descriptions of recommended system maintenance procedures, including:

a. Inspection
b. Periodic preventive maintenance
c. Fault diagnosis
d. Repair or replacement of defective components

PART 2 - PRODUCTS

2.1 BONDING CONDUCTORS

A. Bare Copper:

1. Annealed uncoated stranded conductor.
2. Minimum size 6 AWG.

B. Insulated Copper:

1. Annealed uncoated stranded conductor.

2. Insulation:

a. PVC insulation with nylon outer jacket.
b. Rated ≥ 600 volts.
c. Green.

3. Minimum size 6 AWG.

C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.

D. Bonding Conductor Sizing

1. All Communications bonding system conductors shall be sized by length as follows:

Length Linear ft (m)	Size (AWG)
Less than 13 (4)	6
14 - 20 (4 - 6)	4
21 - 26 (6 - 8)	3
27 - 33 (8 - 10)	2
34 - 41 (10 - 13)	1
42 - 52 (13 - 16)	1/0
53 - 66 (16 - 20)	2/0
Greater than 66 (20)	3/0

2. The BCT shall be the same size as the TBB or larger.

2.2 BONDING CONNECTORS

A. Acceptable Types:

1. Two-hole compression lug
2. Exothermic weld
3. Irreversible compression

B. Connectors shall be provided in kit form and selected per manufacturer's written instructions.

C. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

2.3 GROUNDING BUSBAR (TMGB AND TGB)

A. Features:

1. Wall-mount configuration.
2. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
4. Predrilled holes.
5. Integral insulators.
6. Stainless steel offset mounting brackets.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.

2. Minimum Dimensions: 1/4" thick x 4" high x 12" long.

   a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.

3. Hole pattern shall include:

   a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.

   b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

2.4 RACK-MOUNT TELECOMMUNICATIONS GROUNDING BUSBAR

A. Features:

1. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.

2. Predrilled holes.

3. Mounts in a standard 19" equipment rack.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.

2. Minimum Dimensions: 3/16" thick x 3/4" high x 19" long.

   a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.

3. Hole pattern shall include:

   a. A minimum of eight (8) 6-32 tapped lug mounting holes on 1" centers.

   b. A minimum of two (2) pairs of 5/16" diameter holes spaced 3/4" apart.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Bonding Requirements:

1. The communications bonding system shall be a complete system. Contractor shall furnish and install all necessary miscellaneous components, devices, equipment, material, and hardware, including, but not limited to, lock washers, paint-piercing washers, hex nuts, compression lugs, insulators, mounting screws, lugs, etc., to provide a complete system.

2. A licensed electrician shall perform all bonding.

3. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Main Cross Connect and Service Entrance Room Bonding Requirements:

1. Locate the TMGB in the service entrance room unless otherwise noted on the drawings.

2. The location of the TMGB shall be the shortest practical distance from the telecommunications primary lightning protection devices.

3. Bond the telecommunications primary protectors to the TMGB. Maintain a minimum 1 foot (300 mm) separation of the bonding conductor from all DC power cables, switchboard cable, and high frequency cable.

4. In service entrance rooms where the entrance pathway contains an isolation gap, the pathway on the facility side of the gap shall be bonded to the TMGB.

C. Where the service entrance cable contains a shield, the shield(s) shall be bonded to the TMGB using manufacturer-approved hardware.

D. Telecommunications Main Ground Bar (TMGB) Requirements:

1. Install TMGB such that it is insulated from its support with a minimum 2" standoff.

2. Bond the TMGB to the electrical service ground via the BCT.

   a. A minimum of 1 foot (300 mm) separation shall be maintained between the BCT and any DC power cables, switchboard cable, or high frequency cables.

3. Where backbone or horizontal cabling contains a shield, the shield(s) shall be bonded to the TMGB.

4. TMGB shall be bonded to all electrical panels located in the same room or space as the TMGB or in an immediately adjacent space within 20 linear feet of the TMGB. TMGB shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TMGB.

5. TMGB shall be bonded to accessible metallic building structure located within the same room or space as the TMGB.

6. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TMGB, shall be bonded to the TMGB.

7. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TMGB, shall be bonded to the TMGB.

E. Telecommunications Ground Bar (TGB) Requirements:

1. Provide a TGB in each telecommunications equipment room.

2. Install TGB such that it is insulated from its support with a minimum 2" standoff.

3. Bond each TGB to the TMGB via the TBB.

   a. A minimum of 1 foot (300 mm) separation shall be maintained between the TBB and any DC power cables, switchboard cable, or high frequency cables.

   b. The TBB may be routed from TGB to TGB or as a radial feed to each TGB as the layout requires.

4. When there are multiple telecommunications equipment rooms on <u>each</u> floor in buildings containing more than five stories, the TGBs on the same floor shall be bonded together horizontally using a grounding equalizer (GE) on the first, last, and every third intermediate floor. GE conductors shall be the same size as the TBB.

5. If more than one (1) TGB is provided within the same room or space, they shall all be bonded together via a BC the same size as the TBB.

6. Where horizontal cabling contains a shield, the shield(s) shall be bonded to the TGB.

7. TGBs shall be bonded to accessible metallic building structure located within the same room or space as the TGBs.

8. TGBs shall be bonded to all electrical panels located in the same room or space as the TGB or in an immediately adjacent space within 20 linear feet of the TGB. TGBs shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TGB.

9. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TGB, shall be bonded to the TGB.

10. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TGB, shall be bonded to the TGB.

F. Rack-mount Telecommunications Ground Bar Requirements (RTGB):

1. Provide a rack-mount telecommunications ground bar in each equipment rack and equipment rack enclosure.

2. Install RTGB such that it is electrically bonded to the rack. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between RTGB and equipment rack.

3. Bond each RTGB to the TGB via a BC.

4. If more than one (1) RTGB is provided within the same room or space, they shall all be bonded together via a BC.

5. Where horizontal cabling containing a shield is terminated on rack-mounted termination hardware, the shield(s) shall be bonded to the RTGB.

6. All contractor-furnished and/or contractor-installed metallic communications equipment, including, but not limited to patch panels, fiber optic distribution enclosures, splice enclosures, active electronics, uninterruptible power supplies, etc., mounted within the same equipment rack as the RTGB, shall be bonded to the RTGB. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between equipment rack and installed metallic communications equipment. Active electronics and uninterruptible power supplies shall be bonded to the RTGB via a dedicated BC for each device.

G. Metallic Interior Communication Pathway Bonding Requirements:

1. All metallic interior continuous communication cable pathways, including, but not limited to, conduit, conduit sleeves, fire-rated cable pathway devices, cable tray, basket tray, and ladder rack, shall be bonded to the communications bonding system.

H. Bonding Conductor Requirements:

1. Bonding conductors shall be green or marked with a distinctive green color.

2. Bonding conductors shall be routed parallel and perpendicular to building structure along shortest and straightest paths possible. Number of bends and changes in direction should be minimized. Install and secure conductors in a manner that protects the conductors from impact and from physical or mechanical strain or damage.

3. Bonding conductors shall not be installed in metallic conduit.

4. All conductors, including, but not limited, to the BCT, TBB, GE(s), and BC(s), shall be installed splice-free. If the Contractor believes that site conditions do not allow a splice-free installation, the Contractor may request permission from the Architect/Engineer to splice a specific communications bonding system conductor.

   a. Where documented permission to splice a conductor is granted:

      1) The number of splices shall be limited to as few as possible.

      2) Splices shall be made using exothermic welding or irreversible compression-type connections only. Splice hardware shall be listed for grounding and bonding. Solder is not an acceptable means of splicing conductors.

      3) Splices shall be made in telecommunications spaces in accessible locations to facilitate future inspection and maintenance.

      4) Splices shall be adequately supported and protected from impact and from physical or mechanical strain or damage.

5. All bonding conductors shall be labeled in accordance with the requirements of Section 27 05 53. In addition to the requirements of Section 27 05 53:

   a. Labels shall be nonmetallic.

   b. Labels shall be printer-generated.

   c. Labels shall be located on conductors as close as is practical to their point of termination in a readable position.

d. Additionally, conductors shall be labeled as follows:

1) "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER."

6. Interior water piping is not acceptable for use as a communications bonding system bonding conductor.

7. Metallic cable shields are not acceptable for use as communications bonding system bonding conductors.

I. Bonding Connection Requirements:

1. Make all connections in accessible locations to facilitate future inspection and maintenance.

2. Communications bonding system connections shall be made using exothermic welding, two-hole compression lugs, or other irreversible compression-type connections. The use of 1-hole lugs is prohibited, except for connections to a rack-mount telecommunications ground bar. Connection hardware shall be listed for grounding and bonding. Sheet metal screws shall not be used to make communications bonding system connections.

3. Thoroughly clean conductors before installing lugs and connectors.

4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tool(s) recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.

5. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond at all connections.

6. All bonding connections shall be coated in anti-oxidant joint compound that is purpose-designed and purpose-manufactured for that use. Anti-oxidant joint compound shall be applied in accordance with manufacturer's recommendations and instructions.

7. All installed connectors on conductors installed in damp locations shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against moisture ingress. Applied heat shrink tubing shall overlap conductor's outer jacket a minimum of four (4) inches past connector and be installed in accordance with manufacturer's recommendations and instructions.

3.2 FIELD QUALITY CONTROL

A. Field testing shall be performed under provisions of Section 27 05 00.

B. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product from a reputable manufacturer that meets the requirements of the specifications.

C. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

3.3 ADJUSTING

A. Adjust work under provisions of Section 27 05 00.

B. Contractor shall make any and all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.

3.4 TESTING

A. Test installed system under provisions of Section 27 17 10.

B. Measure and document resistance to ground at TMGB, each TGB, each RTGB, and each electrical distribution panel bonded to the TMGB or a TGB.

1. Measurements shall be made not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 5 ohms.

3. Under no circumstances shall any point in the communications bonding system have a lower resistance to ground than that of nearby electrical distribution system components that it is bonded to.

C. Include measurement documentation in test data submitted at completion of project under provisions of Section 27 17 10.

3.5 SYSTEM TRAINING

A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.

1. Provide two week's advanced notice of training to the Owner and Engineer.

2. The Engineer shall be presented with the option to attend the training.

3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

B. At a minimum, the following training shall be conducted:

1. A course detailing the system functions and operations that a technical user will encounter. Provide training on all aspects of using the system, including making new bonding connections to the TMGB, TGB, or RTGB. Provide training on all recommended inspection, maintenance, and repair procedures for the system.

C. Minimum on-site training times shall be:

1. Technical user: Four hours.

END OF SECTION

SECTION 27 05 28
INTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete wire mesh support systems, conduits, sleeves, innerduct, micorduct, etc. for an interior cabling plant as shown on the drawings.

B. Wire mesh support systems are defined to include, but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports and accessories.

1.2 RELATED WORK

A. Section 26 05 33 - Conduit
B. Section 27 05 00 - Basic Communications Systems Requirements
C. Section 27 05 26 - Communications Bonding

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for requirements.

1.4 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code

B. NEMA VE 2-2000 - Cable Tray Installation Guidelines

1.5 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer’s data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

2. Manufacturer’s installation instructions.

B. Coordination Drawings:

1. Include cable tray and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.6 DRAWINGS

A. The drawings, which constitute a part of these specifications, indicate the general route of the wire mesh support systems, conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Refer to Section 26 05 33 for conduit requirements for this project.

2.2 WIRE MESH CABLE TRAY – OVERHEAD

A. Acceptable Manufacturers:

1. Cooper B-Line "Flextray"
2. Cablofil, Inc.
3. Wiremold "Fieldmate"

B. General: Provide wire mesh of types and sizes indicated on drawings; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Provide drop-out fittings where cable tray is installed over equipment racks. Two drop-out fittings shall be installed over each rack so that a controlled radius is maintained into each side of every equipment rack that cable tray passes over. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

C. Wire mesh shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire mesh sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

D. Materials and Finishes: Material and finish specifications for each wire mesh type are as follows:

1. Electro-Galvanized Zinc: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc in accordance with ASTM B633 SC2. Additionally, straight sections shall be painted Flat Black.

2. Accessories:

a. Pre-Galvanized Zinc: Wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653.

b. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.

E. Type of Overhead Wire mesh Support System:

1. All straight section longitudinal wires shall be straight (with no bends).

2. Wire mesh supports shall be trapeze hangers or wall brackets. Center hung supports will not be allowed.

3. Trapeze hangers are to be supported by 1/4 inch or 3/8 inch diameter rods.

4. Provide manufacturer approved grounding clips as necessary for continuous grounding of tray.

2.3 CABLE HANGERS AND SUPPORTS

A. Provide a non-continuous cable support system suitable for use with open cable.

B. Cable Hooks:

1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.

2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.

3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use.

C. Cable Hangers:

1. Adjustable, non-continuous cable support slings for use with low voltage cabling.

2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.

3. Sling length shall be adjustable to a capacity of 425 4-pair UTP cables.

4. Cabling hanger load limit shall be 100 lbs per foot.

5. Manufacturer: Erico Caddy, CableCat CAT425, Arlington Fittings Tl Series or approved equal.

2.4 INNERDUCT – CORRUGATED

A. Fabricated from self-extinguishing high-impact polyvinyl chloride (PVC), orange in color.

B. Fittings and accessories fabricated from same material as conduit and usable with rigid nonmetallic conduit.

C. Solvent-cement type joints as recommended by manufacturer.

D. Inside diameter not less than that of rigid steel conduit.

E. Dielectric strength a minimum of 400 volts per mil.

F. Corrugated wall construction.

G. Pull rope pre-installed by manufacturer.

H. Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all of the above General requirements plus:

1. Be fabricated of flame-retardant materials (plenum rated) suitable for installation in such environments.

2. Meet or exceed all requirements for flame resistant duct as required by Bellcore TR-NWT-000356 (Section 4.33).

I. Innerduct installed within building riser shafts shall meet all of the above general requirements plus:

1. Be fabricated of flame-retardant materials suitable for installation in such environment.

J. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

2.5 MICRODUCT - INDOOR

A. Indoor MicroDuct – All MicroDuct shall be composed of dielectric materials. All MicroDuct shall be manufactured to include enhanced jetting design, such as internal ribbing to minimize surface contact and permanent slick interior to eliminate the need for jetting-lubricant.

The MicroDuct shall be suitable for installation in cable tray, PVC or metallic conduit, and conventional innerduct. During installation, MicroDuct cable ends are to be completely sealed to prevent ingress of contaminants, including water. Upon completion of MicroDuct installation, all internal MicroDucts shall pass the standard pressure test and ball bearing test per the cable manufacturer's recommended procedures. All unoccupied MicroDucts shall be plugged on both ends. Indoor MicroDuct specifications are as follows:

1. MicroDuct Type:
    a. Single, 2, 3, 4, 7, 12, 19 and 24-way, 8.5mm OD/6mm ID
2. MicroDuct rating: Plenum
3. Handling Temperature: 0º C to +40º C
4. Maximum Pulling Tension: Per Manufacturer's Cable Design
5. Bending Radius: Based on Manufacturer's Specifications
6. All MicroDucts shall be tested to and in compliance with Telcordia GR-3155-CORE. MicroDucts must be compliant as a stand-alone element of the air-blown cabling system.
7. Basis of Design: Dura-Line Corporation FuturePath eABF

B. MicroDuct Spice Closures

1. The splice closure for use within buildings shall be a minimum 24"W x 24"H x 12"D (dependent upon number of MicroDucts and conduit entries) NEMA 1 pull box. Provide strain relief for MicroDucts directly entering the splice closure from cable trays.

C. Strain Relief Grips

1. Strain relief grips shall be installed at all splice closures where the MicroDucts directly enter the splice closure from cable trays and where conduit entries require the support of the tube bundle as in vertical runs.
2. Where strain relief grips are used for MicroDucts directly entering splice closures from cable trays, care shall be used to prevent the crushing or deformation of the MicroDuct when tightening the strain relief grip around the tube bundle.
3. Basis of Design:
    a. Enclosure Connector Seals (Dura-Line Corporation)

PART 3 - EXECUTION

3.1 INNER DUCT INSTALLATION REQUIREMENTS

A. Inner duct shall be riser or plenum rated as required by the installation environment. At minimum, inner duct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

B. All exposed inner duct is to be labeled at 35-foot (10 meter minimum) intervals with tags indicating ownership, the cable type (e.g., “Fiber Optic Cable”) and the cables it contains (e.g., MA-CS or FS-CS).

C. Where exposed, fiber optic cable shall be installed in protective inner duct.

D. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation and to ensure that the mechanical limitations, including minimum bend radius of the cable, are considered.

E. The inner duct should extend into the termination enclosure at system endpoints.

F. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

3.2 CABLE HOOK SUPPORT SYSTEM

A. In areas where cabling is not supported by cable tray, ladder rack, enclosed wireway or installed in conduit, such cabling shall be supported by an approved cable hook support system.

B. Refer to manufacturer’s requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.

C. Cable hooks shall be securely mounted per manufacturer’s instructions. In no case shall the side-to-side travel of any cable hook exceed 6”.

D. Cable hooks shall be selected based on the contractors cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.

E. Support spans shall be based on the manufacturer’s load ratings. In no case shall a 5 foot span be exceeded.

F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.

G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

3.3 CONDUIT AND CABLE ROUTING

A. Refer to specification section 26 05 03 for additional requirements.

B. All conduits shall be reamed and shall be installed with a nylon bushing.

C. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2” or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2”, maintain a bend radius of at least 10 times the internal diameter.

D. No conduit or sleeve containing more than two (2) cables shall exceed 40% fill ratio, regardless of length.

E. Any conduit exceeding 90' in length or containing more than three (3) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.

1. A separate pull box is required for each 90' (or greater) length section.

2. A separate pull box is required after any three (3) consecutive 90-degree bends.

3. Pull box shall be located in an area that maintains accessibility of box, including the ability to remove box lid without removal or relocation of any other materials.

F. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for each 90 degrees of cumulative bend.

G. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense, after the conduit condition has been remedied.

3.4 WIRE MESH TRAY INSTALLATION

A. The wire mesh cable tray system shall be only for telecommunications.

B. Install wire mesh as indicated; in accordance with recognized industry practices (NEMA VE-2 2000), to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.

C. Cable tray sections shall be grounded in accordance with manufacturer's recommendations using manufacturer approved hardware. Painted sections shall have paint removed at each grounding attachment point.

D. Test wire mesh support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. Refer to NFPA 70B, Chapter 18, for testing and test methods.

E. Provide sufficient space encompassing wire mesh to permit access for installing and maintaining cables.

F. Tray shall be continuous from source to termination and shall not change elevation, direction or otherwise expose cables to travel without 2" x 4" mesh support.

G. Overhead Tray shall be field cut using only manufacturer approved cutting device and methods. Cutting device shall be an offset blade bolt cutter; standard bolt cutters are specifically not permitted. Drop-in tray sections shall not be field cut or field modified in any way.

H. Bends in overhead tray shall be accomplished by utilizing manufacturer's cutting guides.

I. All splices of tray shall be provided with splice washers, bars or springs as recommended by the manufacturer.

3.5 ATTACHMENT TO METAL DECKING

A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hangar and a minimum spacing of 2'-0" on center. This 25 lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

3.6 MICRODUCT INSTALLATION

1. Beginning installation means contractor accepts existing conditions.

2. Contractor shall furnish all required tools to facilitate MicroDuct installation without damage to the MicroDuct. Such equipment is to include, but not limited to, sheaves, winches, cable reels, cable reel jackets, duct entrance funnels, pulling tension gauges, and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices that may move or wear in a manner to pose a hazard to the MicroDuct shall not be used. Pulling MicroDuct with a motorized vehicle is not acceptable.

3. MicroDuct pulling shall be done in accordance with the manufacturer's recommendations. Manufacturer's recommendations shall be part of the MicroDuct submittal. Recommended pulling tensions and minimum bending radii shall not be exceeded. Any MicroDuct bent or kinked to a radius less than recommended shall not be installed.

4. During pulling operation an adequate number of workers shall be present to allow observation at all points of duct entry and exit as well as to feed MicroDuct and operate pulling equipment.

5. Pulling lubricant may optionally be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the MicroDuct sheath material used. Lubricant shall not harden or become adhesive with age.

6. Avoid abrasion and other damage to MicroDuct during installation.

7. Prior to pulling MicroDuct, thoroughly mandrel conduits to remove foreign materials. Verify cable trays are free of foreign debris, sharp edges and protruding uncapped bolts.

8. Verify tubes are sealed prior to pulling MicroDuct.

9. Pull MicroDuct with Kellem® style grips and breakaway swivels using the manufacturer's recommended pulling tension for break point.

10. A minimum of 24 hours shall be maintained between the installation of the MicroDuct and the installation of fiber units per manufacturer's specifications.

11. Contractor shall verify that any water in MicroDucts is removed prior to jetting any fiber unit.

END OF SECTION

SECTION 27 05 53
IDENTIFICATION AND ADMINISTRATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the execution and administration requirements relating to the structured cabling system and its termination components and related subsystems.

B. Identification and labeling.

1.2 RELATED WORK

A. Section 27 05 00 – Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

A. Refer to section 27 05 00 for relevant standards.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Documentation of labeling scheme.

PART 2 - PRODUCTS

2.1 LABELING

A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.

B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.

C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface an attachment method.

D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.

1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum “quite zone” of 0.25” on each side of the bar code.

2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.

E. Color Code: Observe the following requirements for color coding:

1. Labels on each end of a cable shall be the same color for each termination.

2. Labels for cross-connects shall be two different colors at each termination fields, representative of the color of that field.

3. Orange (Pantone 15C) shall be used for the demarcation point.

4. Green (Pantone 353C) shall be used for the termination point of network connection on the facility side of the demarc.

5. Purple (Pantone 264C) shall be used to identify the termination of cables from common equipment (PBX, computers, LANS, etc.)

6. White shall be used to identify the first-level backbone termination in the main cross-connect.

7. Gray (Pantone 422C) shall be used to identify the second-level backbone termination in the main cross-connect.

8. Blue (Pantone 291C) shall be used to identify the termination of station cabling at the telecommunications closet and/or equipment room end of the cable.

9. Brown (Pantone 465C) shall be used to identify the termination of the interbuilding backbone cable terminations.

10. Yellow (Pantone 101C) shall be used to identify the termination of auxiliary circuits, alarms, maintenance, security, etc.

11. Red (Pantone 184C) shall be used to identify the termination of key telephone systems.

12. In facilities that do not contain a main cross-connect, the color white may be used to identify second-level backbone terminations.

F. Tag all CAT 3, CAT 5E, CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets. Coordinate labeling scheme with City of Madison staff during Pre-installation meeting.

2.2 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 05 00 and Division 1. Documentation shall include the items detailed in the subsections below.

2. All documentation, including hard copy and electronic forms shall become the property of the Owner.

B. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

3.1 IDENTIFICATION AND LABELING

A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.

1. Provide additional cable labeling at each manhole and pull box.

2. Cables that are routed through multiple pathway segments shall contain reference to all pathway segments in the pathway linkage field.

3. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color, may include blue with a white stripe to indicate the higher performance class station cabling.

B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.

C. Termination Hardware Labeling:

1. An identifier shall be provided at each termination hardware location or its label.

D. Grounding/Bonding Labeling:

1. The TMGB shall be labeled “TMGB.” There shall be only one TMGB in the facility.

2. Label all TBB conductors connecting to the TMGB with a unique label, located at both ends of the TBB.

3. Each TGB shall be labeled with a unique label.

4. All TBB conductors connecting to the TGB shall be labeled uniquely at each end of the cable.

END OF SECTION

SECTION 27 11 00
COMMUNICATION EQUIPMENT ROOMS (CER)

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the products and execution requirements related to furnishing and installing equipment for Communication Equipment Rooms. Communication Equipment Rooms include rooms for the Main Cross Connect (MC), Intermediate Cross Connect (IC), Horizontal Cross Connect (HC), Service Entrance Room (SER) and Equipment Room (ER) (such as data centers and main computer rooms housing servers, mainframes and other central equipment).

B. Definitions:

1. Main Cross Connect (MC): Allows single point administration of technology components for cross-connect of first level backbone cables, entrance cables and equipment cables.

2. Intermediate Cross Connect (IC): Cross connect location between a backbone cable extending from the main cross connect (first level backbone) and the backbone cable from the horizontal cross connect (second level backbone).

3. Horizontal Cross Connect (HC): Cross connect location between the horizontal cabling and the backbone cabling.

4. Service Entrance Room: Accommodates a single location for incoming services to terminate and indicates an interface point and division of responsibility between the building cabling system and the service provider (herein referred to as the demarc).

C. Refer to Specification Section 27 05 28 for cable pathway and support requirements.

1.2 RELATED WORK

A. Section 27 05 00 - Basic Communications Systems Requirements
B. Section 27 05 26 - Communications Bonding
C. Section 27 05 28 - Interior Communication Pathways
D. Section 27 15 00 - Horizontal Cabling Requirements

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for applicable standards.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

2. Manufacturer's installation instructions.

B. Coordination Drawings:

1. Include ladder racking, equipment racks, cable tray and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT GROUNDING

A. Refer to specification section 27 05 26 for grounding requirements.

B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

2.2 EQUIPMENT RACKS AND CABINETS

A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper, optical fiber, coax) and network electronics.

B. The equipment rack shall conform to the following requirements:

1. Standard TIA/EIA 19" Floor Rack:

a. Equipment rack shall be 84" in height, self-supporting and provide a useable mounting height of 45 rack units (RU) (1 RU = 1 ¾").

b. Channel uprights shall be spaced to accommodate industry standard 19" mounting.

c. Equipment rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per TIA/EIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.

d. Equipment racks shall be provided with a supply of spare screws (minimum of 24).

e. Equipment racks shall be provided with a ground bar and #6 AWG ground lug.

f. Provide all mounting hardware and accessories as required for a complete installation.

2. Standard TIA/EIA 19" Floor Cabinet:

a. The equipment cabinets shall be constructed of painted steel or aluminum and offer a usable mounting height of 45 RU. Rack shall be a minimum of 31 inches deep.

b. The equipment cabinet shall be equipped with a lockable steel front door and furnished with two (2) keys that shall be usable on all cabinets furnished under this Contract.

c. The equipment cabinet shall be configured to allow for adjustment of the channel uprights (front to rear) in 1-inch increments and be spaced to accommodate industry standard 19-inch mounting. Cabinet shall be tapped to accept 12-24 screws.

d. The equipment cabinet shall be vented to allow for airflow through the cabinet.

2.3 CABLE MANAGEMENT – VERTICAL AND HORIZONTAL

A. Equipment Racks:

1. Equipment racks shall be equipped with vertical and horizontal cable management hardware in the form of rings and guides. Racks shall incorporate vertical and horizontal covers, to allow an orderly, hidden, routing of copper, optical fiber, and coax jumpers from the modular patch panels and/or 110-type termination blocks to the customer provided network electronics. Vertical and horizontal cable management hardware shall be as follows:

a. Horizontal cable management hardware shall be painted steel (3.5" panel), have a minimum of five (5) jumper distribution rings (1.75" x 3.75" minimum dimension) and incorporate jumper routing clips (plastic) for individual jumpers. Provide with cover designed to conceal and protect cable.

b. At a minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of jacks on modular patch panels, and (b) above and below each optical fiber patch panel and (c) each grouping of two rows of F-type connectors on coax patch panels.

c. Vertical cable management hardware shall provide for cable routing on front and rear of each rack and be 3½" square (minimum). Vertical cable management hardware shall mount on spacers attached to the rack uprights and not on the upright itself. Where multiple equipment racks are to be installed, this hardware shall be mounted between the uprights of adjacent equipment racks. Equipment rack uprights and the spacers shall be secured together per manufacturer's recommendations. Provide with cover designed to conceal and protect cable. Each equipment rack shall be supplied with a minimum of 12 releasable (e.g., "hook and loop") cable support ties.

2. Where cable termination hardware is wall-mounted, the Contractor shall be responsible for establishing a cable pathway for jumpers routed from the equipment rack(s) to the wall. This shall be in the form of slotted ducts or troughs. Routing of jumpers via the overhead cable tray or ladder rack system is NOT acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Architect/Engineer prior to installation.

B. Equipment Cabinets

1. Equipment cabinets shall be equipped with vertical and horizontal cable management hardware, in the form of rings and guides, to allow an orderly routing of optical fiber and copper jumpers from the modular patch panel and/or 110-type termination blocks to the customer provided network electronics. At a minimum, one such horizontal cable

management panel shall be provided with each equipment cabinet. Horizontal cable management panels shall be 3.5" in height and have a minimum of five (5) jumper distribution rings.

C. 110-type Termination Blocks:

1. Horizontal troughs incorporating plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Horizontal troughs shall be positioned at the top of each column of 110-type termination blocks and between each 100-pair 110-type termination block.

2. Vertical troughs incorporating metal distribution rings shall be provided for vertical routing of jumper and/or cross-connect wire.

2.4 PATCH PANELS

A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.

B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 27 15 00.

C. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.

D. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.

E. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

2.5 OPTICAL FIBER PANELS

A. All terminated optical fibers shall be mated to simplex LC -type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., "FDDI Connector"), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted. Refer to Section 27 15 00 for coupling requirements.

B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.

C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.

D. Access to the inside of the fiber distribution cabinet's enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.

E. The fiber distribution cabinet's enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer's recommended minimums or ½", whichever is larger.

F. All fiber distribution cabinets shall provide protection to both the "facilities" and "user" side of the coupling. The fiber distribution cabinet's enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet's enclosure shall provide a physical barrier to access such optical fiber cables.

G. Where "Loose Buffered" cables are installed, the 250 µm coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtails") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar™) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 µm coated optical fibers shall not be permitted.

H. Fiber distribution cabinets for horizontal cabling: Where optical fiber horizontal cabling is to be terminated, the enclosure shall be compliant to all of the above requirements plus the enclosure shall incorporate a storage mechanism designed to allow simplified identification, access to and termination of individual optical fibers. This may be in the form of a storage cassette, tray or other appropriate mechanism.

2.6 TERMINATION BLOCKS

A. Where identified on the drawings in Communication Equipment Rooms, 110-type termination blocks shall be furnished and installed by the Contractor for termination of copper cable.

B. Each horizontal row of the 110-type termination block must be capable of terminating one (1) 25-pair binder group (backbone cables). Backbone and horizontal 110-type termination blocks shall be segregated, clearly identifying their function.

C. The Mechanical Termination Shall:

1. Have the ability of terminating 22 - 26 AWG plastic insulated, solid and stranded copper conductors.

2. Provide a direct connection between the cable and jumper wires.

3. Have less than 0.2 dB of attenuation from 1-16 MHz.

4. Have less than 100 mW of DC resistance.

5. Have less than 5 mw of resistance imbalance.

6. Have minimal signal impairments at all frequencies up to 16 MHz.

D. The 110-type termination block shall identify pair position by a color designation - Blue, Orange, Green, Brown and Slate (backbone only).

E. The 110-type termination block shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.

2.7 LADDER RACK

A. Provide complete ladder rack system including metallic ladder rack, splice connectors, fastening hardware and other miscellaneous materials as required for a complete installation per manufacturer's recommendations.

B. Steel C-Channel Stringer Style Ladder Rack:

1. Rolled steel siderail stringer, 2" stringer height, 9" spaced welded rungs.

2. Steel shall meet the requirements of ASTM A1011 SS Grade 33.

3. Loading limits shall be 292 lbs/ft for 4 ft spans.

C. Ladder rack finish shall be flat black powder coat.

2.8 D-RINGS

A. Rounded edge D-rings for support of cabling in vertical and horizontal configurations.

B. EIA 310D compliant, manufactured from materials meeting UL94-V0 specifications.

C. Provide ¼" screw holes for wall mounting.

2.9 POWER STRIPS

A. Provide power strips on all equipment racks, unless noted otherwise. These power strips shall have the following characteristics:

1. Standard Rack Mount:

a. TIA/EIA 19" equipment rack mountable.

b. Compliant with UL-1449 Second Edition and UL-497A.

c. Provide transient suppression to 13,000-A. Protection shall be in all three modes (line-neutral, line-ground and neutral-ground).

d. Shall meet or exceed ANSI C62 Category A3 requirements.

e. Provide high-frequency noise suppression as follows:

>20-dB @ 50 kHz
>40-dB @ 150 kHz
>80-dB @ 1 MHz
>30-dB @ 6 to 1000 MHz

f. Provide a minimum of 320 joules of AC energy absorption.

g. Be equipped with a 10-foot power cord.

h. Shall meet or exceed IEEE 587 Category A & B Specification.

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS

A. Equipment racks shall be furnished and installed as shown on the drawings.

B. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. The rack shall be stabilized by extending a brace to the wall. Alternately, overhead ladder rack by which the cabling accesses the equipment rack(s) may provide this function.

C. A space between the rack upright and the wall (approximately 4") should be provided to allow for cabling in that area. The rear of the rack should be approximately 40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of the Architect/Engineer for resolution prior to installation.

D. All hardware and equipment is to be mounted between 18" and 79" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware should be reviewed and approved by the Architect/Engineer and Site Coordinator(s) prior to installation.

E. Equipment racks shall be equipped with cable management hardware as to allow an orderly and secure routing of optical fiber and/or copper cabling to the optical fiber distribution cabinets and/or modular patch panels. At minimum, one such horizontal jumper management panel shall be placed below each optical fiber distribution cabinet installed by the Contractor. Additional Jumper Management panels may be required pending installation of other cable types on the equipment rack.

F. Each rack shall be grounded to the Telecommunications Ground Bar (GND) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket) directly or via an adjacent grounded equipment rack. Refer to grounding requirements below.

3.2 LADDER RACK

A. Provide support for ladder rack on 4' centers.

B. Maintain a 1.5 safety factor on all load limits specified herein.

C. Ladder rack support shall be by 5/8” diameter threaded rod when ceiling mounted. Ladder rack requiring wall mounting shall utilize accessories supplied by the ladder rack manufacturer specifically for the purpose of wall mounting ladder rack.

3.3 D-RINGS

A. Provide D-rings for cable routing and management in all areas where open cabling is routed along the wall in an Equipment Room.

B. Locate D-rings on 24” centers vertically and horizontally.

C. Securely attach D-rings to the wall as required by the manufacturer.

3.4 GROUNDING

A. Provide a complete grounding system in accordance with the requirements of Section 27 05 26.

3.5 OPTICAL FIBER TERMINATION

A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.

B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.

C. Each cable shall be clearly labeled at the entrance to all enclosures.

D. A maximum of 12 strands shall be spliced in any tray.

3.6 CONDUITS AND CABLE ROUTING

A. Refer to Section 26 05 33 for additional requirements.

B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3" above the floor slab.

C. Where cabling rises vertically in a telecommunications rooms, provide vertical cable management to support the cabling from floor to ceiling level.

D. All conduits shall be reamed and shall be installed with a nylon bushing.

E. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.

END OF SECTION

SECTION 27 13 00
BACKBONE CABLING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the products and execution requirements relating to furnishing and installing backbone communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of both optical fiber and/or copper cabling.

1.2 RELATED WORK

A. Section 27 05 00 – Basic Technology Systems Requirements.
B. Section 27 15 00 - Horizontal Cabling Requirements.
C. Section 27 17 20 - Support and Warranty.

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

2. Manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 The basis of design is listed herein. Refer to Section **27 17 20** for additional acceptable manufacturers**.**

2.2 OPTICAL FIBER BACKBONE – INSIDE PLANT (RISER)

A. Singlemode (SM):

1. This optical fiber backbone cable shall be suitable for installation in building riser systems, in conduit, in cable tray and/or in innerduct.

2. Optical fiber cable materials shall be all dielectric (no conductive material).

3. Optical fiber cable shall carry an OFNP (Optical Fiber Non-Conductive Plenum) rating.

4. Outer Sheath: The outer sheath shall be marked with the manufacturer's name, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet.

5. Temperature Range:

   a. Storage: -40°C to +70°C (no irreversible change in attenuation).
   b. Operating: -40°C to +70°C.

6. Humidity Range: 0% to 100%.

7. Maximum Tensile Strength (≥ 24 fibers):

   a. During Installation: 100 Newton (22 lb. force)
   b. Long-Term: 30 Newton (7 lb. force).

8. Bending Radius:

   a. During Installation:

      1) 24 Strand: 2 inches

      2) 48 Strand: 2.5 inches

      3) 72 Strand: 2.7 inches

   b. Long Term

      1) 24 Strand: 1.5 inches

      2) 48 Strand: 1.5 inches

      3) 72 Strand: 1.8 inches

B. Optical fiber cables suitable for installation in multiple environments (e.g., underground duct and building risers) may be used at the Contractor's option. Such optical fiber cables shall meet all specifications noted above for cables designated for each environment through which the optical fiber cable shall pass. Installation in multiple environments may require use of MicroDuct designated for each environment through which the optical through which the optical fiber cable shall pass.

C. Basis of Design (Singlemode):

1. AFL / Dura-Line Corporation eABF MicroCable.

2.3 COPPER BACKBONE – INSIDE PLANT

A. CAT 3 Backbone Cable:

1. The CAT 3 backbone cable shall link Communication Equipment Rooms serving the building. These CAT 3 backbone cables shall be terminated on 110-type termination blocks.

2. CAT 3 backbone cable shall incorporate 24 AWG solid annealed copper conductors insulated with a thermoplastic CMP plenum rated skin. Conductors shall be twisted to form pairs and be fully color-coded.

3. Conductors shall be identified by the insulation color of each conductor. The color code shall follow the industry standard composed of 10 distinctive colors to identify 25-pairs in accordance with ICEA publication S-80-576-1988. Marking of each mate of the primary conductor in a pair with the color of that primary conductor is optional.

4. CAT 3 backbone cable shall meet the TIA/EIA Category 3 performance requirements.

5. When CAT 3 backbone cables of larger than 25-pairs are required, the core shall be assembled into 25-pair sub-units, each color-coded in accordance with ICEA publication S-80-576-1988. CAT 3 backbone cables with over 600-pair shall have 25-pair binder groups combined into super units. These super units shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow and violet. Binder color code integrity shall be maintained wherever cables are spliced.

6. Basis of Design:

   a. Belden. 1247A CMP.

B. Singlemode (SM):

1. Fiber Type: Singlemode; doped silica core surrounded by a concentric glass cladding.

2. Core Diameter: 8 to 9 µm. All optical fibers shall be of the same nominal core diameter and profile.

3. Cladding Diameter: 125 ± 1.0µm.

4. Cladding Non-circularity: ≤ 1%.

5. Core to Cladding Offset: ≤ 0.8 µm.

6. Fiber Coating Diameter:

   a. 245 ± 15µm (primary coating).
   b. 900-nm (nominal) secondary coating (tight buffer).
   c. All coatings shall be mechanically strippable without damaging the optical fiber.

7. Cut-off Wavelength (cabled fiber; λ_{ccf}) $\leq$ 1260-nm.

8. Mode Field Diameter: 8.3 to 9.8 m at 1300-nm; 10.5 ± 1.0 µm at 1550-nm.

9. Zero Dispersion Wavelength (λ_0): 1301.5 nm $\leq l_0 \leq$ 1321.5 nm.

10. Zero Dispersion Slope (S_0): $\leq$ 0.092 ps/nm^2*km.

11. Fiber Attenuation (maximum @ 23 ± 5°C; Backbone):

    a. @ 1300-nm: 2.0 dB/km
    b. @ 1550-nm: 1.75 dB/km

When tested in accordance with FOTP-3, “Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components,” the average change in attenuation over the rated temperature range of the optical fiber cable shall not exceed 0.05 dB/km at 1550-nm. The magnitude of the maximum attenuation change of each individual optical fiber shall not be greater than 0.15 dB/km at 1550-nm.

12. Fiber Dispersion (maximum):

    a. @ 1285 to 1330-nm: 3.2-ps/nm*km
    b. @ 1550-nm: 18-ps/nm*km

13. No optical fiber shall show a point discontinuity greater than 0.1 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION REQUIREMENTS

A. Cable slack shall be provided in each backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure.

B. A minimum of 5 meters (approximately 15 feet) of slack cable (each cable if applicable) shall be coiled and secured at both ends located in the entrance room, Telecommunications Room or main equipment room, for backbone and intra-building cable.

C. Where exposed, all backbone fiber optic cable shall be installed in protective inner duct. This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g., between conduit and cable tray or into equipment racks). The inner duct should extend into the termination and/or storage enclosure(s) at system endpoints.

3.2 FIBER OPTIC MICRO-CABLE INSTALLATION

A. Prior to jetting fiber optic MicroCable, thoroughly test MicroDucts.

B. Beginning installation means contractor has fulfilled prerequisites of MicroDuct installation and testing per manufacturer's specifications and pre-installation testing of fiber optic MicroCable per this specification.

C. Contractor shall furnish all required tools to facilitate MicroCable jetting without damage to the cable jacket. Such equipment ins to include, but not limited to, blowing head and wheel, air compressor, air preparation kit, blowing beads, and similar devices. All equipment shall be of substantial construction to allow steady progress once jetting has begun. Makeshift devices or devices not approved by the manufacturer shall not be used. Pulling MicroCables is not acceptable.

D. Jetting of the fiber optic MicroCables shall be done in accordance with the manufacturer's recommendations. Manufacturer's recommendations shall be part of the MicroCable submittal. Recommended minimum bending radii shall not be exceeded. Any fiber optic cable bent or kinked to a radius less than recommended shall not be installed.

E. During jetting operation, an adequate number of workers shall be present to all ow cable observation at all points of cable entry and exit as well as to feed cable and operate jetting machinery.

F. "Pulling" lubricant shall not be used during jetting of MicroCables.

G. Avoid abrasion and other damage to cables during installation.

H. Cable slack shall be provided in each MicroCable. Follow recommended procedures from the manufacturer regarding length of slack cable ensuring a minimum of 5 meters (approximately 15 feet) of cable that shall be coiled and secured at each termination location. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and or equipment relocation. The cable slack shall be stored in a fashion as to protect it from cable damage. The use of suitable enclosures designed for this purpose is encouraged.

I. Fiber optic MicroCables shall be indoor/outdoor and independently flame rated (i.e. Riser or Plenum)

J. Fiber optic MicroCables shall be installed in a continuous length. Splices are not acceptable.

K. Fiber optic MicroCables shall be installed according to manufacturer's recommendations.

L. Slack in each fiber MicroCable shall be provided as to allow for future re-termination in the event of connector or fiber end-to end damage. Adequate slack shall be retained to allow termination at a 30" high work bench adjacent to the termination enclosure(s). A minimum of 1 meter (39") of slack shall be retained at the work area, and minimum of 3 meters (approximately 10') of slack shall be retained in equipment rooms and telecommunications closets. Label each fiber bundle.

M. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all optical fiber terminations.

3.3 CROSS-CONNECTS

A. The Owner will be responsible for all cross-connects between the data backbone cabling and network electronics and between the data network electronics and horizontal cabling.

B. The Owner shall be responsible for the cross-connect wiring between the horizontal and backbone voice cabling.

C. This Contractor shall not be responsible for cross-connects between the cabling terminations at the Entrance Room and the telephone utility network point-of-presence. It shall be the responsibility of the Contractor, to work with the Owner and provide the necessary assistance to allow Owner and/or telephone company personnel to make the necessary connections to establish service on the new cable system. These activities include, but are not limited to cross-connect documentation, general wiring overview and cable pair identification.

END OF SECTION

SECTION 27 15 00
HORIZONTAL CABLING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper cabling.

1.2 RELATED WORK

A. Section 27 05 00 - Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance (and not just to the Standard, should the required performance exceed the Standard).

C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.

D. The installing contractor must be certified by the manufacturer of the structured cabling system.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

2. Manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLE

A. CAT 6 Plenum Cable:

1. The horizontal cable requirements must be met, as well as the following channel requirements.

2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.

3. Performance tests shall be conducted at a maximum discrete test frequency of 250 MHz for the channel. All numbers given are dB per 100 meters.

4. Performance data shall be provided by third party independent testing laboratories only. Testing data shall be submitted on the third party testing laboratory letterhead. Test data will only be accepted if it displays testing as a channel. Electrical characteristics of the performance of the cable itself will not satisfy this requirement.

5. The structured cabling and connectivity may be provided by the same company. Alternately, ally or partnerships between cabling manufacturers and connectivity manufacturers will be acceptable. Ad-hoc cabling solutions in which the cabling manufacturer does not have a relationship, agreement, or other means of support channel arranged with the connectivity manufacturer will not be accepted.

6. Channel Requirements:

Insertion Loss:	250 MHz	34.1 dB
NEXT:	250 MHz	36.1 dB
PS NEXT:	250 MHz	3.2 dB
ACR:	250 MHz	3.0 dB
PS ACR:	250 MHz	1.3 dB
ELFEXT	250 MHz	19.38 dB
PS ELFEXT:	250 MHz	15.3 dB
Return Loss:	250 MHz	10.0 dB

7. The jacket color for CAT 6 cable shall be blue.

8. Basis of Design:

   a. Hubbell Nextspeed CMP.

2.2 CONNECTORS/COUPLERS/ADAPTERS

A. Optical Fiber Connectors (LC-type) (Multimode/Singlemode):

1. LC-type Optical Fiber Connectors: Shall be used to terminate optical fiber in communication equipment rooms.

2. LC-type optical fiber connector plugs shall be snap-type with an integrated pull-proof design.

3. LC-type optical fiber connector plugs shall incorporate a zirconium ceramic ferrule and shall utilize a factory pre-polish end face to ensure fiber-to-fiber physical contact for low loss and reflections.

4. LC-type optical fiber connector plugs shall accept 1.6mm – 2.0mm and 3.0mm outside diameter fiber.

5. The average insertion loss is 0.3db for multimode and single mode connectors.

6. LC-type optical fiber connector plugs shall meet the following performance criteria:

Test Procedure	Maximum Attenuation Change
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

7. Additional Performance Requirements:

   a. Length: 2.23 inches
   b. Operating Temperature: -40 to 85 degrees C

8. Basis of Design:

   a. Hubbell

2.3 FACEPLATES/JACKS

A. CAT 6 Jacks:

1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.

2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.

3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.

5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.

6. All modular jacks will be fitted with a dust cover. Modular jacks shall incorporate a dust cover that fits over and/or into the modular jack opening. The dust cover shall be designed to remain with the modular jack assembly when the modular jack is in use. No damage to the modular jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the modular jack pinning, will not be accepted.

7. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall (1) match the faceplate color used for other utilities in the building or (2) when installed in surface raceway (if applicable), match the color of that raceway.

8. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:

   a. Be a low-profile assembly.

   b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.

   c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.

   d. Incorporate a shroud that protects the optical fiber couplings from impact damage.

9. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.

10. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.

11. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.

12. CAT 6 modular jacks shall be pinned per TIA-568B.

13. CAT 6 termination hardware shall, as a minimum, meet all of the mechanical and electrical performance requirements of the following standards:

    a. ANSI/TIA/EIA-568-A-5
    b. ANSI/TIA/EIA-568A
    c. ISO/IEC 11801
    d. IEC 603-7
    e. FCC PART 68 SUBPART F

14. The color for CAT 6 jacks shall be ivory

PART 3 - EXECUTION

3.1 CABLE INSTALLATION REQUIREMENTS

A. Horizontal Cabling:

1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.

2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellum grips may be used to spread the strain over a longer length of cable.

3. Manufacturer's minimum bend radius specifications shall be observed in all instances.

4. Horizontal cabling installed as open cabling shall be supported at a maximum of 5' between supports. Refer to the specifications for required cable supports.

5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable ties is strictly prohibited.

6. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.

7. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.

8. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each horizontal cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

9. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:

    a. Twelve (12) inches from power lines of <5-kVa.
    b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
    c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
    d. Thirty-nine (39) inches from transformers and motors.

10. Information outlets shown on floor plans with the subscript "W" are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12" vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.

B. Horizontal Cabling in Modular Furniture:

1. This Contractor shall be responsible for providing and installing cable completely to the information outlet in the furniture. This Contractor's responsibility does not end at the furniture feed point.

2. Where furniture panels are installed to include contact with a wall, cabling shall be fed to the furniture panels via conduit.

3. Where modular furniture is installed without wall contact, the Contractor shall install cabling through floor fittings as shown on the drawings.

4. Cabling shall be protected in the transition from the floor or wall fittings to the modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with the Floor and Wall Fittings proposed. There shall be no exposed cable in the transition to the modular furniture. Fill ratio (cable area vs. conduit area) in each feed shall not exceed 40%.

5. For purposes of bidding, it is to be assumed that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.

6. For purposes of bidding, it is to be assumed that it will be the responsibility of the Contractor to punch and reinstall the bottom molding panels on the modular furniture as required to accommodate the communications cabling and information outlets. The panels shall be marked prior to installation by the Owner to identify the desired location of the information outlets.

7. The information outlet shall be secured to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the information outlet to the panel shall not result in sharp protrusions (e.g., sheet metal screw tip) into the channel behind the panel.

3.2 CABLE TERMINATION REQUIREMENTS

A. Cable Terminations - Data UTP:

1. Modular patch panels shall be designed and installed in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.

2. If the "last" patch (per rack) is greater than 50% utilized, one additional patch panel shall be provided for future use. At information outlets and modular patch panels, the Contractor shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

END OF SECTION

SECTION 27 17 10
TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

1.2 RELATED WORK

A. Section 27 05 00 – Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work, the Contractor shall submit:

1. Complete information on testing procedure as described herein.

PART 2 - PRODUCTS

2.1 TESTING COPPER

A. General Requirements:

1. The Contractor is responsible to perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.

2. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor should provide a summary of the proposed test plan for each cable type including equipment to be used, setup, test frequencies or wavelengths, results format, etc. The method of testing shall be approved by the Architect/Engineer.

3. The Contractor shall visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. The Contractor shall provide the Architect/Engineer with a written certification that this inspection has been made.

4. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove the wiring connections are correct.

6. The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, the Contractor shall provide copies of the original test results.

7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.

8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

a. CAT 6 Cable:

1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.

2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.

3) CAT 6 horizontal cable shall also be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Basic Link" including cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:

a) Wire Map
b) Length
c) NEXT Loss (Pair-to-Pair)
d) NEXT (Power Sum)
e) ELFEXT (Pair-to-Pair)
f) ELFEXT (Power Sum)
g) Return Loss
h) Attenuation
i) Propagation Delay
j) Delay Skew

4) The maximum length of horizontal cable shall not exceed 295 feet (90m), which allows 33 feet (10 m) for technology equipment and modular patch cords.

5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.

6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test records shall verify, "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.

7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

2.2 TESTING FIBER

A. General Requirements:

1. The Contractor is responsible to perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.

2. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor should provide a summary of the proposed test plan for each optical fiber cable type including equipment to be used, setup, test frequencies or wavelengths, results format, etc. The method of testing shall be approved by the Architect/Engineer.

3. The Contractor shall visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. The Contractor shall provide the Architect/Engineer with a written certification that this inspection has been made.

4. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.

6. The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, the Contractor shall provide copies of the original test results.

7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.

8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, the Contractor shall provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.

a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.

b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.

c. Tests Prior to Installation:

1) The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. The Contractor shall supply this test data to the Architect/Engineer prior to installation.

d. Tests After Installation:

1) Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:

a) Optical Attenuation ("Insertion Loss" Method):

(1) Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the "Insertion Loss" method measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers shall be tested at 850 ± 30 nm. Singlemode optical fibers (if applicable) shall be tested at 1300 ± 20 nm.7

(2) Attenuation of optical fibers shall not exceed the values calculated as follows:

Attenuation (max.) = 2*C+L*F+S dB

Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice loss (# of splices * maximum attenuation per splice).

b) Verification of Link Integrity (OTDR):

(1) All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.

(2) Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.

(3) OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

10. MicroDuct Testing, The following three test sequences shall be followed per manufacturer's specifications after installation of MicroDuct:

a. Air Flow Testing

b. Pressure Testing

c. Continuity Testing

2.3 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 05 00 and Division 1. Documentation shall include the items detailed in the subsections below.

2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.

3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.

B. Copper Media Test Data:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (CD-ROM). The CD-ROM shall contain the electronic equivalent of the test results as defined by the bid specification and be of a format readable by Microsoft Word (Version 6.0 or newer). The Contractor shall provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. The Contractor shall furnish one (1) copy of the Data and Display (if applicable) software.

C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

2. OTDR traces of individual optical fiber “signatures” obtained as specified above shall be provided to the Architect/Engineer in electronic form on CD-ROM for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in electronic form, the Contractor shall provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a Microsoft Windows-based personal computer.

D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION

SECTION 27 17 20
SUPPORT AND WARRANTY

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes support and warranty requirements relating to the structured cabling system and related subsystems.

1.2 RELATED WORK

A. Section 27 05 00 – Basic Technology Systems Requirements.

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

PART 2 - PRODUCTS

2.1 MANUFACTURER REQUIREMENTS

A. The Basis of Design for all structured cabling components is listed in the individual Division 27 sections. Alternative acceptable manufacturers will be accepted for this project.

1. Exceptions:

a. CAT 3 copper (≥25-pair).
b. Optical fiber.

B. Additional acceptable manufacturers for horizontal cabling:

1. Belden/CDT
2. Systimax
3. Ortronics

C. Additional acceptable manufacturers for optical fiber:

1. Corning

2.2 WARRANTY

A. A twenty-five (25) year Product Installation Warranty shall be provided for the structured cabling system as described in the contract documents.

B. The Product Installation Warranty shall cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

C. The system assurance warranty shall cover the failure of the wiring system to support the application it was designed to support, as well as additional applications introduced in the future by recognized standards or user forums that use the TIA/EIA 568A component and link/channel specifications for cabling.

D. Submit to Owner at notice to proceed, the most current copy of the manufacturer's certificate of registration and the warranty terms and conditions that apply to the manufacturer's solution.

E. Submit to Owner, at notice to proceed, a statement of any Contractor warranties in addition to the manufacturer's stated and supplied warranties. Submit at closeout signed copies of the Contractor provided warranties that are in addition to manufacturer's stated and supplied warranties.

F. Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate from the manufacturing company registering the installation.

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION

SECTION 27 21 33
WIRELESS ACCESS POINTS (WAP)

PART 1 – GENERAL

1.1. SCOPE

A. The work under this section is for the installation of OWNER PROVIDED, CONTRACTOR INSTALLED Wireless Access Points (WAP).

B. The WAPs shall be installed by the contractor providing and installing the Communications Cable and Equipment. All contractor qualifications and certifications for that section shall apply to this section.

1.2. RELATED SPECIFICATIONS

A. The Contractor shall be responsible for reviewing all other specifications for requirements associated with the complete installation of WAP's. This includes but is not limited to the following:

1. 01 31 23 Project Management Web Site
2. 01 33 23 Submittals
3. 27 00 05 Communications Cable and Equipment

1.3. SUBMITTALS

A. Contractor licenses and qualifications are required as part of the complete Division 27 submittal package as indicated under Specification 27 00 05.

B. No submittals are required for the owner provided WAP.

C. Submittals are required for installation/hanger equipment, connectors, and any other required equipment/material required for a complete WAP installation.

PART 2 - PRODUCTS

2.1. WIRELESS ACCESS POINT (WAP) DEVICES

A. The City of Madison Information Technology Department (CoM-IT) will be providing the WAP devices for this project.

B. The WAP device being used will be as manufactured by the Cisco, Model 3700E and shall be used for all types of ceiling mounted installations (suspended, gyp board, open truss, etc).

PART 3 - EXECUTION

3.1. OWNER RESPONSIBILITIES

A. The CoM-IT shall be responsible for ordering, making payment (including shipping fees), and configuring all WAP devices in a timely manner to comply with the Contractors schedule.

B. The CoM-IT shall configure and test each WAP to CoM-IT specifications prior to providing them to the contractor for installation.

C. The CoM-IT shall number each WAP and provide the contractor with a location map indicating where each WAP will be installed.

C. The CoM-IT shall test all WAP's after installation to verify configuration and signaling is correct prior to accepting the final installation of the WAP system.

3.2. CONTRACTORS RESPONSIBILITIES

A. The Contractor shall be solely responsible for coordinating with CoM-IT the scheduling and receipt of all WAP devices with his/her installation schedule.

B. The Contractor shall inspect all WAP devices upon receipt for damage. CoM-IT shall be notified immediately of any damage.

C. The Contractor shall provide all mounting hardware, blocking, and other items required for a complete installation to the manufacturers installation requirements.

D. The Contractor shall install all WAP devices per plans and specifications including cable connections.

E. The Contractor shall be responsible to pick up WAP devices from City IT and delivery to the jobsite.

3.3. FINAL TESTING

A. Contractor shall provide final testing of all WAP devices after installation is complete.

B. In the event any WAP device is not operating properly the contractor shall trouble shoot the installation and work with the CoM-IT to determine if re-configuration of the device will be required.

C. The CoM-IT shall be responsible for reconfiguring WAP's as needed after installation is complete. The contractor shall be responsible for verifying connections, cabling and connectivity of the installation is correct.

3.4. WARRANTY

A. The CoM-IT will be responsible for registering any warranty information associated with the purchase and ownership of all WAP devices.

B. The Contractor shall warrant the installation of the WAP device for one (1) year per the terms of this contract.

END OF SECTION

SECTION 27 41 00
PROFESSIONAL AUDIO/VIDEO SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Quality Assurance
B. Submittals
C. Media Players
D. IP Cable Television
E. Audio/Video GUI Control Systems
F. Video Cameras
G. Microphone Systems
H. Audio Processing and Distribution
I. Audio Amplifiers
J. Assisted Listening Systems (ALS)
K. Power Conditioning and Surge Protection

L. Uninterruptable Power Supplies (UPS)
M. Digital Video Signal Equalizers and Regenerators
N. Extended Display Identification Data (EDID) Emulators
O. Audio Converters, Transformers and Line Drivers
P. Workstation Computers
Q. Audio Connectors and Cabling
R. Video Connectors and Cabling
S. Transmission Connectors and Cabling
T. Control System Cabling
U. Installation, Calibration, Programming, and Performance Requirements
V. System Commissioning
W. Training

1.2 RELATED SECTIONS

A. Section 26 05 33 - Conduit
B. Section 26 05 13 - Wire and Cable
C. Section 27 05 00 - Basic Communications Requirements
D. Section 27 05 26 - Communications Bonding
E. Section 27 05 03 - Through Penetration Firestopping
F. Section 27 11 00 - Communication Equipment Rooms
G. Section 27 05 28 - Interior Communications Pathway
H. Section 27 15 00 - Horizontal Cabling Requirements
I. Section 27 42 00 - Electronic Digital Systems

1.3 REFERENCES

A. ADA - Americans with Disabilities Act
B. ADAAG - Americans with Disability Accessibility Guidelines
C. ANSI - American National Standards Institute
D. ANSI/InfoComm 1M-2009 - Audio Coverage Uniformity in Enclosed Listener Areas
E. ANSI/InfoComm 2M-2010 - Standard Guide for Audiovisual Systems Design and Coordination Processes
F. BICSI/InfoComm - AV Design Reference Manual (AVDRM)
G. CCNA – Cisco Certified Network Associate
H. IBC - International Building Code
I. IEC - International Electrotechnical Commission
J. InfoComm – Dashboard for Controls
K. NFPA 70 - National Electrical Code (NEC)
L. PCVE – Polycom Certified Video Engineer
M. UL 813 - Commercial Audio Equipment
N. UL 1419 – Professional Video and Audio Equipment
O. UL 1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
P. UL 1492 – Audio/Video Products and Accessories

1.4 SYSTEM DESCRIPTION

A. This specification section describes the furnishing, installation, commissioning and programming of audio/video components and systems.

B. Performance Statement: This specification section and the accompanying Contract Documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made and every feature and function that must be programmed and configured. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment and other miscellaneous equipment required for proper system installation and operation shall be provided by the Contractor.

D. This document describes the major programming features and functions of the system. All additional programming, configuration and integration required for proper system installation and operation shall be provided by the Contractor.

E. When a specific manufacturer is not provided in this document for minor pieces of equipment, the Contractor shall provide only those materials considered to be of the same industry commercial and professional quality level as the major equipment manufacturers.

1.5 LICENSING REQUIREMENTS

A. All user licenses required for system operation shall be included in the Contractor's bid. User licenses shall include, but not be limited to, server and workstation software and any other licensing that is required by the manufacturer for operation of any system component.

1. Licenses shall be provided on a one-to-one basis. One license shall be provided for each server, workstation, and device requiring a license. In the event the manufacturer requires the purchase of a block of licenses, the minimum standard licensing package to support all devices shall be provided.

2. In addition to the licensing requirements listed above, provide licensing and configuration of remote central asset management, scheduling, and control software on up to 20 Owner-provided workstations.

1.6 QUALITY ASSURANCE

A. Manufacturer: The manufacturer of equipment shall have a complete service organization for all products in the manufacturer's line.

B. Integrator/Dealer: The Contractor must be a factory-authorized and certified integrator/dealer specializing in the selected manufacturer's products, with demonstrated prior experience with the selected manufacturer's system installation and programming.

C. The Contractor shall have an InfoComm International (ICIA) Certified Technology Specialist (CTS) on staff and supervising the project. This service shall not be subcontracted.

D. The Contractor shall have staff with Cisco Certified Network Associate (CCNA) certification or more advanced Cisco certification, or equivalent experience, education, or certification.

E. Control System Dealer: The media control system shall be provided, terminated, installed, and programmed by a factory-authorized and certified dealer and integrator in good standing with the manufacturer. The dealer shall have direct purchasing and support authority. These services shall not be subcontracted.

F. Control System Programmer: The media control system shall be programmed by a factory-trained and certified programmer.

1. Should the installer of the system not employ a factory-trained and certified programmer, a representative from the equipment manufacturer or certified independent programmer shall be retained for programming services. The Contractor shall be responsible for payment of his/her services until the job is complete and signed off.

2. The programmer providing programming of the systems shall be a factory-certified Crestron certified level Master Programmer.

G. The Contractor shall have a certified Crestron Digital Media Certified Engineer (DMC-E) on staff to provide and supervise the installation and configuration of the Crestron Digital Media system. The Contractor shall also have a certified Crestron Digital Media Certified Technician (DMC-T) on staff to provide the installation of the Crestron Digital Media system.

H. Audio System Programmer: All digital sound processing equipment (DSP) used on the project shall be setup, programmed and calibrated by a factory-trained and certified technician.

I. Video System Programmer: All video distribution and processing used on the project shall be setup, programmed and calibrated by a factory-trained and certified technician.

J. When Polycom video conference functionality is to be integrated with audio/video components and systems, the Contractor shall have a Polycom Certified Video Engineer (PCVE) on staff to provide the installation and configuration of Polycom equipment. The Contractor shall have Polycom Video Endpoint Certification and Polycom Video Content Management Certification.

K. When Polycom SoundStructure components are to be installed, the Contractor shall have staff with Polycom SoundStructure Technical Training.

L. When Polycom video conference functionality is to be integrated with audio/video systems and when an annual service contract is awarded for extended service and maintenance after the first year, the Contractor shall have the Polycom RealPresence Services Specialization.

M. The Contractor shall have acquired and maintained all certifications for a minimum of one (1) month prior to the posted bid date of this project.

N. Servicing Contractor: The installer must be factory certified to provide service on the installed manufacturer's equipment and must have local service representatives within a 100 mile radius of the project site.

1.7 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 27 05 00.

B. Initial Submittals: To be submitted after the project is awarded but before equipment is purchased and installed.

1. Contractor(s) résumé of qualifications.

2. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

   a. Compliance with each requirement of these documents.
   b. All component options and accessories specific to this project.
   c. Electrical power consumption rating and voltage.
   d. Wiring requirements.
   e. Pre-terminated cable distances and requirements identified by each room where required.

3. Manufacturer Certifications:

   a. All certifications shall be current and valid. Any certificate with expired dates will not be accepted.
   b. Control system authorized dealer certification and dealer #.
   c. Control system certified programmer certification(s).
   d. Audio system DSP dealer certification and dealer #.
   e. Audio system DSP programmer certification.
   f. Video system dealer certification(s) and dealer #.
   g. All other applicable dealer, installation and programming certifications.

4. If an alternate manufacturer(s) is submitted, the equivalent certifications to the basis of design manufacturer(s) shall be required and submitted.

5. Audio and video testing and calibration equipment and software.

6. All applicable InfoComm International (ICIA) certifications.

7. All Polycom certification documentation including a letter of Certification & Specialization from Polycom.

8. Proof of network communications competency. May provide a Cisco Credential Verification Report.

9. Available wireless microphone frequencies within a 50 mile range based on the submitted system(s) and coordinated with the quantity of channels.

10. Alternate System Drawings: If an approved alternate manufacturer is submitted, the Contractor shall provide project-specific system CAD drawings as follows:

    a. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as “typical” of the device shown.

C. Later Submittals: To be submitted after all initial submittals have been approved but before equipment is installed, configured, and programmed.

1. System Drawings: Project-specific system CAD drawings shall be provided as follows:

    a. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as “typical” of the device shown.

D. The Contractor **shall** submit graphic or emulated representations of the control system touch panels for each unique space and layout prior to purchase, installation and programming for review and comment by the Engineer and Owner. These shall show and describe the intended programming/macro control features and functions of each button/icon for all pages.

E. The Contractor shall submit graphic or emulated representations of the control system keypads for each unique space and layout prior to purchase, installation and programming for review and comment by the Engineer and Owner. These shall show and describe the intended programming/macro control features and functions of each button/knob.

F. The Contractor shall submit the actual DSP audio processor files prior to purchase, installation, and programming for review and comment by the Engineer and Owner.

G. The Contractor shall submit the actual DSP audio processor control software files prior to programming and project completion for review and comment by the Engineer and Owner.

H. The Contractor shall submit the number of IP addresses, VLANS, and subnetworks that will be required from the Owner’s Information Technology Department.

I. Submit meeting agenda for planning/programming meetings as required in Part 3 of this specification.

J. Submit detailed description of Owner training to be conducted at project end, including specific training times.

K. Provide rack drawing(s) showing the mounting of equipment in each rack or cabinet on the project.

L. A console and equipment rack plan shall be provided showing console and rack elevations and dimensions in plan view. The plan shall include equipment layout within the console and rack.

M. Quality Assurance:

1. Provide system checkout and commissioning procedure to be performed at acceptance.

N. Discontinued Products and New Model Releases:

1. For each product, the Contractor shall submit (in addition to the specified product) a product cutsheet if the specified product has been replaced, improved upon, phased out or otherwise upgraded at the time of shop drawing submittal.

    a. The intent of this requirement is for the Contractor to submit only direct replacements for the specified products. A direct replacement shall be defined as a product of newer release that has equal or greater capabilities, which is available for not more than a 10% premium over the specified product's bid unit cost.

    b. It is not the intent of this requirement for the Contractor to submit new products or other product options that significantly differ in capability and/or cost from the specified product.

O. Coordination Drawings:

1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.8 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 05 00.

B. Provide all applicable certifications.

C. Provide final system block diagram showing any deviations from shop drawing submittal.

D. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.

E. Provide schedules documenting all terminal block wiring, including cable numbers.

F. Warranty: Submit written warranty and complete all Owner registration forms.

G. Complete all operation and maintenance manuals as described below.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit documents under the provisions of Section 27 05 00.

B. Manuals: Final copies of the manuals shall be delivered after completing the installation. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the Contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation shall include all modifications made during installation, checkout, and acceptance. Manuals shall be submitted in electronic format. The manuals shall consist of the following:

1. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.

2. Hardware Manual: The manual shall describe all equipment furnished including:

    a. General description and specifications.
    b. Installation and checkout procedures.
    c. Equipment layout and electrical schematics to the component level.
    d. System layout drawings and schematics.
    e. Alignment and calibration procedures.
    f. Manufacturers repair parts list indicating sources of supply.

3. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

    a. Definition of terms and functions.
    b. System use and application software.
    c. Initializations, startup, and shutdown.
    d. Reports generation.
    e. Details on forms customization and field parameters.

4. Operator's Manual: The operators manual shall fully explain all procedures and instructions for the operation of the system including:

    a. Computers and peripherals.
    b. System startup and shutdown procedures.
    c. Use of system, command, and applications software.
    d. Recovery and restart procedures.
    e. Use of report generator and generation of reports.
    f. Data entry.
    g. Operator commands.
    h. Alarm messages and reprinting formats.
    i. System permissions functions and requirements.

5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

C. Video Calibration Data: Provide documentation of all calibrated settings for each projector and display.

D. Audio Calibration Data: Provide documentation on all EQ settings, crossover points, limiter settings, gate settings and all other applicable settings.

E. Crestron Digital Media cable bandwidth and distance information readouts for each connection.

F. Intellectual Property Ownership: Provide all uncompiled source code and DSP programming for all systems and spaces as described in Part 3 of this specification section.

G. Polycom: Provide codec serial numbers and firmware versions. Provide a complete inventory of all Polycom equipment to Owner.

1.10 EXTRA MATERIALS

A. Furnish extra materials as described below.

B. Extra stock shall match products installed and shall be packaged with protective covering for storage. Provide identification labels describing contents. Deliver extra materials to Owner.

1. Filters: Provide a total of two (2) filters for each device that utilizes filters. If the device is equipped with more than (1) filter, provide a total of two (2) filters for each filter.

1.11 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.

B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.

1. Inspections: The Contractor shall perform two (2) minor inspections at even intervals (or more often if required by the manufacturer), and two (2) major inspections offset equally between the minor inspections.

2. Minor Inspections: These inspections shall include:

   a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.

   b. Mechanical adjustments if required on any mechanical or electromechanical devices.

3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:

   a. Clean all equipment, including filters, interior and exterior surfaces.

   b. Perform diagnostics on all equipment.

   c. Check, test, and calibrate (if required) any sensors or other equipment that contain settings.

   d. Check zoom and focus of all projectors.

   e. Run all system software diagnostics and correct all diagnosed problems.

C. Operation: Upon the performance of any scheduled adjustments or repairs, Contractor shall verify operation of the systems.

D. Emergency Service: The Owner will initiate service calls when the systems are not functioning properly. Qualified personnel shall be available to provide service within the distance defined within this specification section. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Service personnel shall be at site within 24 hours after receiving a request for service. Contractor is responsible for transportation to and from the service location as often as needed during the warrany period. Contractor is responsible for fees associated with the shipping of any component that needs to be returned or supplied by the manufacturer for repair or replacement.

E. Records and Logs: The Contractor shall keep records and logs of each task completed under warranty. The log shall contain all initial settings at substantial completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the systems.

F. Work Requests: The Contractor shall separately record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. Service personnel will provide technical support within 24 hours of the Owner contracting the Contractor. The Contractor shall deliver a record of the work performed within five (5) business days after work is accomplished.

G. System Modifications: The Contractor shall make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

H. Software: The Contractor shall provide all software and firmware updates during the period of the warranty and verify operation of the system upon installation. These updates shall be accomplished in a timely manner, fully coordinated with system operators, shall include training for the new changes/features, and shall be incorporated into the operations and maintenance manuals, and software documentation.

I. Refer to the individual product sections for further warranty requirements of individual system components.

1.12 ANNUAL SERVICE CONTRACT

A. Provide annual cost for extended service and maintenance warranty after the first year for the audio/video systems according to the following terms:

1. The term of the warranty shall begin on the system acceptance date and shall continue for one (1) year. The extended service and maintenance warranty may begin following this first year if accepted by the Owner. The term may be automatically renewed for successive one-year periods unless canceled by the Owner. The service and maintenance agreement shall include the following basic services to the Owner, including all necessary parts, labor and service equipment:

    a. Repair or replace any equipment item that fails to perform as initially installed, as specified, or as determined per the manufacturer's performance criteria.

    b. Perform semi-annual preventive maintenance on the equipment. This preventive maintenance shall include, but is not limited to, cleaning, realignment, bulb replacement, filter cleaning and replacement, inspection, re-calibration, and testing of devices. The Owner shall receive a written report of these inspections that identifies the device's status and, if required, a list of all necessary repairs or replacements.

    c. Provide software and firmware maintenance on the system. Contractor shall install and configure any software and firmware updates that the manufacturer provides at no cost. Any additional software or firmware options, updates, or enhancements purchased by the Owner shall be installed. The Contractor shall not be responsible for the purchase of additional software packages or the maintenance of Owner data.

2. The Contractor shall be compensated for any repairs or maintenance provided as a result of Owner abuse, misuse, intentional damage, accidental damage, or power fluctuations exceeding specified equipment tolerances.

3. System defects or failures shall be corrected within four (4) hours on the same business day if the Owner makes a service request before 11:00 am or before 12:00 noon the next business day if the Owner makes the request after 11:00 am. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Contractor's services shall be performed in a good and workmanlike manner and remain free from defects for a period of one (1) year.

B. Provide complete terms and conditions of warranty and service.

C. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services.

PART 2 - PRODUCTS

2.1 The following product information represents the minimum requirements for approved equals:

A. Media Players:

1. All media players, including Blu-ray players that are capable of outputting protected content including HDCP and DPCP, shall have a minimum of 16 keys available.

B. IP Cable Television

1. IP Cable Television Set-Top Boxes:

a. IP cable television set-top boxes shall be owner furnished, contractor installed.

C. Audio/Video GUI Control Systems:

1. Contractor shall furnish a Crestron programmable software-based audio/video control system. The system shall be field configurable and programmable by the factory and/or a factory-trained programmer.

2. The control system shall be TCP/IP based allowing direct connection of the system processors to a 10/100BaseT compatible Ethernet network.

3. The control system(s) shall connect to a centralized software-based management system for central control, monitoring and statistical information.

4. Virtual touch panel and keypad control shall be provided for remote trouble shooting and control.

5. Refer to contract documents for required central processors, touch panels, keypads and additional information.

D. Video Cameras:

1. PTZ Cameras:

a. PTZ cameras shall be controllable via RS-232 or Ethernet by Crestron controllers and via Ethernet by Panasonic AW-RP120 or compatible remote camera controllers.

b. PTZ cameras shall have a minimum video resolution of 1920x1080.

c. PTZ cameras must have SDI and HDMI outputs. A direct SDI output from each camera is preferred, but dedicated SDI outputs for individual cameras on an A/V router can be used.

E. Microphone Systems:

1. Wireless Microphones:

a. Wireless microphones shall not operate in the 698 to 806 MHz band (channels 52 to 69).

b. Features:

1) Dual antenna reception with true diversity reception.

c. Microphone systems that are common (shared) by multiple spaces or when the receivers are located in a remote area shall include a compatible wireless antenna distribution system by the same manufacturer as the wireless microphone system.

F. Audio Processing and Distribution:

1. Audio Mixers/Processors:

a. Audio mixing/processing system shall employ Dante networked audio protocol to make individual pre-fader audio signals from microphones and other audio sources and the mixed program output available to other networked Dante-enabled devices.

2. Portable Press Box:

a. Room 260 Audio system shall include a portable press feed distribution box with 12 balanced XLR outputs. PressPower 2 as manufactured by U.S.Audio, WhirlwindUSA shall be used, substitutions shall not be allowed.

G. Audio Amplifiers:

1. Power Amplifier(s), 25, 70.7 and 100 Volt:

a. Power: The following calculation shall be used to determine the minimum required output of the amplifier(s):

1) Calculate the total power tap value of each transformer with insertion loss using the following equation:

a) Tap wattage x 10^(xdB/10) where x = the rated insertion loss at 1,000Hz.

2) Calculate the total wattage loss based on cable distance, cable gauge and cable resistance.

3) Add together all the speaker taps' total power values that will be on a single channel of the amplifier. Multiply that total by 1.2, which will allow for a 20% future expansion. Multiply that number by 1.25 to ensure the amplifier never exceeds 75% of its total output. Utilize the final number to determine the minimum amplifier power requirements.

H. Power Conditioning and Surge Protective Devices:

1. All equipment shall be plugged in through a power conditioning surge arrestor.

2. Provide a minimum of 50 dB noise attenuation.

3. Provide a minimum of 1,500 joules of surge protection.

4. UL 1449 – Standard for Safety for Surge Protective Devices listed to 330 volt clamping voltage.

5. Provide automatic voltage regulation from 97 VAC to 137 VAC at a minimum to maintain a stable 120 VAC where specified.

6. Power sequencers shall be equipped with bi-directional RS-232 or Ethernet control for remote turn on and off.

7. Refer to the contract documents for additional information.

I. Digital Video Signal Equalizers and Regenerators:

1. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install a signal equalizer at the far end (sink) with the following minimum features:

a. HDMI/DVI equalizers shall be HDCP compliant and support actively buffered DDC transmission.

b. Display port equalizers shall be HDCP and DPCP compliant, support actively buffered DDC transmission, and be DP++ compatible.

c. Provide automatic equalization.

d. Pass all embedded audio and metadata.

e. Have an auxiliary power input when adequate power is not available on the cable.

f. Provide output reclocking and jitter reduction for multi-rate SDI signals.

2. For any cable run that that fails to transmit video or audio due to a weak source signal, the Contractor shall provide and install a signal regenerator at the near end (source) with the following minimum features:

a. HDMI/DVI regenerators shall be HDCP compliant and support actively buffered DDC.

b. Display port regenerators shall be HDCP and DPCP compliant, support DDC transmission, and be DP++ compatible.

c. Provide automatic output reclocking and jitter reduction.

d. Pass all embedded audio and metadata.

e. Have an auxiliary power input when adequate power is not available on the cable.

J. Extended Display Identification Data (EDID) Emulators:

1. If any source or Owner-furnished equipment (OFE) is not outputting video properly, the Contractor shall provide and install an EDID Emulator and set it to the highest common EDID table of the displays (sinks) being outputted to, with the following minimum features:

a. EDID capture mode from a display.

b. Have an auxiliary power input when adequate power is not available on the cable.

K. Audio Unbalanced to Balanced Converters, Balanced to Unbalanced Converters, Combiners, Dividers, Isolation Transformers, and Line Drivers Minimum Requirements:

1. Unbalanced to Balanced Active Converter:

a. Provide signal isolation from the audio signals of differing channels.

b. Provide output trim gain and set to optimal output level while preventing over amplification and clipping of the signal.

c. Minimum frequency response of 20 Hz to 20 kHz (± 0.5dB).

d. Provide with appropriate power supply and mounting kit for rack or wall use.

e. Provide appropriate converter for mono to mono, mono to stereo, stereo to stereo, or stereo to mono to match the input of the equipment to which it is being connected.

2. Balanced to Unbalanced Passive Converter:

a. Provide transformer isolation from the input to output.

b. Provide output trim attenuation and set to optimal output level while preventing over-amplification and clipping of the signal.

c. Minimum frequency response of 20 Hz to 20 kHz (± 0.5dB).

d. Provide with appropriate mounting kit for rack or wall use.

e. Provide appropriate converter for mono to mono, mono to stereo, stereo to stereo, or stereo to mono to match the input of the equipment to which it is being connected.

3. Stereo to Mono and Mono to Stereo Passive Combiner/Divider:

a. Passive resistive network.

b. Provide RF filtering.

c. Provide a minimum of 3dB of isolation between channels.

d. Provide no greater than 3dB of Insertion Loss.

e. Minimum frequency response of 20 Hz to 20 kHz (± 3dB).

f. Provide with appropriate mounting kit for rack or wall use.

g. Provide appropriate passive combiner for low impedance or high impedance and balanced or unbalanced signals to maintain the original signal type.

4. Passive Isolation Transformer:

a. Provide Galvanic Isolation.

b. Minimum frequency response of 20 Hz to 20 kHz (± 3dB).

c. Isolate the input shield from the output shield. Input shield is electrically isolated from the transformer chassis and provides a ground return. The output shield is connected to the transformer chassis.

d. Provide with appropriate mounting kit for rack or wall use.

e. Provide appropriate isolation transformer for low impedance or high impedance, stereo or mono signals, and balanced or unbalanced signals to maintain the original signal type.

5. Active Signal Line Driver:

a. Provide balanced or unbalanced inputs with balanced outputs.

b. Provide input trim gain for a minimum of unity gain from -14dBu to +24dBu, set to optimal output level while preventing over-amplification and clipping of the signal.

c. Provide a minimum balanced output of +4dBu nominal for a minimum output gain of +25dBu.

d. Minimum frequency response of 20 Hz to 20 kHz (± 0.5dB).

e. Provide with appropriate power supply and mounting kit for rack or wall use.

f. Provide appropriate line driver for low impedance or high impedance and stereo or mono signals.

L. Refer to contract documents for all other equipment not listed.

2.2 AUDIO CONNECTORS

A. Phono Jack:

1. Panel Mount: Professional grade, three conductor, stereo, 0.375" hole diameter mounting, self-locking, double-open circuit. Switchcraft, Neutrik or approved equal.

2. Cable Mount: Professional grade, three conductor, stereo, all-metal construction, integral cable clamp, nickel body, cable strain relief. Switchcraft, Neutrik or approved equal.

B. Phono Plug:

1. Professional grade, 1/4" stereo phone plug, strain relief, internal cable clamp, all metal body, tin-plated solder terminals. Switchcraft, Neutrik, Mogami or approved equal.

C. RCA Jack:

1. Panel Mount: Professional grade, isolated, gold-plated connectors, solders connection. Switchcraft, Neutrik, Mogami or approved equal.

2. Panel Mount (Recessed): Professional grade, isolated, gold-plated connectors, solders connection. Switchcraft, Neutrik, Mogami or approved equal.

3. Cable Mount: Professional grade, nickel-plated body, metal shell, heavy-duty cable clamp. Switchcraft, Neutrik Mogami or approved equal.

D. RCA Plug:

1. Professional grade, nickel-plated metal shell, solid center pin, gold-plated contact surface. Switchcraft, Neutrik, Mogami or approved equal.

E. XLR Jack:

1. Panel Mount: Professional grade, crimped insert for vibration control, nickel shell, silver pins, pin quantity as required for application. Switchcraft, Neutrik or approved equal.

F. XLR Plug:

1. Professional grade, 360° strain relief, nickel shell, silver pins. Provide colored boot. Switchcraft, Neutrik, Mogami or approved equal.

2.3 AUDIO CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. Microphone Level Audio Cabling:

1. For patch cables less than or equal to 25 feet:

a. 24 AWG 2-conductor, twisted, stranded (19x36) tinned bare copper.

b. Single Layer Shield:

1) Shield: 100% aluminum foil shield.

c. Nominal Capacitance: 30.0 pF/Ft.

1) Belden 9452 non-plenum
2) West Penn
3) Liberty
4) Gepco

2. For cable runs greater than or equal to 25 feet:
    a. 22 AWG 2-conductor, twisted, stranded (16x34) tinned bare copper.
    b. Dual Layer Shield:
        1) Shield: 85% total tinned copper braid shield.
    c. Nominal Capacitance: 18.0 pF/Ft.
    d. Acceptable Manufacturers:
        1) Belden 8422 non-plenum
        2) West Penn
        3) Liberty
        4) Gepco

C. Line Level Audio Cabling:
1. For patch cables less than or equal to 25 feet:
    a. 22 AWG 2-conductor, twisted, stranded (7x30) tinned bare copper.
    b. Single Layer Shield:
        1) Shield: 100% aluminum foil shield.
    c. Nominal Capacitance: 24.0 pF/Ft.
    d. Acceptable Manufacturers:
        1) Belden 9461 non-plenum
        2) West Penn
        3) Liberty
        4) Gepco
2. For cable runs greater than or equal to 25 feet:
    a. 18 AWG 2-conductor, twisted, stranded (16x30) tinned bare copper.
    b. Single Layer Shield:
        1) Shield: 100% aluminum foil shield.
    c. Nominal Capacitance: 30.0 pF/Ft.
    d. Acceptable Manufacturers:
        1) Belden 9460 non-plenum
        2) West Penn
        3) Liberty
        4) Gepco

D. AES/EBU Digital Audio Cabling:
1. For patch cables less than or equal to 25 feet:
    a. 24 AWG 2-conductor, twisted, stranded (7x32) tinned bare copper.

b. Single Layer Shield:

1) Outer shield: 100% aluminum foil shield.

c. Nominal Impedance: 110 ohms.

d. Nominal Capacitance: 12.0 pF/Ft.

e. Velocity of propagation: 76%.

f. Maximum attenuation (per 100 feet):

1) at 2-MHz: 1.3 dB.
2) at 4-MHz: 1.56 dB.
3) at 5-MHz: 1.7 dB.
4) at 6-MHz: 1.81 dB.
5) at 12-MHz: 2.28 dB.
6) at 24-MHz: 3.08 dB.

g. Acceptable Manufacturers:

1) Belden 1800B non-plenum
2) West Penn
3) Liberty
4) Gepco

2. For cable runs greater than or equal to 25 feet:

a. 22 AWG 2-conductor, twisted, stranded (7x30) tinned bare copper.

b. Dual Layer Shield:

1) Inner shield: 100% aluminum foil shield.
2) Outer shield: 90% tinned copper braid shield.

c. Nominal Impedance: 110 ohms.

d. Nominal Capacitance: 13.0 pF/Ft.

e. Velocity of propagation: 76%.

f. Maximum attenuation (per 100 feet):

1) at 2-MHz: .93 dB.
2) at 4-MHz: 1.15 dB.
3) at 5-MHz: 1.2 dB.
4) at 6-MHz: 1.3 dB.
5) at 12-MHz: 1.6 dB.
6) at 24-MHz: 1.97 dB.

g. Acceptable Manufacturers:

1) Belden 1696A non-plenum
2) West Penn
3) Liberty
4) Gepco

E. Constant Voltage Speaker Cabling:

1. Class 2, non-plenum rated, stranded, twisted, shielded 2-conductor, 16-gauge wire for all 25/70.7/100 volt applications unless noted otherwise.

2. All shielded cables drain wire SHALL be grounded and continuous throughout the entire length of the system. The shield shall be grounded to the building ground system at the amplifier end of the cable only.

3. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

4. Provide plenum-rated cable when not installed in conduit or non-plenum areas.

5. As manufactured by Belden 5200FE (white), Liberty, Gepco, or approved equal.

F. High Performance Constant Voltage Speaker Cabling:

1. Class 2, non-plenum rated, stranded, twisted, shielded 2-conductor, 12-gauge wire for all 25/70.7/100 volt high wattage (50-watts per speaker or greater) applications unless noted otherwise.

2. All shielded cables drain wire SHALL be grounded and continuous throughout the entire length of the system. The shield shall be grounded to the building ground system at the amplifier end of the cable only.

3. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

4. Provide plenum-rated cable when not installed in conduit or non-plenum areas.

5. As manufactured by Belden 5000FE (white), Liberty, Gepco, or approved equal.

G. Low Impedance Speaker/Subwoofer Cabling:

1. Class 2, non-plenum rated, high strand count (65x34), oxygen free copper, low capacitance (19.9 pF/Ft), twisted, 2-conductor, 16-gauge wire for all 2/4/8/16 ohm low impedance applications where amplifier output is 150 watts or less and/or the distance is less than 50', unless noted otherwise.

2. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

3. Provide plenum-rated cable when not installed in conduit or non-plenum areas.

4. As manufactured by Belden 1307A, Liberty, Gepco, or approved equal.

H. High Performance Low Impedance Speaker/Subwoofer Cabling:

1. Class 2, non-plenum rated, high strand count (259x34), oxygen free copper, low capacitance (23.2 pF/Ft), twisted, 2-conductor, 10-gauge wire for all 4/8 ohm low impedance applications where amplifier output is 150 watts or greater and/or the distance is greater than 50', unless noted otherwise.

2. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

3. Provide plenum-rated cable when not installed in conduit or non-plenum areas.

4. As manufactured by Belden 1313A, Liberty, Gepco, or approved equal.

2.4 VIDEO CONNECTORS

A. RF Video F-Connector:

1. 75 ohm, broadcast quality, two-piece compression type. Return Loss: < -36 dB to 1 GHz, -25 dB to 2 GHz, -23 dB to 3 GHz. Twist-on and crimp connectors are not acceptable. Corning Gilbert, King, Amphenol or approved equal.

B. BNC Bulkhead:

1. Chassis Mount: 1/2" D jack, 75 ohm, feed-through jack-to-jack type.
2. Recessed: 1/2" D jack, 75 ohm, nickel face, feed-through jack-to-jack type.

C. BNC Connector:

1. 75 ohm, broadcast quality, two-piece compression type. Return Loss: < -36 dB to 1 GHz, -25 dB to 2 GHz, -23 dB to 3 GHz. Twist-on and crimp connectors are not acceptable. Corning Gilbert, King, Amphenol or approved equal.

D. Video RCA:

1. Plug: 75 ohm, compression style, designed exclusively for video, gold center pin, brass body, Teflon dielectric.

2. Jack: Designed for video applications, 3/8" round hole, gold.

E. VGA Assembly:

1. 75 ohm, metal shell, connections for coaxial RGBHV cables.

F. RJ-45 Un-shielded Connector:

1. 100 ohm, un-shielded, Category 5e rated, 8-pin, 8-conductor crimp type with strain relief boot. Match manufacturer or manufacturer partner of approved UTP cabling.

G. RJ-45 Un-shielded Jack:

1. 100 ohm, un-shielded, Category 5e rated, 8-pin, 8-conductor punch-down type. Provide with appropriate faceplate; coordinate color with Electrical Contractor. Match manufacturer or manufacturer partner of approved UTP cabling.

H. RJ-45 Shielded Connector:

1. 100 ohm, shielded, Category 6 or 6A rated, 8-pin, 8-conductor shielded crimp type with strain relief boot. Match manufacturer or manufacturer partner of approved ScTP or FTP cabling.

I. RJ-45 Shielded Jack:

1. 100 ohm, shielded, Category 6 or 6A rated, 8-pin, 8-conductor shielded punch-down type. Provide with appropriate faceplate; coordinate color with Electrical Contractor. Match manufacturer or manufacturer partner of approved ScTP or FTP cabling.

2.5 ANALOG VIDEO CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. RGBHV Video Cable:

1. For patch cables less than or equal to 25 feet:

a. 5-coax, center conductors: 26 AWG stranded (7x34) bare copper; 0.019" OD (nominal); foam HDPE insulation.

b. Double Layer Shield:

1) Inner shield: 100% non-bonded aluminum foil tape.
2) Outer shield: 93% tinned copper braid.

c. Nominal Impedance: 75 ohms.

d. Nominal Capacitance: 17.3 pF/Ft.

e. Velocity of propagation: 78%.

f. Maximum attenuation (per 100 feet):

1) at 1-MHz: 0.6 dB.
2) at 50-MHz: 3.9 dB.
3) at 400-MHz: 10.4 dB.
4) at 700-MHz: 13.5 dB.
5) at 1000-MHz: 15.9 dB.

g. Acceptable Manufacturers:

1) Belden 1418B non-plenum
2) CommScope
3) Liberty
4) Extron

2. For horizontal cable runs less than or equal to 100 feet:

a. 5-coax, RG-59, center conductors: 20 AWG solid bare copper; 0.032" OD (nominal); foam FEP insulation (plenum).

b. Double Layer Shield:

1) Inner shield: 100% non-bonded aluminum foil tape.
2) Outer shield: 95% tinned copper braid.

c. Nominal Impedance: 75 ohms.

d. Nominal Capacitance (plenum): 16.2 pF/Ft.

e. Velocity of propagation (plenum): 83%.

f. Maximum attenuation (plenum) (per 100 feet):

1) at 1-MHz: 0.3 dB.
2) at 71.5-MHz: 2.1 dB.
3) at 360-MHz: 4.4 dB.
4) at 750-MHz: 6.5 dB.
5) at 1000-MHz: 7.6 dB.
6) at 3000-MHz: 13.8 dB.

g. Acceptable Manufacturers:

1) Belden 1283S5 Plenum
2) CommScope
3) Liberty
4) Extron

3. For horizontal cable runs greater than or equal to 100 feet:

a. For any cable run that exceeds the manufacturer-recommended distances, the Contractor shall provide and install a line driver amplifier and set the level and peaking to achieve the proper signal level.

b. 5-coax, RG-6, center conductor: 18 AWG solid bare copper; 0.04" OD (nominal); foam FEP Teflon insulation (plenum).

c. Double Layer Shield:

1) Inner shield: 100% non-bonded aluminum foil tape.
2) Outer shield: 95% tinned copper braid.

d. Nominal Impedance: 75 ohms.

e. Nominal Capacitance: 16.2 pF/Ft.

f. Velocity of propagation: 82%.

g. Maximum attenuation (per 100 feet):

1) at 1-MHz: 0.24 dB.
2) at 71.5-MHz: 1.6 dB.
3) at 360-MHz: 3.43 dB.
4) at 750-MHz: 5.0 dB.
5) at 1000-MHz: 5.89 dB.
6) at 3000-MHz: 10.67

h. Acceptable Manufacturers:

1) Belden Plenum
2) CommScope
3) Liberty
4) Extron

C. Low Skew Unshielded Twisted Pair (UTP) Cable:

1. The jacket color for Low Skew UTP cable shall be Maroon (Red), Green or Yellow for analog video applications.

2. Maximum Skew ≤ 2.2ns/100m

3. Nominal Impedance = 100 ohms

4. Velocity of propagation (plenum): 70%.

5. Nominal attenuation (per 100 meters):

a. at 1-MHz: 2.0 dB.
b. at 25-MHz: 10.4 dB.
c. at 100-MHz: 22.0 dB.
d. at 350-MHz: 44.8 dB.

6. Return Loss = 15 dB

7. Intended for analog video applications only; not suitable for use as an IP data cable or digital video cable.

8. Acceptable Manufacturers:

   a. Belden Nanoskew 7987P Plenum
   b. Extron
   c. Liberty Cable
   d. Mohawk Cable
   e. General Cable

2.6 DIGITAL VIDEO CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. High Definition Multi-Media Interface (HDMI) “High Speed” Cable:

1. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install am HDCP-compliant signal equalizer at the far end (sink).

2. For cable runs less than or equal to 25 feet:

   a. Four (4) 28AWG solid bonded twisted pairs for clock and data, and seven (7) 28AWG solid conductors for control.

   b. Two Layer Shield:

      1) Inner shield: non-bonded aluminum foil tape.
      2) Outer shield: 85% tinned copper braid shield.

   c. Nominal attenuation of clock and data pairs (per 100 feet):

      1) at 100-MHz: 9.6 dB
      2) at 400-MHz: 19.3 dB
      3) at 825-MHz: 28.9 dB
      4) at 1200-MHz: 36.1 dB

   d. Nominal capacitance between shielded pairs: 15.3 pF/ft nominal.

   e. Nominal capacitance between control pairs: 16.5 pF/ft nominal.

   f. Nominal return loss of shielded pairs: 15 dB, 1-1200 MHZ.

   g. Nominal shield DC resistance of individual shield: 24.4 ohms/1000 ft.

   h. Nominal shield DC resistance of overall shield: 3.7 ohms/1000 ft.

   i. The cable shall be HDMI 1.3a Category 1 certified to 25 feet, and HDMI 1.3a Category 2 certified to 15 feet.

   j. Supports a maximum digital data rate of 10.2 Gbit/s.

   k. Supports up to eight (8) channels of HD audio.

   l. HDCP compliant.

m. Acceptable Manufacturers:

1) Belden BJC Series-F2 as assembled by Bluejeanscable
2) Atlona Technologies
3) Extron
4) Approved equal

3. For cable runs greater than 25 feet:

a. Four (4) 24AWG solid bonded twisted pairs for clock and data, and seven (7) 24AWG solid conductors for control.

b. Two Layer Shield:

1) Inner shield: non-bonded aluminum foil tape.
2) Outer shield: 82% tinned copper braid shield.

c. Nominal attenuation of clock and data pairs (per 100 feet):

1) at 100-MHz: 6.0 dB
2) at 400-MHz: 13.5 dB
3) at 825-MHz: 19.8 dB
4) at 1200-MHz: 24.1 dB

d. Nominal capacitance between shielded pairs: 15.3 pF/ft nominal.

e. Nominal capacitance between control pairs: 16.5 pF/ft nominal.

f. Nominal return loss of shielded pairs: 15 dB, 1-1200 MHZ.

g. Nominal shield DC resistance of individual shield: 15.0 ohms/1000 ft.

h. Nominal shield DC resistance of overall shield: 1.75 ohms/1000 ft.

i. The cable shall be HDMI 1.3a Category 1 certified to 45 feet, and HDMI 1.3a Category 2 certified to 25 feet.

j. Supports a maximum digital data rate of 10.2 Gbit/s.

k. Supports up to eight (8) channels of HD audio.

l. HDCP compliant.

m. Acceptable Manufacturers:

1) Belden BJC Series-1 as assembled by Bluejeanscable
2) Atlona Technologies
3) Extron
4) Approved equal

C. Screened Twisted Pair (ScTP) or Foil Twisted Pair (FTP) Cabling:

1. For patch cables less than or equal to 16.5 feet (10 meters):

a. 4-pair, 26-AWG tinned stranded (7/34) copper conductors, TIA/EIA Category 5E rated.

b. Single Layer Shield:

1) Shield: non-bonded 100% aluminum foil.

c. Nominal Impedance: 100 ohms.

d. Nominal Capacitance (plenum): 46 pF/m.

e. Velocity of Propagation (plenum): 68%.

f. Delay Skew: 30ns/100m.

g. Maximum attenuation (plenum) (per 100 meters):

1) at 1-MHz: 2.3 dB.
2) at 100-MHz: 27.5 dB.
3) at 250-MHz: 45.9 dB.
4) at 350-MHz: 55.9 dB.
5) at 400-MHz: 60.4 dB.

h. Acceptable Manufacturers:

1) Mohawk M5754* plenum

a) Where * = cable color

2) Liberty
3) Belden
4) General Cable
5) Or approved structured cabling manufacture

2. For medium bandwidth and/or medium distance digital video applications:

a. 4-pair, 23-AWG solid copper conductors, TIA/EIA Category 6 rated.

b. Single Layer Shield:

1) Shield: non-bonded 100% aluminum foil.

c. Nominal Impedance: 100 ohms.

d. Nominal Capacitance (plenum): 46 pF/m.

e. Velocity of Propagation (plenum): 72%.

f. Delay Skew: 30ns/100m.

g. Maximum attenuation (plenum) (per 100 meters):

1) at 1-MHz: 1.9 dB.
2) at 100-MHz: 18.5 dB.
3) at 250-MHz: 30.7 dB.
4) at 500-MHz: 45.7 dB.

h. Acceptable Manufacturers:

1) Mohawk M5817* plenum

a) Where * = cable color

2) Liberty
3) Belden
4) General Cable
5) Or approved structured cabling manufacture

3. For high bandwidth and/or long distance digital video applications:
   a. 4-pair, 23-AWG solid copper conductors, TIA/EIA Category 6A rated.
   b. Single Layer Shield:
      1) Shield: non-bonded 100% aluminum foil.
   c. Maximum Skew ≤ 45ns/100m.
   d. Nominal Impedance = 100 ohms.
   e. Velocity of Propagation: 68%.
   f. Nominal attenuation (per 100 meters):
      1) at 1-MHz: 1.6 dB.
      2) at 25-MHz: 8.7 dB.
      3) at 100-MHz: 17.6 dB.
      4) at 250-MHz: 31.1 dB.
      5) at 500-MHz: 40.7 dB.
   g. Intended for digital video applications only; not suitable for use as an analog video cable.
   h. Acceptable Manufacturers:
      1) Liberty 24-4P-P-L6ASH plenum
      2) Belden
      3) Mohawk Cable
      4) General Cable

D. Crestron Digital Media (DM) Copper Cabling:
   1. For any cable runs that exceed the manufacturer-recommended distances, the Contractor shall provide and install an HDCP-compliant signal equalizing repeater.
   2. Consists of three (3) individual cables within a single jacket, one (1) digital video cable, one (1) Category 5E-rated data cable and one (1) control and power cable.
   3. Digital Video Cable:
      a. 4-pair, 24 AWG S/FTP.
      b. Aluminum shield (100% coverage) with tinned/copper braid (45% coverage).
      c. Nominal Impedance = 100 ohms
   4. Category 5E UTP Data Cable:
      a. 4-pair, 24 AWG UTP.
      b. Nominal Impedance = 100 ohms
   5. Control and Power Cable:
      a. One (1) 22 AWG shielded, twisted pair for control and one (1) 18 AWG unshielded pair for power.
      b. Nominal Impedance of control pair = 100 ohms

c. The Contractor shall size power cable as required and utilize larger AWG additional cabling as required.

6. Acceptable Manufacturers:

a. Crestron DM-CBL-P Plenum

2.7 TRANSMISSION CONNECTORS

A. BNC Bulkhead:

1. Chassis Mount: 50 ohm, feed-through jack-to-jack type.
2. Recessed: 50 ohm, nickel face, feed-through jack-to-jack type.

B. BNC Connector:

1. 50 ohm, RF broadcast quality, two-piece compression or crimp type. Return Loss: < -36 dB to 1 GHz, -25 dB to 2 GHz, -23 dB to 3 GHz. Twist-on and connectors are not acceptable. Corning Gilbert, King, Amphenol or approved equal.

C. RJ-45 Shielded Connector:

1. 100 ohm, shielded, Category 6 rated, 8-pin, 8-conductor shielded crimp type with strain relief boot. Match manufacturer or manufacturer partner of approved UTP cabling.

D. RJ-45 Shielded Jack:

1. 100 ohm, shielded, Category 6 rated, 8-pin, 8-conductor shielded punch down type. Provide with appropriate faceplate; coordinate color with Electrical Contractor. Match manufacturer or manufacturer partner of approved UTP cabling.

2.8 TRANSMISSION CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. For patch cables less than or equal to 25 feet:

1. RG-174, center conductor: 26 AWG stranded (7x34) copper-covered steel; 0.019" OD (nominal); polyethylene insulation.

2. Single Layer Shield:

a. Outer shield: 90% tinned copper braid shield.

3. Nominal Impedance: 50 ohms.

4. Nominal Capacitance: 30.8 pF/Ft.

5. Velocity of propagation: 66%.

6. Maximum attenuation (per 100 feet):

a. at 1-MHz: 1.9 dB.
b. at 50-MHz: 5.8 dB.
c. at 400-MHz: 19.0 dB.
d. at 700-MHz: 27.0 dB.
e. at 1000-MHz: 34.0 dB.

7. Provide with plenum-rated jacket where used in a plenum space without conduit.

8. Acceptable Manufacturers:

    a. Belden 8216 non-plenum
    b. CommScope
    c. Liberty
    d. Times Fiber

C. For horizontal cables less than or equal to 50 feet:

1. RG-58, center conductor: 20 AWG bare solid copper; 0.037" OD (nominal); FEP Teflon dielectric (plenum).

2. Single Layer Shield:

    a. Outer shield: 95% tinned copper braid shield.

3. Nominal Impedance: 50 ohms.

4. Nominal Capacitance (plenum): 26.4 pF/Ft.

5. Velocity of propagation (plenum): 69.5%.

6. Maximum attenuation (plenum) (per 100 feet):

    a. at 1-MHz: 0.5 dB.
    b. at 50-MHz: 3.0 dB.
    c. at 400-MHz: 9.7 dB.
    d. at 700-MHz: 13.7 dB.
    e. at 1000-MHz: 17.3 dB.

7. Provide with plenum-rated jacket where used in a plenum space without conduit.

8. Acceptable Manufacturers:

    a. Belden 82240 plenum
    b. CommScope
    c. Liberty
    d. Times Fiber

D. For horizontal cables greater than or equal to 50 feet:

1. RG-8 Center conductor: 10 AWG bare solid copper; 0.108" OD (nominal); foam FEP dielectric (plenum).

2. Two Layer Shield:

    a. Inner shield: non-bonded aluminum foil tape.
    b. Outer shield: 90% tinned copper braid shield.

3. Nominal Impedance: 50 ohms.

4. Nominal Capacitance (plenum): 24.2 pF/Ft.

5. Velocity of propagation (plenum): 84%.

6. Maximum attenuation (plenum) (per 100 feet):

    a. at 1-MHz: 0.1 dB.
    b. at 50-MHz: 1.1 dB.
    c. at 400-MHz: 3.2 dB.
    d. at 700-MHz: 4.5 dB.

e. at 1000-MHz: 5.9 dB.
f. at 4000-MHz: 14.1 dB.

7. Provide with plenum-rated jacket where used in a plenum space without conduit.

8. Acceptable Manufacturers:

a. Belden 7733A plenum
b. CommScope
c. Liberty
d. Times Fiber

E. Patch cables for products that require Category 6/5e Screened Twisted Pair (ScTP) or Foil Twisted Pair (FTP) cabling:

1. 4-pair, 26-AWG tinned stranded (7/34) copper conductors, TIA/EIA Category 5E rated.

2. Single Layer Shield:

a. Shield: non-bonded 100% aluminum foil.

3. Nominal Impedance: 100 ohms.

4. Nominal Capacitance (plenum): 46 pF/m.

5. Velocity of Propagation (plenum): 68%.

6. Delay Skew: 30ns/100m

7. Maximum attenuation (plenum) (per 100 meters):

a. at 1-MHz: 2.3 dB.
b. at 100-MHz: 27.5 dB.
c. at 250-MHz: 45.9 dB.
d. at 350-MHz: 55.9 dB.
e. at 400-MHz: 60.4 dB.

8. Acceptable Manufacturers:

a. Mohawk M5754* plenum

1) Where * = cable color

b. Liberty
c. Belden
d. General Cable
e. Or approved structured cabling manufacturer

F. Horizontal cabling for products that require Category 6/5e Screened Twisted Pair (ScTP) or Foil Twisted Pair (FTP) cabling:

1. 4-pair, 23-AWG solid copper conductors, TIA/EIA Category 6 rated.

2. Single Layer Shield:

a. Shield: non-bonded 100% aluminum foil.

3. Nominal Impedance: 100 ohms.

4. Nominal Capacitance (plenum): 46 pF/m.

5. Velocity of Propagation (plenum): 72%.

6. Delay Skew: 30ns/100m

7. Maximum attenuation (plenum) (per 100 meters):

   a. at 1-MHz: 1.9 dB.
   b. at 100-MHz: 18.5 dB.
   c. at 250-MHz: 30.7 dB.
   d. at 350-MHz: 37.2 dB.
   e. at 500-MHz: 45.7 dB.
   f. at 650-MHz: 53.5 dB.

8. Provide with plenum-rated jacket where used in a plenum space without conduit.

9. Acceptable Manufacturers:

   a. Mohawk M5817* plenum

      1) Where * = cable color

   b. Liberty
   c. Belden
   d. General Cable
   e. Or approved structured cabling manufacturer

2.9 CONTROL CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. Crestron/Control:

1. For Bidding Purposes: Two-pair, twisted, shielded, one (1) #18 AWG pair and one (1) #22 AWG pair. Provide with plenum-rated jacket where used in a plenum space without conduit. Provide PVC jacket where installed in conduit or non-plenum areas.

2. Size conductors as required for distance and voltage drop.

3. Coordinate exact requirements with selected manufacturer and system prior to submitting bid.

C. Other Control Circuits:

1. #20 AWG, stranded, shielded cable, number of conductors as required for the applications. Provide with plenum-rated jacket where used in a plenum space without conduit. Provide PVC jacket where installed in conduit or non-plenum areas.

2. Coordinate exact requirements with selected manufacturers prior to submitting bid.

2.10 HORIZONTAL COPPER DATA AND FIBER CABLING AND CONNECTORS

A. Refer to Section 27 15 00 - Horizontal Cabling Requirements, for telecommunications cabling and connector requirements including fiber optics being utilized for A/V systems.

B. Refer to Section 27 17 10 - Testing, for telecommunications cabling testing requirements including fiber optics being utilized for A/V systems.

C. All category-rated copper data cabling and fiber optic cabling shall be installed, terminated, tested and certified by the Division 27 Telecommunications contractor certified by the selected manufacturers for the copper and fiber optic cabling plant. The Contractor shall submit all cabling and certifications to the Engineer for approval in the shop drawings.

D. The A/V contractor shall coordinate purchase, installation, testing and certification with the telecommunications contractor for all required category-rated copper data cabling and fiber optic cabling required for A/V system operation prior to bid.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

A. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Provide all system wiring between all components as directed by the manufacturer or required for proper system operation.

C. Mount all touch screen and keypad devices where shown on plans in accordance with Americans with Disabilities Act (ADA) requirements for both side reach and front reach.

D. Cabling Requirements:

1. Non-plenum rated cabling may be used instead of plenum when installed with-in conduit in plenum rated areas.

2. All cabling shall be routed according to function. Cabling shall be grouped and bundled by groups, such as: microphone and line level audio, control, video and speaker. In no case shall cabling from different functional groups be intermixed. No cabling shall be routed parallel to 120 VAC or higher power circuits unless separated by a minimum of 6" and the 120 VAC or higher power is installed in conduit.

3. When cabling is installed in conduit, a separate conduit shall be provided for each cabling functional type.

4. Cable bundles shall be loosely bundled to allow the visual following of individual cables within the bundle and to permit the easy removal and addition of cables as necessary.

5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable zip ties is strictly prohibited in any situation.

6. Cabling shall not be spliced under any circumstances.

7. Each cable shall be appropriately identified (as defined on the record documents) at each end's termination point using pressure sensitive label strips.

8. Audio Cabling:

   a. All amplified audio cabling shall not be located in the same enclosed pathway as any other type of cabling as required by the NEC. Refer to the NEC for definitions and additional requirements.

b. The polarity of all cabling shall remain consistent throughout the project, on all equipment. Red conductors shall be used for the positive "+" side, and black used for the negative "-" side.

c. Cable shield length shall be equal to the cable's conductor length.

d. All shielded cables drain wire SHALL be grounded and continuous throughout the entire length of the system, including splices where speakers are installed.

e. Balanced audio connections shall be used whenever the mating equipment allows.

f. Do not run unbalanced cables longer than 3m. For interconnecting of unbalanced equipment in lengths longer than 3m, the Contractor shall provide a line driver located at the source.

9. Video Cabling:

a. All video cabling, unless otherwise noted, shall be provided with BNC connectors of the two-piece compression type. Twist-on BNC connectors are not permitted.

b. Provide BNC 75 ohm terminators where required for all open BNC connectors.

c. All coaxial video cables used for S-video, component/RGB and RGBHV shall be the same length to minimize skew.

10. Twisted Pair Cabling for All Applications:

a. The Contractor shall ensure that the twists in each cable pair are preserved to within 0.5 inch of the termination. The cable jacket shall be removed only to the extent required to make the termination.

b. The Contractor shall ensure that the cable shields are continuous throughout, terminated, and grounded according to the manufacturer's recommendations.

E. Grounding Requirements:

1. Provide a minimum of #6 AWG conductor from the nearest electrical service ground bus or nearest telecommunications room ground bus bar to the A/V equipment racks and cabinets regardless of location. Size cable as required by the NEC.

2. Cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground the shield only at the equipment end.

3. Audio cable shields for line-level signals shall be connected to the metal equipment chassis at both ends of the cable.

4. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.

5. The Contractor shall not connect cable shields together from differing cables.

6. XLR cable shields shall be connected to chassis ground.

7. Signal-grounded balanced shields are not acceptable and shall not be installed. All balanced shields shall be chassis grounded.

F. Rack and Cabinet Requirements:

1. Ground equipment racks/cabinets as noted within this specification section and Section 27 05 26 - Communications Grounding.

2. Provide one (1) RU of space between adjacent pieces of equipment with top and/or bottom vents, above the topmost piece of equipment, and below the bottommost piece of equipment. Provide a vented cover panel covering each rack space.

3. Terminate all speaker cabling on individual barrier strips for positive "+", negative "-", and shield. The shield barrier strip shall be grounded.

4. Provide a power conditioning surge arrestor in the rack for distribution of AC power from the wall receptacles indicated on the plans. The quantity of plugs shall be adequate so that no equipment in the rack shall require plugging into an AC source outside the rack.

5. Power sequencing shall be provided in the racks where shown on the drawings. All amplifiers located in the racks shall be sequenced “last on – first off”. Power sequencers shall provide power conditioning and surge protection.

G. Video System Installation Requirements:

1. The Contractor shall perform calculations for the optimal distance from the screen to the projector lens based on actual field conditions and submit to the Engineer for review and approval.

2. If the projector and screen are in a fixed position, the Contractor shall provide the appropriate lens for the throw distance.

H. Audio System Installation Requirements:

1. The Contractor shall perform calculations for the optimal speaker tap settings to reach the desired SPL level and coverage without overloading the amplifier(s).

a. At a minimum, the following calculations shall be used:

1) Add together all speaker taps that will be on a single channel of the amplifier. Multiply that total by 1.2, which will allow for a 20% future expansion. Multiply that number by 1.25 to ensure the amplifier never exceeds 75% of its total output. Utilize the final number to determine the minimum amplifier power requirements.

2. Connections of balanced to unbalanced equipment shall only be done through an active converter at the unbalanced side.

3. Connections of unbalanced to balanced equipment shall only be done through an active converter at the unbalanced side.

4. Connections from stereo balanced or unbalanced equipment to mono equipment of the same signal type shall only be done through a passive combiner.

5. Connections from mono balanced or unbalanced equipment to stereo equipment of the same signal type shall only be done through a passive divider.

6. The Contractor shall provide an isolation transformer for any balanced or unbalanced audio line that exhibits a hum, noise from EMI or RFI, power line noise, or ground loops.

7. The Contractor shall provide an active audio line driver for all balanced and unbalanced signals that exceed the distance limitations of the cabling.

I. Control System Installation Requirements:

1. The Contractor shall perform calculations for the required wire AWG size based on distance for system power for touch panels, keypads and other devices being powered. A minimum of a 15% overhead is required.

3.3 VIDEO SYSTEM PERFORMANCE REQUIREMENTS

A. Crestron Digital Media:

1. Each digital media cable shall certify to a minimum of 4.46 Gpbs for all applications up to 1920x1080P/30.

3.4 VIDEO SYSTEM TESTING AND CALIBRATION

A. All video equipment shall receive proper testing and configuration.

B. All video conference equipment will be tested for network connectivity to the internet and to the City of Madison network. All video conference equipment will be tested for audio input and output, camera input, video output, and content input when specified.

C. Color Space Optimization:

1. The Contractor shall set the color space of each source and display device to a uniform color space to optimize the switching speed and compatibility of a digital video system. Each device shall be set to an RGB or YCbCr color space depending on the systems primary function and compatibility of the devices.

2. If the primary function of the space is video and other digital media, the color space of each device shall be set to a YCbCr color space. If the primary function of the space is computer-based graphics and presentations, the color space of each device shall be set to an RGB color space.

3. Chroma subsampling shall be set to a consistent 4:4:4 or 4:2:2 across all devices. Set to 4:4:4 when all equipment is capable.

4. If all devices are not capable of displaying a certain color space, all devices shall be set to a common shared color space.

D. Extended Display Identification Data (EDID) Management:

1. The Contractor shall set the EDID management tables in capable equipment so all sources output the highest common EDID table of the displays (sinks).

2. For systems with capable matrix switches, the matrix shall dynamically adjust its EDID tables so any source will output the highest common EDID table of the displays (sinks) being outputted to.

3. If any source or Owner-furnished equipment (OFE) is not outputting properly, the Contractor shall provide and install an EDID Emulator and set it to the highest common EDID table of the displays (sinks) being outputted to.

E. Projector, monitors and receivers shall be tested and adjusted for proper signal sync, convergence, brightness, contrast, and color level. The Contractor shall adjust all other parameters necessary to achieve a proper video image.

F. All video source selections shall be tested and verified.

G. All projectors and displays shall have a minimum burn-in time of 96 hours prior to any adjustments are made and the completion of the project

H. All projectors and displays shall have their hue/tint and color/saturation calibrated with a video signal test generator and blue lens filter after a minimum warmup time of 20 minutes. Provide all calibrated settings results for each projector and display in the final documentation.

I. All projectors and displays shall have their brightness, contrast and sharpness calibrated with a video signal test generator after a minimum warmup time of 20 minutes. Provide all calibrated settings results for each projector and display in the final documentation.

J. All dynamic contrast functions shall be turned off.

K. The Contractor shall utilize a portable oscilloscope to set video output gain and peaking levels on all line drivers and receivers for analog signals.

1. The Contractor shall submit screen shots of the fixed signal.

2. Calibration by eye is not acceptable.

L. Full video calibration for all projectors and displays shall be provided with the following minimum requirements:

1. The Contractor shall utilize non-contact professional video calibration tools such as Sencore OTC1000-CM ColorPro Optical Tri-stimulus Colorimeter or Klein K-10 Tri-stimulus CIE Colorimeter, Sencore or Extron Video Generator and the latest version of ColorPro by CalMan software or approved equal.

2. The projector or display shall have a minimum burn-in time of 96 hours prior to calibration.

3. The projector or display shall have a minimum warmup time of 20 minutes before calibration begins. All efforts shall be taken to allow the display to warm up for a minimum of 60 minutes to allow the luminance to fully stabilize.

4. The space shall be as dark as possible. The colorimeter's ambient light sensor filter shall be recalibrated every 30 minutes when outside ambient light is present to account for the changes in daylight levels.

5. All inputs utilized on the projector or display shall be calibrated using the appropriate video signal, aspect ratio and resolution. Submit results for each input as a separate report.

6. The projector or display shall be calibrated to the Rec. 709 HDTV color standard. White balance shall be calibrated as close as possible to the D65 point for both high IRE and low IRE levels.

7. The projector or display shall have its 3D Color Management calibrated.

8. The projector or display shall have its brightness and contrast adjusted both before and after the gamma is calibrated.

9. Gamma shall be calibrated to an average of 2.2. Gamma shall be verified after the calibration is completed and readjusted as necessary.

10. The projector or display shall have its hue/tint and color/saturation calibrated with a blue lens filter.

11. Record the full on/full off contrast ratio both before and after calibration. Provide these results in the final documentation.

12. The Contractor shall submit the final calibration results to the Engineer for approval and include the approved results in final documentation submitted to the Owner.

13. Calibration by eye is not acceptable.

14. Any setting that cannot be calibrated because the projector or display lacks the functions shall be noted in the final documentation.

15. For video wall applications, or where multiple projectors or displays that will share content are being used within a single space, all displays after calibration shall be adjusted to match the lowest performing projector or display so all projectors or displays are uniform. If a projector or display differs greatly from the other displays, that projector or display shall be replaced at no cost to the Owner and recalibrated.

3.5 AUDIO SYSTEM TESTING AND CALIBRATION

A. This Contractor shall adjust any surface-mounted or flown loudspeaker orientation to achieve the necessary coverage pattern.

B. All speakers shall be connected in-phase.

C. The Contractor shall make incremental adjustments on the equipment output and input tolerances to achieve matching signal levels.

D. The Contractor shall utilize a Real Time Audio (RTA) spectrum analyzer with AES2 Broadband pink noise at a minimum of 1/3 octave, capable of providing detailed plots and reports.

E. The Contractor shall provide graphic plots of the reference ambient noise for each space at the time of the calibration and submit with the calibration results.

F. The Contractor shall use a listener sitting height of four (4) feet ± 1" for rooms where the primary function will be sitting. The Contractor shall use a listener standing height of five feet three inches (5.25') ± 1" for rooms where the primary function will be standing.

G. Calibration by ear is not acceptable.

3.6 AUDIO SYSTEM PERFORMANCE REQUIREMENTS

A. The Contractor shall test and provide documents verifying all the following performance criteria. The Engineer shall be informed when the testing will take place and have the option to witness the testing and ask for additional testing for any reason.

B. The Contractor shall develop an Audio Coverage Uniformity Measurement Location (ACUML) plan for each required space based on the project floor plans, and submit to the Engineer for review and approval prior to testing. The plan shall represent the majority of the listening areas and a "sweet" spot directly under an overhead speaker in the center of the listening area or directly in line of a point source speaker.

C. The tests shall be performed at the multiple locations defined on the ACUML plan representing the majority of the listening area(s). The Contractor shall indicate on the floor plan drawings where each test was performed, with the corresponding graphic plot, and submit with the final documentation for review and approval by the Engineer.

D. The test shall be taken with AES2 Broadband pink noise at a minimum of 25 dB above the reference ambient noise level, taking caution to not overdrive and clip any component of the system beyond 0.5% Total Harmonic Distortion (THD), with a maximum system THD of 1.0%.

E. The audio system(s) shall meet the following minimum requirements:

1. Achieve a total average SPL of 95 dB.

2. The system's total SPL frequency response shall be within ± 4 dB from 250 Hz to 8000 Hz. All efforts shall be made to equalize the system's frequency response as flat as possible throughout the system's entire 20 Hz-20 kHz spectrum.

3. All vocal microphones shall have high and low pass filters set to minimize rumble, pop and hiss. The high pass filter cutoff frequency shall be set between 80 and 100 Hz, with a 12 dB per octave slope. The low pass filter cutoff frequency shall be set at 12,000 Hz, with a 12 dB per octave slope. Adjust frequency and slope as required to maximize performance for both male and female voices.

4. The subwoofer/speaker low/high crossover points shall be a Butterworth (BW) filter set at 80 Hz with a 24 dB per octave slope. This crossover point shall be adjusted as needed to achieve a smooth frequency response.

5. Achieve a minimum RaSTI value of 0.63.

3.7 VIDEO CONFERENCING SYSTEM INSTALLATION TESTING

A. All codec programming (by CoM IT) and software programming (Contractor) shall be completed prior to doing any installation testing and acceptance.

B. It is the sole responsibility of the Contractor to notify CoM IT no less than two (2) weeks in advance of completing the installation to coordinate all final testing of the completed system.

C. The Contractor and CoM IT shall test each video conference system installation to ensure the installed components work per the specifications.

1. All installed components shall be inspected as follows:

   a. All connections are tight, where applicable thumb screws have been properly installed and are finger tight

   b. All components are clean and free of dust, finger prints and other general dirt

   c. Camera lenses are clean and free of lint, dust and finger prints

   d. Cameras are free to rotate

   e. Excess cabling has been neatly wrapped with velcro wire wraps and are properly stored

2. Each installation at the project site shall be tested with an offsite installation to insure that all of the following performance measures have been achieved:

   a. All network connectivity is complete and installed properly.

   b. Audio input (microphone, table top or ceiling mounted)

   c. Audio output

   d. Camera input

   e. Video output (may be one or more monitors)

3.8 DSP-BASED AUDIO PROCESSOR PROGRAMMING

A. Full system programming shall be provided for the system. Programming shall be performed by a factory trained and certified programmer or an employee of the equipment manufacturer.

B. The Contractor shall schedule a series of meetings with the Owner and Engineer to define the exact DSP requirements of the audio system prior to installation of the audio headend system and components.

C. The IP-based audio (Dante) and components shall be on a dedicated Virtual LAN (VLAN) for the A/V systems. These components shall be on a dedicated subnetwork of the VLAN. The Contractor shall coordinate these requirements with the Owner prior to installation.

D. A 16-band parametric EQ shall be provided after each crossover point. These shall be utilized to set the room to flat as defined in the Audio System Calibration section within this specification. These equalizers should not be made available to the user to adjust.

E. Levelers, compressor/limiters, duckers, gates and delays should be programmed in and made available to the user for adjustment via the system software installed on the computer touch panel as described within this specification section.

F. 1/3 octave 31-band EQs, 16 band parametric EQs, feedback eliminators and suppressors, high-pass filters, low-pass filters, levelers, compressor/limiters, duckers, gating and other functions shall be provided for inputs and outputs as required. These settings should be made available to the user for adjustment via the system software installed on the workstation computer touch panel as described within this specification.

G. Acoustic Echo Cancelation (AEC) shall be provided and shall be selectable where applicable.

H. A broadband pink noise generator shall be provided with a selectable on/off control button on the touch panel. The noise shall be run through all processing EQs and effects.

I. Provide meters for each monitorable function.

J. Provide with user control software to be installed on Owner-provided and installed computer.

K. Provide user level access to the above stated functions at a minimum, unless noted otherwise.

L. The Contractor shall utilize the latest version of the programming software.

M. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.

3.9 DSP-BASED AUDIO PROCESSOR CONTROL SOFTWARE PROGRAMMING

A. Full system software programming shall be provided for the system. Programming shall be performed by a factory-trained and certified programmer or an employee of the equipment manufacturer.

B. The Contractor shall schedule a series of meetings with the Owner and Engineer to define and determine the exact page layout requirements prior to the final configuration of the audio system. An Owner sign-off of the final layouts shall be required.

C. The Contractor shall use the latest version of the software.

D. At a minimum, there shall be password-protected pages for zone combining, input/output volume control with meters, speaker output volume control with meters, signal routing, signal processing (EQ's, feedback suppression, etc.), and supervision/maintenance for all spaces and combined zones.

3.10 MULTIMEDIA CONTROL SYSTEM INTEGRATION AND PROGRAMMING

A. Programming and Integration for Control Systems:

1. Full system programming shall be provided for the system. Programming shall be performed by a factory trained and certified programmer or an employee of the equipment manufacturer.

2. The Contractor shall schedule a series of meetings with the Owner and Engineer to define and determine the exact integration requirements of the control system prior to the installation of the control system and components. An Owner sign-off of the final configuration shall be required.

3. This section only defines the minimum requirements. The programmer shall provide complete programming for a fully functional system.

4. The Contractor shall utilize the latest version of the programming software.

5. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.

6. Integration and programming of the following pieces of equipment shall be provided, with the following minimum features and functions:

   a. All equipment shall include on/off control, with the exception of equipment that must remain active for system functionality.

   b. Integration of HDCP (High-bandwidth Digital Content Protection) and DPCP (Display Port Content Protection) protected content and sources:

      1) No protected sources or content shall be allowed to be selected to route through non-protected devices and displays. A warning shall be displayed stating this information to the user.

   c. Crestron C2N-SPWS300 Power Supply Integration:

      1) The Contractor shall provide Crestron connections and programming with the following minimum functions:

         a) On/off status of all outputs
         b) Voltage level of all outputs
         c) Ambient temperature and fault status

   d. Matrix Switcher Integration:

      1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

         a) On/off control of the matrix switcher.

         b) Allow for independent video routing of individual video inputs to any audio number of audio outputs.

         c) Allow for independent audio routing of individual audio inputs to any audio number of audio outputs.

         d) Provide source detection of video inputs.

         e) HDCP (High-bandwidth Digital Content Protection) and DPCP (Display Port Content Protection) Protection:

            (1) HDCP-compliant switchers shall allow HDCP source devices to only route to HDCP compliant devices.

            (2) Room Combining/Uncombining features shall allow for complete audio and/or video devices to be connected to the system using simplified interface.

e. DSP Audio Processor Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) On/off control of all microphones.
b) Volume and mute control of all microphones and input sources.
c) Volume and mute control of all outputs.
d) Independent volume and mute control of all assisted listening outputs.
e) On/off and reset control of feedback eliminators and suppressors.
f) Advanced routing of audio signals.
g) Audio conferencing dialer keypad with speed dials.
h) Audio conferencing CallerID display on touchpanel and/or workstation.
i) Acoustic Echo Cancelation (AEC) control.

f. Audio Conference Integration:

1) Refer to DSP Audio Processor Integration for requirements.

g. Display Integration:

1) The displays shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. Provide with the following minimum functions:

a) On/off control.
b) Display status feedback.
c) Source switching control.
d) Audio volume control with mute.
e) Video mute.
f) Tuner channel control with direct channel access.
g) Station presets with station icons.

h. Video Conference Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Refer to DSP Audio Processor Integration for audio requirements.

b) Video conferencing touch panel with speed dials.

c) PTZ near end camera control.

d) PTZ far end camera control with lockout control at the far end.

e) Multi-window control with multiple presets.

(1) The Contractor shall coordinate with the Owner and users on desired layouts.

(2) All system inputs shall be selectable for each window.

i. Pan/Tilt/Zoom (PTZ) Camera Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Provide full pan, tilt and zoom control.

b) Provide presets for fixed camera positions.

(1) The Contractor shall coordinate with the Owner for desired preset positions.

j. Multi-channel Receiver Integration:

1) The Contractor shall provide IR based control **[OR]** bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Power on/off control.
b) Audio/video source select.
c) XM/Sirius/FM/AM tuner direct station access and preset access.
d) Master volume control with mute.
e) Surround sound mode.
f) Real time metadata.
g) Receiver status feedback.

k. TV Tuner Integration:

1) The Contractor shall provide control system connections and programming with the following minimum functions:

a) Channel up/down control.

b) Direct type in channel access.

c) Provide a channel shortcut page with station icons for each channel the Owner chooses, including IPTV channels.

(1) Coordinate with Owner the desired channels for presets.

d) Provide real time metadata and schedule information for display on the touch panel.

2) Infrared Control shall be used only if bi-directional connections (Ethernet, RS-232) do not exist.

l. Uninterruptible Power Supply (UPS) Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) The control system shall provide monitoring and readouts for the following:

(1) Power mode.
(2) Battery maintenance status.
(3) Battery charge status.
(4) Battery time remaining.

(5) Internal temperature.
(6) Current line voltage.
(7) Min/max voltages.
(8) Output voltage and load.

b) The control system shall provide a pop-up warning if any status item exceeds or falls below its threshold.

c) Upon loss of power or sustained under voltage for more than thirty (30) seconds, the control system shall begin a shutdown sequence of projectors and other heat-sensitive, active-cooled equipment.

m. Power Sequencer Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Power on/off control.

b) On/off status via +12VDC output from the sequencer to the I/O input of the control system processor.

n. Multi-window Processor Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) All system inputs shall be selectable for each window of the processor.

b) Multiple pre-configured window presets shall be provided.

(1) The Contractor shall coordinate with the Owner and users on desired layouts.

o. Lighting Integration:

1) Lighting shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. The A/V contractor shall coordinate with the lighting control contractor for full system integration.

2) Basic scene presets shall be provided for different presentation modes.

a) The A/V contractor shall schedule a meeting to coordinate with the Owner and lighting control contractor for desired scene presets.

3) A master dimmer shall be provided.

4) This defines only the basic integration requirements.

5) Refer to the Electrical Lighting Integration Section 26 09 33 for additional information.

p. Occupancy Sensor Integration:

1) Sensors shall be integrated into the A/V control system via 0-10V analog signal, digital logic level, or proprietary control signal, with the following minimum functions:

a) When the sensor(s) first sense motion, the touch panel shall automatically activate and light up.

b) When the sensor(s) stops sensing motion after the defined time limit, a warning message shall pop up on the touch panel warning the user that the room will automatically go into standby mode.

(1) An override button shall be present during the duration of the warning message to reset the time limit.

(2) If the warning is not acknowledged, the system shall enter a standby mode.

c) If more than one sensor is in a single space, all sensors shall read the same status before their intended function is performed.

B. Programming and Configuration for Touch Panels:

1. This section only defines the minimum requirements. The programmer shall provide complete touch panel layouts and programming for a fully functional system.

2. The Contractor shall schedule a series of meetings with the Owner and Engineer to define and determine the exact touch panel layout requirements prior to the purchase and installation of the touch panels. An Owner sign-off of the final layouts shall be required.

a. Some tabs, pages, buttons and functions may be required to have a password at the Owner's discretion. This shall be coordinated during the meetings.

3. Contractor logos are not allowed on the touch panels. The Contractor shall coordinate with the Owner on desired logos to be displayed.

4. All programming for interface and control of all devices shown on the drawings shall be provided. Programming shall be provided for the following minimum functionality:

a. The main screen shall include graphical buttons for the primary room functions.

1) Upon selection of the graphical button, all the required functions shall be displayed on the screen. All required equipment shall turn on.

b. Master System On/Off Control:

1) When the master system off button is selected, all capable components within the system shall be turned off or placed on standby, with the exception of equipment that is required to remain on for the system to function like the control system processor.

c. The main screen shall include graphical buttons for the selection of individual source selections.

1) Upon selection of the graphical button for a source selection, all functional controls for the pieces of equipment, as well as all status indicators, shall be provided in graphical format on the screen.

2) Rooms with multiple independent outputs and displays shall have a source routing matrix to allow any input to be routed to any output.

d. The main screen shall include a button for advanced equipment status and monitoring.

1) Upon selection of the graphical button, the page shall display the on/off status of all monitored equipment, projector lamp hours, projector filter status, and all other features listed within this section that require monitoring.

e. The main screen shall include a button for microphone volume control and muting.

1) Upon selection of the graphical button, it shall display the individual volume level of each wired and wireless microphone, with a mute for each.

2) Rooms with multiple independent audio outputs and zones shall have a source routing matrix to allow any input to be routed to any output or zone.

f. At all times, on all screens, a button shall be provided to return to the main screen, with the exception of modal pop-ups.

g. A master volume control and mute shall be provided at all times on all screens, with the exception of modal pop-ups.

h. A master video mute shall be provided at all times on all screens, with the exception of modal pop-ups and audio-only functions.

i. A modal countdown timer shall be displayed showing the warmup and cooldown time of the projector. All functions shall be locked out while the projector is in cooldown mode.

j. All unused hard buttons shall not be labeled. A blank touch panel bezel shall be provided if no hard buttons are used.

C. Touch Panel Layout Principles, Considerations and Guidelines:

1. Icons and Buttons:

a. Icons shall not be used solely as a button but can be embedded in a button.

b. Icons shall appear to be flat and unpressable.

c. Status bars or text windows for time, date, room number, and similar information shall appear to be slightly depressed into the screen and appear to be unpressable.

d. Buttons shall appear to be pressable by appearing to come off the screen with beveled edges, lighting gradients, and shadows. When pressed, the button shall appear to be depressed into the screen.

1) Buttons that are momentary shall change color when pressed, appear to depress, then pop back up and revert to the original button color and state.

2) Buttons that are not momentary shall change color when pressed, appear to depress, remain depressed, then pop back up, and revert to the original button color and state when pressed again.

e. Buttons and icons shall appear to be lit from the top left corner of the screen.

f. Buttons shall be grouped together according to general function.

g. Button size shall be based on the ratio of Phi (1:1.618) and be sized appropriately based on the screen area and dpi (pixel pitch).

h. Maintain a minimum of 5 to 10 pixels between buttons on small to medium touch panels, and a minimum of 10 to 15 pixels between buttons on medium to large touch panels.

i. Telephone dialer keypads shall be based on the ITU-T E.161/ANSI TI-703 standard telephone layout and include the a-z letters below each appropriate number.

j. TV and radio tuner keypads shall be based on the ITU-T E.161/ANSI TI-703 standard telephone layout, with the exception of the asterisk (*) being replaced by a dot (.) and the pound (#) being replaced with Enter.

k. IP-address keypads shall be based on the standard computer keyboard 10-key numeric keypad typically found on the right side of the keyboard.

l. Buttons such as Power, Play, Stop, Record, Rewind, Previous, Forward, Eject, Return, Next, Up, Down, Left, Right, Plus, Minus, etc. shall use standard industry symbols. Record shall always be a solid red circle.

2. Text and Fonts:

a. The Contractor shall used a standard sans-serif bold **Arial** or **Calibri** font style unless the Owner dictates otherwise.

b. Words shall have the first letter capitalized and the rest of the word lower case. No words shall be all capitals or all lower case. Follow standard grammatically correct sentence structure where the first word is capitalized and the rest of the sentence is lower case, followed by the appropriate punctuation mark with accurate syntax and correct verbs.

c. All font size in a single group or cluster shall maintain the same font size. Headers to a group or cluster shall have a slightly enlarged font size. and footers shall have a slightly smaller font size in comparison to the group font size to maintain a visual hierarchy.

3. Color Considerations:

a. Colors shall be selected so that, when converted to monochrome, all text, buttons, icons, groups, clusters, borders, etc. are clearly visible to accommodate all color blind or color-impaired individuals and ADA requirements.

b. Background colors shall be cool low saturation colors such as grey, blue, or green and their analogous colors, and be a gradient from top down or top left to bottom right.

c. Base colors shall be analogous to the background color but be of a higher saturation to stand out more clearly.

d. Button colors shall be analogous to the background color, stand out clearly from the base colors, and be of a higher saturation cool color, gray, or a low saturation black.

e. Icon, symbols, and text color shall be a neutral white or black, or a low saturation grey, and shall clearly stand out from the background or button it is placed on.

f. Buttons for modal acknowledgement, exit or return, or other modal action shall be a warm color such as red or yellow and their analogous colors.

g. Buttons, icons, symbols or text for emergency or urgent notifications shall be bright red.

4. Pages and Background:

a. Groups and clusters shall have clearly defined borders, with spacing between adjacent groups.

b. Modal pop-up windows or pages shall be required when a command requires user input before it is executed or when a button has multiple nested elements to control, such as microphone volumes, zone control, lighting and environment control, advanced system controls, etc.

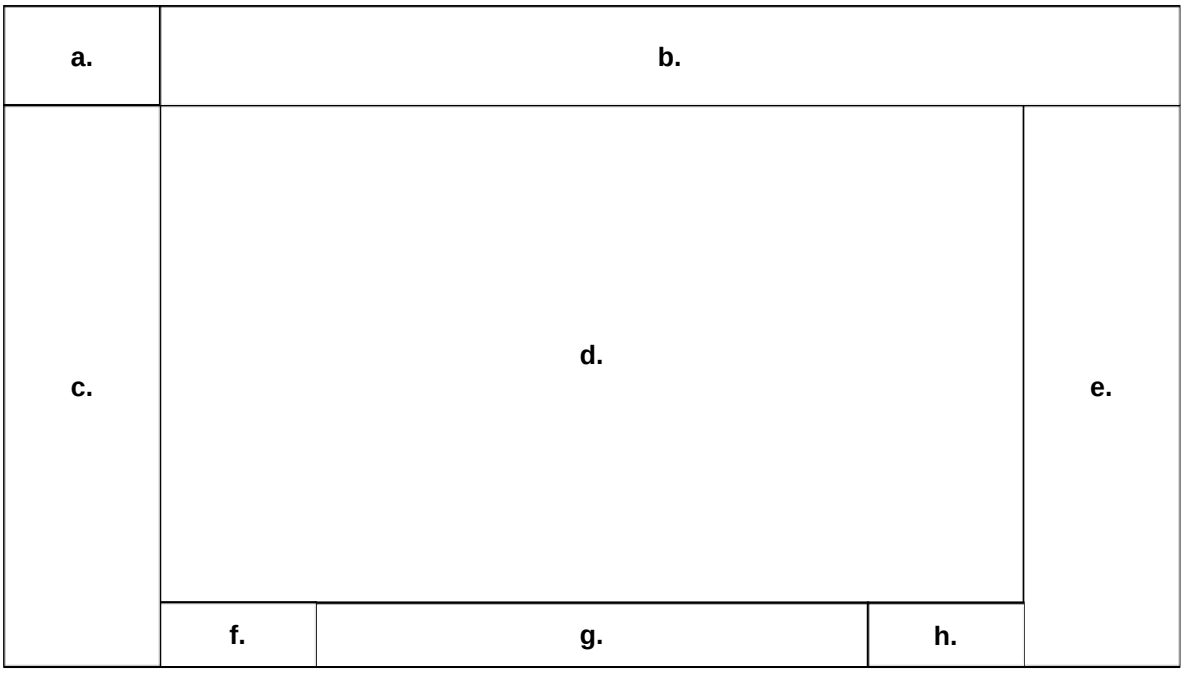
1) The modal pop-up pages shall dim and grey out the background and buttons, overlay the main page, and have a clear back or exit button to bring the user back into the active page the user was on before the modal pop-up.

2) A model pop-up timer page shall appear when a projector is being turned on or off for the appropriate warmup or cooldown time. No additional commands shall be allowed during this time.

3) Model pop-ups shall not replace or completely overlay the background.

c. Images or pictures shall never be used as backgrounds to any page other than a master start page, if appropriate.

5. Medium to Large Format Touch Panel Layout Guideline Template:



a. Client Logo – Static Window

b. A/V Source Selection – Static Window

c. Display Power, Screen Controls, Light Controls, Shade Controls, and other Environmental Controls – Static Window

d. Controls for Selected Source and Status or Home Page – Dynamic Window

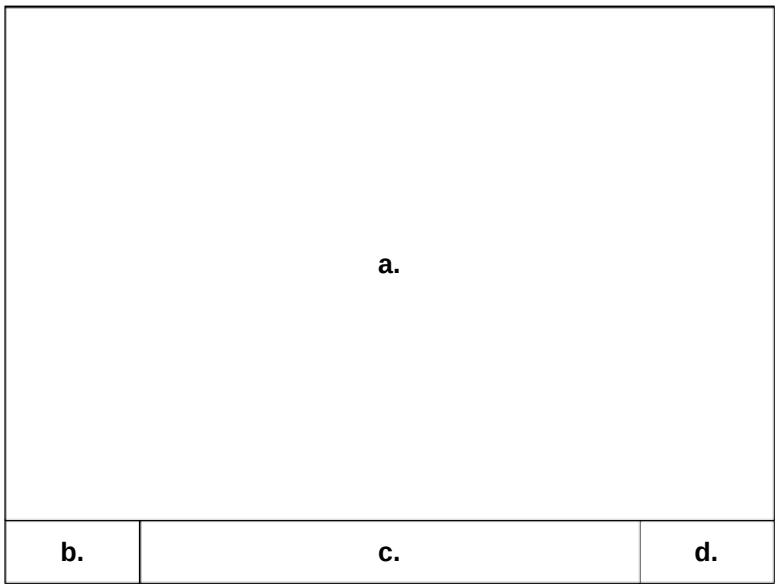
e. Master Volume and Mute, Video Mute, and Microphone Volume – Static Window

f. Home Button – Static Window

g. Date, Time, and Room Number – Static Window

h. Master System Off – Static Window

6. Small Format Touch Panel Layout Guideline Template:



a. A/V Source Selection and Source Control and Status After Selection – Dynamic Window

b. Home Button – Static Window

c. Date, Time, and Room Number – Static Window

d. Master System Off – Static Window

D. Programming and Configuration for Keypads:

1. This section only defines the minimum requirements. The programmer shall provide complete keypad layouts and programming for a fully functional system.

2. Full system programming and configuration shall be provided for the system. Programming and configuration shall be performed by a factory-trained and certified programmer or an employee of the equipment manufacturer.

3. This section only defines the minimum requirements. The programmer shall provide complete programming and configuration for a fully functional system.

4. The Contractor shall utilize the latest version of the programming and configuration software.

5. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.

6. All programming and configuration for interface and control of all devices shown on the drawings shall be provided. Programming and configuration shall be provided for the following minimum functionality:

   a. A master system on and off button.

      1) All capable components within the system shall be turned off or placed on standby when the system is selected to be off.

   b. A master volume control up/down buttons or knob and a mute

   c. Source select or source toggle button(s).

   d. TV channel up and down control.

   e. All unused hard buttons shall not be labeled.

3.11 CENTRALIZED CONTROL SYSTEM ASSET MANAGEMENT SOFTWARE PROGRAMMING

A. A Centralized Control Asset Management System shall be provided to integrate all IP-based control systems for remote control, monitoring, troubleshooting and statistics.

B. The workstation(s) and/or server(s) shall be Owner provided and Owner installed. The Contractor shall provide, install, and program all software specified and required. The Contractor shall coordinate with the Owner on the Owner's preferred operating system, antivirus, and all other required software to be installed on the workstation(s) and/or server(s). Refer to manufacturer recommendations for computer workstation and server requirements and ensure the Owner is aware of and complies to these recommendations.

C. The Contractor shall coordinate with the Owner on the location of the preferred file server for the central database files to which the workstations will connect.

D. The Centralized Control Asset Management System shall be on the same dedicated Virtual LAN and subnetwork as the control systems. The Contractor shall coordinate these requirements with the Owner prior to installation.

E. The Contractor shall provide, install and configure the software on up to three (3) workstations of the Owner's choosing.

F. The system shall be based on Crestron's latest version of RoomView Express.

G. Crestron's e-Control 2 XPanel IE and XPanel EXE emulators shall be provided for remote control of all Crestron-based touch panels and keypads.

   1. The Contractor shall provide, install and configure the software on up to three (3) Windows based workstations of the Owners choosing. The software shall be provided for the Owner to load onto additional workstations as required after completion of the project.

   2. The exact look and labeling scheme for each touch panel and keypad shall be programmed and provided including, but not limited to, subpages, annotations and pop-ups.

H. The Contractor shall include Crestron's e-Control 2 XPanel PDA emulator for Windows-based PDAs and smart phones.

   1. The Contractor shall provide, install and configure the PDA software on up to three (3) Windows based PDA's and smart phones of the Owners choosing. The software shall be provided for the Owner to load onto additional PDA's and smart phones as required after completion of the project.

2. A similar "slimmed down" look and labeling scheme for each touch panel and keypad shall be programmed and provided.

I. A series of meetings shall be scheduled by the Contractor with the Owner, Engineer, and control system manufacturer to determine all required functions, reports, and statistics to be utilized. An Owner sign-off of the final layouts and configuration shall be required. At a minimum, provide the following:

1. Hardware polling for system diagnostics.
2. Processor “on line” status.
3. Rooms system on/off status.
4. Display presence.
5. Display on/off status.
6. On/off switching capabilities with log of devices used.
7. Which devices are in use.
8. Event/error codes.
9. Lamp status.
10. Equipment fault or out of tolerance status
11. Filter status.
12. Room scheduling with on/off control of system.
13. Status of lights in room (if applicable).
14. Motion detection in room (if applicable).
15. Log of audio and video conference numbers and IP addresses.
16. Reporting features would be included for the following:
    a. Lamp life.
    b. Room system usage.
    c. Device usage.

3.12 SYSTEM COMMISSIONING

A. The Contractor shall notify the Engineer and Owner prior to conducting final system commissioning.

B. Contractors’ tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 09 00 - General Commissioning.

C. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 09 00 - General Commissioning, for system verification tests and commissioning requirements.

D. Contractor shall demonstrate system performance of all equipment and adjust settings as directed by the Engineer and/or Owner.

1. All system settings, software options and other parameters shall be simulated and tested by the Contractor

3.13 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications, as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the Contract Documents.

3.14 FIELD SERVICES

A. The installer shall conduct a planning meeting with the Owner. The purpose of this meeting shall be to determine all equipment settings that are considered preferences (where proper system operation does not depend on the setting).

B. The installer shall include labor for all planning and all programming activities required to implement the Owner's preferences for equipment settings.

C. It shall be the responsibility of the Contractor/installer to provide a complete, functional system as described by the design documents. These responsibilities include:

1. Complete hardware setup, installation and wiring and software configuration.

2. Complete programming of software in accordance with the Owner's desires determined by the planning meeting.

3. Complete system diagnostic verification.

4. Complete system commissioning.

3.15 SYSTEM ACCEPTANCE

A. The Contractor shall submit for review a formal acceptance and system checkout procedure. The system checkout procedures shall include all system components and software. The Contractor shall perform the tests and settings and document all results.

3.16 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided for the system. The documentation shall describe:

1. All operational parameters of the system.
2. Complete documentation of programming and features.
3. Complete operating instructions for all hardware and software.

B. The following sections shall be provided in the system documentation:

1. User Manual: A step-by-step guide and instructions detailing all system user functions.

2. Technical Manual: A comprehensive document providing all system operations, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.

3. Maintenance Manual: A comprehensive document on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning, filter changing and UPS maintenance.

C. Intellectual Property Ownership:

1. All intellectual property shall remain in escrow for an unlimited period of time. Should the integrator and/or programmer liquidate or fail to maintain applicable services, all latest versions of the supporting documentation, programming, uncompiled source code, graphic files, DSP code and diagrams, written and electronic files, including all documentation and software necessary to edit and adapt the system(s), shall be provided to the Owner at no charge.

   a. A written release shall be given by the integrator and/or programmer and all other required parties for all programming done by the personnel or subcontractors for the project. This release will acknowledge the client's ownership and right to modify the intellectual property directly, or to have the intellectual property modified by any party of the Owner's choosing.

3.17 SYSTEM TRAINING

A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.

1. Provide two week's advanced notice of training to the Owner and Engineer.

2. The Engineer shall be presented with the option to attend the training.

3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

B. At a minimum, the following training shall be conducted:

1. User Manual: A course detailing the system functions and operations that a daily user will encounter.

2. Technical User: Provide configuration training on all aspects of the system(s), including equipment and software.

3. Maintenance User: Provide training on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning and filter changing.

C. Minimum on-site training times shall be:

1. User Manual: One (1) day.

2. Technical user: One (1) day.

3. Maintenance user: Four (4) hours.

4. The Contractor shall include in his/her bid one (1) additional day of training each quarter for the 12-month period of the project warranty. The Contractor shall return to the site for additional follow-up training during this period.

END OF SECTION

SECTION 27 51 19
SOUND MASKING SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Sound Masking Equipment

1.2 RELATED WORK

A. Section 26 05 33 - Conduit
B. Section 26 05 35 - Surface Raceways
C. Section 26 05 13 - Wire and Cable
D. Section 26 05 31 - Boxes
E. Section 27 05 00 - Basic Communications Systems Requirements
F. Section 27 05 03 - Through Penetration Firestopping
G. Section 27 05 26 - Communications Bonding
H. Section 27 05 28 - Interior Communication Pathways
I. Section 27 15 00 - Horizontal Cabling Requirements
J. Section 27 05 53 - Identification and Administration

1.3 QUALITY ASSURANCE

A. Manufacturer: The manufacturer shall have five (5) years documented experience.

B. Installer: The installing dealer must be a factory-authorized service and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.

1. The Contractor shall own and maintain all tools and equipment necessary for successful installation and testing of the system and have personnel adequately trained in the use of such tools and equipment

C. Service: The manufacturer of the system must have local service representatives within 60 miles of the project site.

D. The entire installation shall comply with all applicable electrical and safety codes. All applicable equipment shall be listed by Underwriters' Laboratories, Inc.

1.4 REFERENCES

A. ADAAF - Americans with Disabilities Accessibility Guidelines

B. ANSI S1.4 - American National Standard Specifications for Sound Level Meters

C. ANSI S1.6 - American National Standard Specifications for Preferred Frequencies and Band Numbers for Acoustical Measurements

D. ANSI S1.11 - American National Standard Specifications for Octave-Band a Fractional-Octave-Band Analog and Digital Filters

E. ASTM E 1041-85 - Standard Guide for Measurement of Masking Sound in Open Offices.

F. ASTM E 1130-02 - Standard Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index.

G. ASTM E 1374-93 - Standard Guide for Open Office Acoustics and Applicable ASTM Standards.

H. ASTM E 1573-02 - Standard Test Method for Evaluating Masking Sound in Open Offices Using A-Weighted and One-Third Octave Band Sound Pressure Levels.

I. NFPA 70 - National Electrical Code.

J. UL 813 - Standards for Commercial Audio Systems

K. UL 1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use

1.5 SUBMITTALS

A. Submit product data under the provisions of Section 27 05 00.

B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item.

2. All component options and accessories specific to this project.

3. Electrical power consumption rating and voltage.

4. Wiring and connection requirements.

5. Manufacturer's installation instructions, indicating application conditions and limitations of use as stipulated by product testing agency and instructions for storage, handling, protection, examination, preparation, installation, and initiating usage of product.

C. System Drawings: Project-specific system CAD-generated drawings shall be provided as follows:

1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical speaker zones), the diagram may show one device and refer to the others as "typical" of the device shown.

2. Where applicable, an equipment rack plan shall be provided showing rack elevations and dimensions in plan and elevation view. The plan shall include equipment layout within the rack.

D. Provide voltage drop calculations for each speaker cable circuit or run, showing the drop for the specific circuit or run wattage and cable size used.

E. Provide list of test equipment proposed for use in testing the installed system.

F. Quality Assurance:

1. Provide materials documenting experience requirements of the manufacturer and installing contractor.

2. Provide system checkout test procedure to be performed at acceptance, including demonstration of specified performance and all required system features and functions listed herein and as further detailed on the drawings.

G. Coordination Drawings:

1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under the provisions of Section 27 05 00.

B. Store and protect products under the provisions of Section 27 05 00.

1.7 SYSTEM DESCRIPTION

A. This section describes the furnishing, installation, commissioning and programming of a complete, turnkey sound masking system.

B. Performance Statement: This section and the accompanying design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed or every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming, and miscellaneous equipment required for a complete and operational system.

C. This Contractor shall furnish and install a sound masking system as hereinafter specified and further detailed on the drawings. System shall be completely wired and ready for use including, but not limited to, outlet boxes, conduit, wire, equipment, speakers, controls, and equipment cabinets.

D. Basic System Requirements: The system shall be capable of providing the following minimum features in addition to those specified elsewhere in this section and on the drawings:

1. Multi-zone paging system, capable of expanding the quantity of zones by the addition of modular components. System-wide and zone-wide background music from audio source located at equipment head end.

2. Field-configurable priority override hierarchy for signal source inputs.

3. Individual volume control for each zone.

1.8 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 05 00.

B. Provide floor plans identifying actual locations of all installed overhead paging system equipment and devices.

C. Provide final system block diagram showing any deviations from shop drawing submittal. Block diagram shall include cable number documenting the numbers installed on both ends of the cable in the field.

D. Provide documentation of all test results and a statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described herein.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 27 05 00.

B. Operation and Maintenance Data shall be submitted in hard copy and electronic .pdf format.

C. Operation data shall include:

1. Manufacturer's full operation instructions for each piece of equipment.

2. Complete documentation of all settings and programming.

3. Detailed, step-by-step instructions for system operation, including accessing, initiating, and performing all required system features and functions listed herein.

D. Maintenance data shall include:

1. Description of servicing procedures:

a. Documentation of all manufacturer's recommended preventive and remedial maintenance procedures to be performed by the Owner.

b. Troubleshooting flowcharts.

2. Spare parts list.

1.10 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after Substantial Completion, as defined by the Contract. Certain system components may require additional manufacturer's warranty as described.

B. The warranty shall:

1. Ensure that all approved devices, equipment, cabling, and other components specified in this section meet or exceed the specified requirements.

2. Ensure against product defects.

3. Cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

4. Include emergency service and repair on site, with response times of 48 hours from time of notification. The system shall be repaired and restored to operation within 72 hours of technician's arrival on site.

C. Refer to the individual product sections for further warranty requirements of individual system components.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers indicated are for the main system components as noted on the riser diagrams on the drawings. Refer to the Material List on the drawings for acceptable manufacturers of additional equipment.

1. Cambridge Sound Management.
2. Speech Privacy Systems

2.2 SOUND MASKING EQUIPMENT

A. The sound masking equipment shall have the following features and functions:

1. The loudspeakers shall be direct field, radiating directly into the space.

2. All loudspeakers shall be directly powered and managed by a controller.

3. The sound masking system shall have controllers that power one or more individually controllable zones. The system shall provide:

   a. One or more rack or wall-mounted controllers, each with one or more zones and one or more line level audio inputs.

   b. Four uncorrelated noise sources per zone. The signals to adjacent loudspeakers shall be uncorrelated.

   c. Direct field loudspeakers that automatically sequence the four noise channels and that are mounted either in office ceiling tiles or other enclosures.

   d. Category 3/5/6 pre-terminated cable assemblies.

4. Output adjustment on independent channels equalized on a separate 1/3rd octave band equalizer. Octave bands for the sound generator shall range from 25 to 20,000 Hz.

5. Head end music/paging interface that shall be field selectable.

B. System Processor/CPU: All system programming shall be retained in nonvolatile RAM,

C. Basis of Design: Cambridge Sound Management QtPro 3/6.

2.3 CABLING

A. Cables terminated with RJ45 modular connectors.

1. Type: CAT3 provided with system: CAT5/5A, CAT6 are compatible.

2. Unshielded solid twisted pair construction; stranded optional.

3. Meet EIA/TIA Standard 568b.

4. Optional AWG #24 stranded conductors with overall plenum-rated jacket (CMP (UL)/C(UL) 4PR 24 AWG Plenum).

2.4 NON-CONTINUOUS CABLE HANGERS AND SUPPORTS

A. Refer to Section 27 05 28 for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with all manufacturer's instructions and recommendations for installation of all equipment, devices, and materials.

B. Provide a privacy index appropriate for the utilization of the space defined as follows:

1. Confidential Privacy: Privacy Index from 85% to 100%.

C. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

D. Wiring:

1. Refer to Section 26 05 33 for conduit requirements and Section 26 05 13 for additional wiring requirements. Wiring not installed in conduit shall be plenum rated.

2. All cabling shall be run "free-air" in non-continuous cable supports or cable tray above accessible ceilings, and in conduit or in a secured metal raceway in exposed areas. Supports shall be spaced at a maximum 4-foot interval. If cable "sag" at mid-span exceeds 6 inches, another support shall be used.

3. All sound masking system audio cabling including, but not limited to, speaker, line-level audio, and microphone-level audio cabling, shall be installed in its own cable pathway and shall not share any raceway or cable pathway with telephone or computer network cabling or cabling of any other system.

4. Cable shall not be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires. Cables shall not be attached to or supported by existing cabling, plumbing or steam piping, ductwork, ceiling supports, electrical or communications conduit, or structural elements.

5. Manufacturer's minimum bend radius specifications for cables shall be observed in all instances.

6. All cable shall be installed at right angles and be kept clear of work by other trades. To reduce or eliminate EMI, the following minimum separation distances from $\leq$ 480V power lines shall be adhered to:

   a. 12 inches from power lines of $<$ 5-kVa
   b. 18 inches from high voltage lighting (including fluorescent)
   c. 39 inches from power lines of 5-kVa or greater
   d. 39 inches from transformers and motors

7. All cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

8. All cable shall be free of tension at both ends.

9. Both ends of all cables shall be clearly labeled with an alphanumeric identifier. On speaker cables, the label shall indicate the speaker cable circuit zone or run and the telecommunications room in which the zone or run initiates. On line-level cables, the label shall indicate the signal and signal source. Record all speaker cable identifiers on record drawings.

10. No acid core or other corrosive flux solder shall be used in this system.

E. Equipment:

1. Equipment shall be mounted in shared racks as shown on the drawings.

2. All necessary devices, sub-components, accessories, and incidental materials required to provide a complete, turn-key paging system that provides specified performance, and all required system features and functions listed herein and as further detailed on the drawings, shall be provided and installed as part of a complete system.

3. Install all head end equipment and devices in a manner that allows ample airflow for cooling.

4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate tools recommended by the manufacturer for that purpose. Use caution to avoid stripping or damaging connectors, terminals, or equipment by over-tightening termination fasteners.

5. The conductor color code used in terminating system cabling at system equipment and devices shall remain consistent from device to device for each unique device type throughout the project.

F. Speaker Installation:

1. Sound masking speakers shall be mounted in acoustic tile with appropriate tile support or support cabling fixed to above structure.

2. Speaker spacing shall not exceed 12' in any direction unless otherwise noted.

3. Unforeseen field coordination between trades may require speakers to be located other than shown on the drawings. Contractor shall adjust locations as required as follows:

a. Speakers must be at least 4' from any return air grille in a suspended ceiling.

b. Speakers must be at least 2' from an air duct or structural beam.

c. Speakers must not impede access clearance to other equipment.

d. Speakers must be at least 4' away from any light fixture that has more than a 2" exposed opening to the plenum (AFTER the fixture is installed).

e. Grounding Requirements:

1) Furnish and install a minimum #6 AWG bonding conductor from each sound masking system head end component to the nearest wall-mounted telecommunications grounding busbar. Actual bonding conductor size determined by its length. Refer to Section 27 05 26 for grounding and bonding conductor sizing criteria.

2) Audio cable shields for line level signals shall be connected to the metal equipment chassis at both ends of the cable. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.

3.2 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.

C. Periodic observations will be performed during construction to verify compliance with the requirements of the project documents. These services do not relieve the Contractor of responsibility for compliance with the project documents.

D. System Setup and Checkout: The installed system shall be a complete and operating system. The Contractor shall provide all incidental materials required for a complete and operating system. The Contractor shall provide all system startup, testing, balancing, tuning, and satisfactory system performance as part of the requirements of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting and final adjustments that may be required.

3.3 SYSTEM SETUP, PROGRAMMING, AND ADJUSTMENT

A. Complete all necessary programming to provide the indicated functionality.

3.4 TESTING

A. Under no circumstances shall the Contractor turn the system on without having all level controls turned off and providing notification to all building occupants in advance.

B. The Contractor shall conduct all system testing as part of the requirements of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments or corrective action that may be required to provide a complete system that provides the specified performance and all required system features and functions listed herein and as further detailed on the drawings.

C. At a minimum, the installer shall perform the following inspections and tests of the installed overhead paging system:

1. Verify that all features and functionality are operating properly.

2. Verify that the system receives signal from all sources and routes those signals as specified.

3. Verify that priority override hierarchy functions properly.

4. Verify specified paging sound level at each speaker

5. Verify that all controls are properly labeled and interconnecting wires and terminals are identified.

D. Document all test results and submit as part of final system documentation package.

E. Final Acceptance Test:

1. Provide a minimum of one week notice of testing date to Owner. Document tests performed, adjustments made, and final testing status.

2. Testing shall not commence until all interior finishes and furnishings are installed. Testing shall be finished prior to occupants occupying the space.

3. Testing shall be provided at not less than 20 test positions per 50,000 of finished floor space.

4. Record all test methods, observations, results, equipment reading and corrective actions.

5. Test, per zone, to the following:

Band	Open Areas (SPL)	Enclosed Areas (SPL)
200 Hz	+2.5	-2
250 Hz	+3	-2

Band	Open Areas (SPL)	Enclosed Areas (SPL)
315 Hz	+2	-2.5
400 Hz	+1	-3
500 Hz	0	-4
630 Hz	-1	-5
800 Hz	-2	-6
1000 Hz	-3	-7
1250 Hz	-4	-8.5
1600 Hz	-5	-10
2000 Hz	-6	-12

a. Masking level shall be adjusted for each zone to ensure that 1/3 octave band centered on band noted above has the final selected sound power level for that zone.

b. Deviation from the listed values in 1/3 octave bands from 400 to 2000 Hz shall be measured. Measured values shall not deviate from those listed by > 4 dB for open areas and > 8 dB for enclosed areas. The total of individual band deviations in eight bands shall not exceed > 16 dB for open areas and > 30 dB for enclosed areas.

6. Temporal Stability Test: Check for uniformity to the defined performance requirement stated herein.

7. Correct deficiencies as required, as identified by tests, and retest until performance requirements have been met.

8. Record all final settings, programming, tap settings and other configuration parameters.

9. Record all final sound level measurements and observations.

3.5 TRAINING

A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.

B. Provide two week's advanced notice of training to the User.

C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

D. At a minimum, the following training shall be conducted:

1. Users:

a. Provide training on the system functions and operations that a daily user will encounter, including navigation of the user interface to accomplish common operations.

2. Maintenance Staff:

a. Provide training on the system functions and operations that a daily user will encounter, including navigation of the user interface to accomplish all common operations.

b. Provide training on all system components and the basic configuration of the system.

c. Identify and describe preventive and remedial maintenance procedures to be performed by the Owner.

d. Review troubleshooting flowcharts and describe troubleshooting procedures for common issues.

E. Minimum on-site training times shall be:

1. Users: Two (2) hours.

2. Maintenance Staff: Two (2) hours.

END OF SECTION

SECTION 28 05 00
BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.

1.2 SCOPE OF WORK

A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the security systems as shown on the drawings and specified herein.

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

C. Description of systems include but are not limited to the following:

1. Electronic Access Control System

2. Video Surveillance

3. Fire Detection and Alarm

4. Low Voltage Security Wiring (less than +120VAC) as specified and required for proper system control and communications.

5. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the “Suggested Matrix of Scope Responsibility”.

6. Firestopping of penetrations of fire-rated construction as described in Specification Section 28 05 03.

1.3 WORK SEQUENCE

A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.

B. The successful Bidders shall be responsible for scheduling overtime hours for the following work:

C. Successful Bidders shall itemize all work and list associated hours and pay scale for each item.

1.4 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.

2. “Electrical Contractor” shall also refer to the Contractor listed in Division 28 of this specification when the “Suggested Matrix of Scope Responsibility” indicates the work shall be provided by the EC. Refer to the Contract Documents for the “Suggested Matrix of Scope Responsibility”.

3. “Security Contractor” as referred to herein refers to the Contractors listed in Division 28 of this Specification.

4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.

C. General:

1. The purpose of these Specifications is to outline typical Electrical and Security Contractor's work responsibilities as related to Security Systems including conduit, power wiring and Low Voltage Security Wiring. The prime contractor is responsible for all divisions of work.

2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Security Drawings but required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor’s bid.

3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.

4. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Security Wiring, the installation shall not begin until the Security Contractor has completed a coordination review of the cable tray shop drawing.

5. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:

   a. Lighting Fixtures
   b. Gravity Flow Piping, including Steam and Condensate
   c. Sheet Metal
   d. Electrical Busduct
   e. Cable Trays, including 12" access space
   f. Sprinkler Piping and other Piping
   g. Conduit and Wireway
   h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.

2. Responsible for Security Systems grounding and bonding.

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

E. Security Contractor's Responsibility:

1. Assumes all responsibility for the Low Voltage Security Wiring of all systems, including cable support where open cable is specified.

2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."

3. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of Security equipment which is required to be bonded to the telecommunications ground system.

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

1.5 COORDINATION DRAWINGS

A. Definitions:

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

a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

d. Maintenance clearances and code-required dedicated space shall be included.

e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

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

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.

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

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

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

C. Drawing Requirements:

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

a. Scale of drawings:

1) General plans: 1/4 Inch = 1 '-0" (minimum).

2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.

3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

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

2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.

8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

   a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.

   b. Potential layout changes shall be made to avoid additional access panels.

   c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

   d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

   e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.

2. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the installation, termination, testing, and placing into operation electronic security devices shall be individually trained by the manufacturer.

3. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.

4. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of electronic security devices and have personnel adequately trained in the use of such tools and equipment.

5. A resume of qualification shall be submitted with the Contractor's bid indicating the following:

   a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

B. Compliance with Codes, Laws, Ordinances:

1. This Contractor shall conform to all requirements of the City of Madison, WI Codes, Laws, Ordinances and other regulations having jurisdiction over this installation.

2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.

3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, the codes and regulations shall determine the method or equipment used.

4. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.

5. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

C. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.

3. Pay all applicable charges for such permits or licenses that may be required.

4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.

5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.

6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.

7. All equipment, and materials shall be as approved or listed by the following: (Unless approval or listing is not applicable to an item by all acceptable manufacturers.)

   a. Factory Mutual
   b. Underwriters' Laboratories, Inc.

D. Examination of Drawings:

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

2. Contractor shall determine the exact locations of equipment and the exact routing of cabling so as to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.

3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.

5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.

6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

E. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing MEP Revit.

2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

3. Upon request for electronic media, the Contractor shall complete and return a signed “Electronic File Transmittal” form provided by KJWW.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.

5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.

6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

F. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.7 SUBMITTALS

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

1. Submittals list:

Referenced Specification Section	Submittal Item
28 13 00	Electronic Access Control
28 23 00	Video Surveillance

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

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

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

   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses
   e. Supplier and manufacturer's names and addresses
   f. Division of work (e.g., plumbing, heating, ventilating, etc.)
   g. Description of item submitted (using project nomenclature) and relevant specification number
   h. Notations of deviations from the contract documents
   i. Other pertinent data
   j. Provide space for Contractor's review stamps

3. Composition:

   a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor's review shall include, but not be limited to, verification of the following:

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

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

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

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

b. The Contractor shall clearly indicate the size, finish, material, etc.

c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

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

a. Submittal file name: 28 XX XX.description.YYYYMMDD
b. Transmittal file name: 28 XX XX.description.YYYYMMDD

5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

D. Paper Copy Submittal Procedures:

1. Paper copies are acceptable where electronic copies are not provided.

2. The Contractor shall submit ten (10) paper copies of each shop drawing.

3. Each set shall be bound in a three-ring binder or presentation binder. Copies that are loose or in pocket folders are not acceptable.

1.8 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

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

C. Preparation:

1. Itemize the cost for each of the following:

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

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

   a. Contractor's own labor forces.
   b. All subcontractors.
   c. All major suppliers of products or equipment.

3. Break down all costs into:

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

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

   a. Security Systems
      1) Surveillance
      2) Access Control

D. Update Schedule of Values when:

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

1.9 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.

B. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:

1. Firestopping, including mechanical firestop systems.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.

B. Store materials on the site so as to prevent damage.

C. Keep fixtures, equipment and materials clean, dry and free from harmful conditions.

1.12 WARRANTY

A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.

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

C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.13 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.14 MATERIAL

A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.

B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured **in writing** from the Architect/Engineer not later than ten (10) days prior to the bid opening date. The Contractor bears full responsibility for the unnamed manufacturer's equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.1 REFER TO INDIVIDUAL SECTIONS

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.

D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 28 sections for further requirements.

2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.

3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.

4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.

2. Refer to the end of Section 27 05 00 for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."

3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.

2. Submitted bound copies of approved shop drawings.

3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.

4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.

5. Submitted testing reports for all systems requiring final testing as described herein.

6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.

7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; submit receipt to Architect/Engineer prior to final payment being approved.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies copies shall be distributed as directed by the Architect/Engineer.

2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

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

   a. O&M file name: O&M.div28.contractor.YYYYMMDD
   b. Transmittal file name: O&Mtransmittal.div28.contractor.YYYYMMDD

5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.

6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.

2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copy of final approved test and balance reports.

5. Copies of all factory inspections and/or equipment startup reports.

6. Copies of warranties.

7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

8. Dimensional drawings of equipment.

9. Capacities and utility consumption of equipment.

10. Detailed parts lists with lists of suppliers.

11. Operating procedures for each system.

12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

13. Repair procedures for major components.

14. List of lubricants in all equipment and recommended frequency of lubrication.

15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

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

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

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

D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.

E. Refer to the individual specification sections for minimum hours of instruction time for each system.

F. Operating Instructions:

1. The Contractor is responsible for all instructions to the Owner and/or Owner’s operating staff on the security systems.

2. If the Contractor does not have Engineers and/or Technicians on staff that can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM COMMISSIONING

A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to insure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer’s hourly rates in effect at the time of work.

D. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.

E. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.

C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

3.10 SPECIAL REQUIREMENTS

A. In accordance with LEED EQc4.1, Low-Emitting Materials - Adhesives and Sealants, all adhesives and sealants used on the interior of the building must comply with the following requirements:

1. Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.

2. Aerosol adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

3.11 CONSTRUCTION WASTE MANAGEMENT

A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).

1. This Contractor shall coordinate with the General Contractor to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.

2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor's scope of work. The Contractor shall provide this information to the General Contractor so that it can be incorporated with similar information from all other contractors for the project.

    a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the General Contractor to establish the preferred calculation method and report the results accordingly.

    b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.

END OF SECTION

SECTION 28 05 03
THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

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

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

1.3 REFERENCES

A. UL 723 - Surface Burning Characteristics of Building Materials
B. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
C. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
D. Intertek / Warnock Hersey - Directory of Listed Products
E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
F. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
G. The Building Officials and Code Administrators National Building Code
H. Wisconsin Administrative Code
I. 2009 International Building Code
J. NFPA 5000 – Building Construction Safety Code

1.4 SUBMITTALS

A. Submit under provisions of Section 28 05 00.

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

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

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

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

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

F. Submit VOC rating of firestopping material in g/L (less water) with documentation that it meets the limits set forth in SCAQMD Rule 1168.

1.5 DELIVERY, STORAGE, AND HANDLING

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

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

1.6 PERFORMANCE REQUIREMENTS

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

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

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

1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings**:**

    a. Floor penetrations located outside wall cavities.
    b. Floor penetrations located outside fire-resistance-rated shaft enclosures.
    c. Wall penetrations above corridor ceilings which are not part of a fire-resistive assembly.
    d. Wall penetrations below any ceiling that are larger than 4" diameter or 16 square inches.

3. L-Rated Systems: Provide through-penetration firestop systems with L-ratings of not more than 5.0 cfm/sq.ft. (0.0254 cu. m/s x sq. m) at both ambient temperature and 400°F (204°C) for smoke barriers.

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

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

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

F. In accordance with LEED EQc4.1, Low-Emitting Materials - Adhesives and Sealants, all adhesives and sealants used on the interior of the building must comply with the following requirements:

1. Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.

2. Aerosol adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

1.7 MEETINGS

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

1. Review foreseeable methods related to firestopping work.

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

1.8 WARRANTY

A. Provide one year warranty on parts and labor.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. 3M; Fire Protection Produces Division.
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk.
4. Tremco; Sealant/Weatherproofing Division.
5. Johns-Manville.
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Wiremold/legrand: FlameStopper

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

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

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

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

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

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

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

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

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated
   F Rating = Floor/Wall Rating
   T Rating = Floor/Wall Rating
   L Rating = Penetrations in Smoke Barriers

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

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated
   F Rating = Wall Rating
   T Rating = 0
   L Rating = Penetrations in Smoke Barriers

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

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated
F Rating = Wall/Floor Rating
T Rating (Walls) = 0 or Wall Rating
T Rating (Floors) = Floor Rating
L Rating = Penetrations in Smoke Barriers

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

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

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

3.2 INSTALLATION

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

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

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

3.3 CLEANING AND PROTECTING

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

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

3.4 IDENTIFICATION

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

1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."

2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

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

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

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

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

END OF SECTION

SECTION 28 13 00
ACCESS CONTROL SYSTEM (KEYSCAN)

PART 1 - GENERAL

1.1. SUMMARY

A. The City of Madison Information Technology Department has been assisting other City agencies with standardizing facilities through the use of access cards, key fobs, and punch pads. All hardware is installed locally at the facility while software controls access to various doors remotely.

B. These specifications describe the materials, equipment, and installation requirements to install an integrated, computerized access control and alarm monitoring system utilized by the City of Madison Information Technology (CoM-IT) Department.

C. The ACS System Contractor shall be responsible for verifying equipment requirements, locations, and coordination with the General Contractor and all other necessary trades as needed for a complete installation.

D. The ACS System Contractor shall be aware that the installation plans and specifications are for two (2) independent buildings on two (2) separate fire alarm systems and shall be wired as such. Refer to the Part 3-Exectuion for additional details.

1.2. RELATED SPECIFICATIONS

A. 01 31 23 Project Management Web Site
B. 01 33 23 Submittals
C. 08 71 00 Door Hardware
D. 14 21 00 Electric Traction Elevator
E. 27 05 00 Basic Communication Systems Requirements

1.3. RELATED DRAWINGS

A. Refer to all Electrical drawings for locations of distribution panels and equipment as it relates to standard line voltage locations.

B. Refer to all Technical drawings for locations of Access Control System (Keyscan) equipment.

C. Refer to the door hardware schedule and Architectural floor plans for information relating to door access locations and specific hardware requirements.

1.4. REFERENCES

A. The system shall comply with the standards, codes and regulations of the following regulatory bodies:
   1. Underwriters Laboratories (UL) Std No. 294 – Access Control System Units
   2. Canadian Standards Association (CSA) Std C22.2 No. 205-M1983 – Signal Equipment
   3. CE Standards
      a. EN 55022 RF Emissions
      b. EN 55024 RF Immunity
      c. EN 60950-1 Equipment Safety
   4. FCC Subpart B – RF Emissions
   5. Industry Canada ICES 003 Emissions
   6. RoHS

1.5. CONTRACTORS QUALIFICATIONS

A. The Contractor installing the ACS system shall:
   1. Be a Certified Keyscan Enterprise Partner
   2. Utilize installers who are Keyscan Enterprise Certified Technicians
   3. Be based within 25 radial miles of the project location
   4. Be able to provide 24/7/365 support during the warranty period of this project
   5. Be able to respond and repair or replace most components within 4 hours of notification

1.6. SUBMITTALS

A. The Contractor shall provide a complete submittal package in a timely manner to allow sufficient review time prior to ordering the system components required for a complete installation. The contractor shall be solely responsible for any equipment, purchased/ordered/delivered that is not approved of during the submittal review process.

B. The complete submittal package shall include but not be limited to the following:
   1. All certifications of the contractor and contractor's installation team. Certifications shall be current from the start of the contract through the end of the warranty period.
   2. Cut sheets indicating, shop drawings, performance data, and other such information that will indicate the component being installed matches the component that was specified.
   3. Cut sheets and shop drawing of Contractors recommendations for tags and labels.

1.7. WARRANTY

A. The Contractor shall warrant for one year the complete installation of equipment and components associated with this contract and installation. Contractors warranty shall be in the form of a written letter on company letterhead referring to the contract information, dates of installation and acceptance, signed by an authorized representative of the Contractors Company.
   1. The Contractors warranty shall include but not be limited to the following:
      a. Transportation to and from the location as often as needed during the warranty period.
      b. All labor and materials necessary to properly and thoroughly trouble shoot the system.
      c. All fees associated with the shipping of any component that needs to be returned or supplied by the manufacturer for repair or replacement.
      d. All labor and materials required to remove, repair, replace, or re-install any component.

B. The Contractor shall also provide all manufacturers warranties/guarantees associated with installed components of the completed installation.

1.8. QUALITY ASURANCE

A. The Contractor shall be responsible for coordinating his/her Work with other trades and divisions as needed for a complete installation. This shall include pre-installation meetings for locating equipment, conduit, cabling, control devices, and other materials and equipment required by this installation.

B. The General Contractor (GC) shall be responsible for ensuring that all doors requiring controlled access are properly prepared and installed per the contract documents. The GC shall further be responsible for ensuring all project coordination, pre-installation meetings, submittals and other such project management responsibilities are conducted efficiently and according to the project specifications and schedules.

PART 2 - PRODUCTS

2.1. EXISTING SYSTEM PRODUCTS OVERVIEW

A. The City of Madison Information Technology Department (CoM IT) owns and operates a fully licensed copy of the Keyscan Access Control System software.
   1. The Keyscan Access Control System (ACS) provides controlled access to secured doors and elevators through the use of electronic door latches, proximity readers, control panels, and a proprietary software program.
   2. The Keyscan software allows CoM-IT and the facility the Owner to customize multiple levels of access and system performance through any combination of the following:
      a. Calendar and time based lock/unlock controls
      b. Group access control for common personnel groups
      c. Individual access control for specialized access control
      d. Elevator access control for accessing/not accessing various floors
      e. Temporarily disable access control for a specified time period
      f. Remotely unlock/lock a door
      g. Lockdown a facility from one location
      h. Provide customizable alert notifications

2.2. NEW EQUIPMENT AND COMPONENTS

A. The Contractor guarantees that all equipment and components shall be furnished new, undamaged, free of defects, and conform to the drawings and specifications of this contract. The contractor is solely responsible for replacing any damaged or defective item.

B. New ACS components on interior and exterior access doors shall be able to be integrated with the Owners existing system.

2.3. DISTRIBUTION SUPPLY PANEL (AC-DS-1)

A. AC-DS-1 brings line voltage into the ACS system with the following performance specifications:
   1. Input
      a. 115VAC, 60Hz, 1.45A
   2. Output
      a. Eight (8) PTC protected outputs
      b. 16VAC output
      c. 16VAC @ 10amp (175 VA) supply current (1.25 amp per device, 2.5 amp max.)
      d. Outputs rated @ 2.5 amp
      e. Main fuse rated @ 15 amp/32V
      f. Surge suppression
   3. Miscellaneous electrical information
      a. Operating temperature 0^{o} C to 49^{o}C ambient
      b. 81.89 BTU/hr
      c. System AC input VA requirement 166.75 AV
   4. Miscellaneous required features
      a. AC power LED indicators
      b. Illuminated master power disconnect circuit breaker with manual reset
   5. Agency Approvals
      a. UL 294 listed for Access Control System Units
      b. CUL listed-CSA Standard C22.2 No 205-M1983 Signal Equipment

B. AC-DS-1 shall be:
   1. Altronix, AL168175CB
   2. Pre-approved equal

2.4. POWER SUPPLY PANEL (AC-PS-1)

A. The AC-PS-1 brings line voltage from the AC-DS-1, reduces then distributes the voltage to the Access Security Panels (AC-SEC-1) with the following performance specifications:
   1. Input
      a. 115VAC, 60Hz, 1.9A
      b. Power supply input options
         i. One (1) common power input for ACM8 and lock power (factory installed)

ii. Two (2) isolated power inputs; one (1) to power the ACM8 and one (1) for lock accessory power, (external power supply is required). Current is determined by the power supply connected, not to exceed a maximum of 10 amp total

c. Eight (8) Access control System trigger inputs with the following options:
i. Eight (8) normally open (NO) inputs
ii. Eight (8) open collector inputs
iii. Any combination of the above

2. Output
a. 12VDC or 24VDC @ 6 amp supply current
b. Eight (8) independently controlled outputs with the following options:
i. Eight (8) Fail-Safe and/or Fail-Secure power outputs
ii. Eight (8) form "C" 5 amp rated relay outputs
iii. Any combination of the above
c. Eight (8) auxiliary power outputs (un-switched)
d. Output fuses rated @ 3.5 amp
e. Filtered and electronically regulated outputs (built-in power supply).

3. Miscellaneous electrical information
a. Operating temperature 0^{o} C to 49^{o}C ambient
b. BTU/hr:
i. 12VDC = 36.85 BTU/hr
ii. 24VDC = 73.70 BTU/hr
c. ACM8 board main fuse is rated at 10 amp

4. Battery Backup
a. Built-in charger for sealed lead acid or gel type batteries
b. Power supply board maximum charge current 0.7 amp
c. Automatic switch over to stand-by battery when AC fails
d. Zero voltage drop when unit switches over to battery backup (AC failure condition)
e. Battery fail and battery presence supervision (form "C" contact)

5. Miscellaneous required features
a. Fire Alarm disconnect (latching or non-latching) is individually selectable for any or all of the eight (8) outputs.
b. Fire Alarm disconnect input options:
i. Normally open (NO) or normally closed (NC) dry contact input
ii. Polarity reversal input for FACP signaling circuit
c. Alarm output relay indicates that FACP input is triggered (form "C" contact rated @ 1 amp 28VDC)
d. Short circuit and thermal overload protection
e. AC fail supervision (form "C" contact)
f. Red LEDs indicate outputs are triggered (relays energized)
g. Green LED indicates FACP disconnect is triggered
h. AC input and DC output LED indicators
i. Enclosure accommodates up to two (2) 12AH batteries

6. Agency Approvals
a. UL 294 listed for Access Control System Units
b. CUL listed-CSA Standard C22.2 No 205-M1983 Signal Equipment

B. AC-PS-1 shall be:
1. Altronix, AL600ULACM
2. Pre-approved equal

2.5. SECURITY PANEL (AC-SEC-1)

A. The AC-SEC-1 distributes the reduced voltage and control wiring to/from each door with an access control device.

B. AC-SEC-1 shall be:
1. Keyscan CA8500 – 8 Reader Access Control Panel

C. The AC-SEC-1 shall be provided, located and mounted by the Contractor.

2.6. ELEVATOR FLOOR ACCESS CONTROL PANEL (EFACP)

A. The EFACP distributes the reduced voltage and control wiring to the elevator equipment for providing access control to specific floors while providing general public access to others.

B. EFACP shall be:
   1. Keyscan EC1500 – 1 Cab Elevator Floor Access Control Panel
C. The EFACP shall be provided, located and mounted by the Contractor in the elevator machine room (B11).
D. The EFACP requires two (2), 16.5 VAC, 37 or 40VA transformers to be supplied and installed by the Contractor.

2.7. DOOR CONTROL DEVICES

A. The Contractor shall be responsible for verifying the Door Control Device (DCD) quantities and locations with the door hardware schedule.
B. DCD shall be:
   1. Keyscan K-KPR – Keyscan Proximity Reader, this reader accepts swipe monitoring of cards, key fobs, and other such devices.
      i. Plan designation = AC-CR1-W and AC-CR5-W
   2. The K-KPR shall be used for all locations including the elevator cab.

2.8. DOOR CONTROL CABLES

A. The following cables are required for a complete installation of the ACS, per controlled door, as follows:
   1. One (1) 22/6 shielded cable, required; to DCD
   2. One (1) 18/2 un-shielded cable, required; lock power
   3. One (1) 22/2 un-shielded cable, required; door contact
   4. One (1) 22/4 un-shielded cable, required but not used; for future request to exit sensors
B. At the Contractors option he/she may run a manufactured cable bundle containing all four (4) cables listed above. It shall be the sole responsibility of the contractor to appropriately size the conduits for the installation.

PART 3 - EXECUTION

3.1. COOPERATION OF THE ACS CONTRACTOR

A. The Contractor shall be required to coordinate with all trades for a complete and timely installation. This includes attending all pre-installation meetings where equipment locations, conduit locations, and control devices will be installed or may be in conflict with the installation of other trades. The Contractor shall be solely responsible for any additional cost required for removing/replacing/modifying any completed work by other trades because the installation was not properly coordinated.
B. The Contractor shall coordinate with the Owners Representative from City IT for all information necessary to complete the installation and integration with the Owners existing hardware and software.
C. The Contractor shall verify with the appropriate Owners Representative for mounting heights of all hardware and equipment prior to installation. This shall be completed at a pre-installation walk through prior to rough-in.
D. The Contractor shall coordinate with the elevator equipment installer the location and wiring of the EFACP.
E. The Contractor shall coordinate with the Owner's Representative from City IT to verify all requirements for all access controlled doors are properly coordinated and understood prior to roughing in the installation.

3.2. GENERAL EQUIPMENT MOUNTING

A. All ACS equipment shall be mounted to the 3/4" AC fire rated plywood panels provided and installed by the General Contractor. Contractor shall tape out all equipment prior to mounting to insure adequate space is allotted for the complete installation per the riser diagrams including all related conduits and cables.
B. The EFACP shall be mounted to the 3/4" AC fire rated plywood panels provided and installed by the General contractor in the elevator Equipment Room. The General Contractor shall coordinate the location of the plywood panels with the Elevator Equipment Contractor and the ACS Contractor prior to installation.
C. All equipment shall be neatly arranged so as to meet or exceed the manufacturer's recommended working space around each component.
D. Equipment to be installed on plywood mounting panels shall include but not be limited to the following:
   1. Distribution Service Panel (AC-DS-1)
   2. Power Supply Panel (AC-PS-1)
   3. Access Control Panel (AC-SEC-1)
   4. Elevator Control Panel (EFACP), including transformers
   5. All required conduits, and boxes for line voltage

3.3. GENERAL CONDUITS AND WIRING

A. This section shall apply to both the ACS Contractor and the Electrical Contractor. The following division of responsibilities shall apply:

1. The Electrical Contractor shall be responsible for furnishing, installing, and connecting all conduits, connectors, conductors, and other related materials associated with providing line voltage to the ACS system as follows:
   a. Providing an 110V, 15A, dedicated circuit from the designated distribution panel to AC-DS-1 as described in Section 2.3 above.
   b. Providing line voltage from AC-DS-1 to AC-PS-1 as described in Section 2.4 above.
   c. Providing and installing the required 110V, 20A dedicated duplex outlet in the elevator Equipment Room (B11). Coordinate the location with the ACS Contractor and the Elevator Contractor.
2. The ACS Contractor shall be responsible for furnishing installing, and connecting all conduits, connectors, conductors and other related materials required to complete the installation of the low voltage wiring and door controller cabling.

B. All conduits shall be properly sized for the number of wires or wire bundles being pulled through the conduit. The Contractor shall verify with the manufacturer the recommended fill rate by conduit size and shall not exceed the recommendations.

C. The contractor shall neatly lay out all conduits in such a fashion so as to minimize bending, crossovers, etc.

D. Bends, pull boxes, and pull points shall be sized and located as per all applicable codes and standards for the number of wires or wire bundles in the bend, pull box, pull point.

E. CAT6 cables from each AC-SEC-1 and the EFACP shall be neatly run in cable management equipment supplied and installed by the cabling contractor or conduits supplied and installed by the ACS Contractor as needed. The switch to be used for all ACS equipment shall be located in Telecom Room 021. Cables shall be labeled on both ends per the cabling specification.

F. The General Contractor and the ACS Contractor shall ensure the following Emergency Access requirements are properly installed and operational prior to the final Madison Fire Department inspection for occupancy.
1. CoM IT shall provide a minimum of six (6) swipe cards to each installed Knox Box for emergency entrance. The cards shall be appropriately coded for entry at all controlled access doors.
2. The following doors shall be wired to unlock in the event of an emergency.
   a.

3.4. ACS CONTROL OF ELEVATOR EQUIPMENT

A. The contractor shall coordinate the installation of all required ACS equipment in the elevator Equipment Room with the Elevator Equipment Contractor and the Electrical Contractor.

B. The Elevator Equipment Contractor shall provide and install a 6 conductor, shielded 18 gauge cable between the elevator equipment and the elevator cab for use with the ACS control equipment.

C. The Contractor shall coordinate with the Elevator Equipment Contractor for locating and installing the DCD device (2.7. above) in the elevator cab and for coordinating all wiring between the two systems to attain the desired control specification (3.4.D. below)

D. Prior to programming the elevator controls, coordinate with the City Project Manager and the appropriate representatives from City IT, for final control parameters.

3.5. EQUIPMENT IDENTIFICATION AND LABLEING

A. The Contractor shall provide and install all equipment identification and labeling to the following specifications.
1. Tags and labels shall be permanent rigid plastic or metal tags with engraved or machine stamped lettering. Hand written self stick or metal hand stamped tags will not be accepted.
2. The Contractor shall work out the labeling scheme for doors with City IT, Owner, and Architect prior to ordering any labels or tags.
3. The Contractor shall provide all labels and tags associated with this specification. This shall include the line voltage feed to each AC-DS-1 from the electrical distribution panel.

B. Panels and Boxes
1. All panels and boxes shall be labeled on the outside cover that readily identifies the panel/box as a "Distribution Supply", "Power Supply", "Access Control Panel", "Elevator Floor Access Control Panel", etc. An associated number shall also be on each tag and the number "1" shall be used even if there is only one of that type panel/box.
2. Access Control Panels shall have a card index inside the front cover of each door indicating the controller number, door number, and door location being served by that panel.

C. Conduits
1. Line voltage from electrical distribution panels shall have conduits labeled on both ends as follows:
   a. At the distribution panel the line voltage conduit shall be labeled with the system supplied, and the ACS distribution supply panel number.

b. In the Telecommunications Room the line voltage conduit label shall indicate the distribution panel and circuit number(s) controlling the supply line.

2. Conduits between Access Control Panels and the controlled doors shall be labeled on both ends as follows:
   a. In the Telecommunications Room each conduit shall labeled with the door number(s) being supplied.
   b. Above the finished ceiling where the conduit is exposed prior to going into the wall space that serves the door the conduit shall be labeled with the Door Control Panel and Controller number associated with the door being served.
   c. If the conduit size is reduced as control cabling is supplied to doors along the run each change is conduit size shall be re-labeled as noted in 2.b. above.
3. Conduits between equipment and components in the Telecommunications Room do not need to be identified.

3.6. INSTALLATION TESTING AND ACCEPTANCE

A. The CoM IT and the Owner shall be responsible for completing all software programming associated with the installation of this contract prior to the completion of the installation of the system components. It is the sole responsibility of the Contractor to notify the Owner no less than two (2) weeks in advance of completing the installation that all codes and time setting shall be prepared for final installation and testing.

B. The Contractor, CoM IT, and the Owner shall test each access control point with swipe cards and PINs to insure the door unlocks.

C. CoM IT shall test each door using the existing fully integrated software. This shall include but not be limited to the following:
   1. Remotely lock/unlock the doors
   2. Verify time clock feature works for locking doors
   3. Verify swipe cards and PINs work on all doors
   4. Verify emergency entrance cards for knox boxes work on all doors for the areas served.

D. The Contractor, CoM IT, and the Owner shall test the elevator floor access functions as follows:
   1. With swipe cards and PINs to ensure controlled access to all floors.
   2. With no swipe cards or PINs to ensure that the general public can only access the designated public floors and not controlled access floors.
   3. Verify time clock feature works for accessing floors

E. A completed and accepted installation shall pass all of the above tests for all controlled access points.

F. The warranty period for the completed and accepted installation shall not begin until the date of the accepted general contract. The Contractor shall coordinate this date with the General Contractor.

END OF SECTION

SECTION 28 20 00
ELECTRONIC SURVEILLANCE

PART 1 – GENERAL

1.1. SUMMARY

A. The City of Madison requires video surveillance of interior and exterior areas of the Madison Municipal Building as indicated in the Technology plan sheets.

B. This specification shall identify major equipment components and accessories required for a complete video surveillance installation. It does not include materials such as cables, boxes, connectors, conduit, supports and other ancillary equipment required to complete the installation.

C. For the purposes of this specification the term Contractor shall refer to the person(s) responsible for installing the Electronic Surveillance System and may or may not be the same contractor installing other Division 27 and 28 related equipment. Other contractors having related work shall be referred to by full title (Electrical Contractor).

D. Please note: The Madison Municipal Building is a National Historic Landmark. All camera selection finishes and mounting will require architectural review for compliance with the historic preservation efforts.

1.2. RELATED SPECIFICATIONS

A. 01 31 23 Project Management Web Site
B. 01 33 23 Submittals
C. 01 78 23 Operation and Maintenance Data
D. 01 78 36 Warranties
E. 01 78 39 As-Built drawings
F. All Division 27 specifications that may apply to this installation

1.3. AREAS OF RESPONSIBILITY

A. The General Contractor (GC) shall be responsible for ensuring all of the following:
   1. Coordinate all Contractor related work with the construction schedule.
   2. Coordinate all required Work with the Contractor and other trades during pre-installation meetings and resolve installation issues as needed.

B. The Contractor shall be responsible for all of the following:
   1. For all equipment ordering and purchasing, setup, configuration, and testing of equipment being installed under this specification and connected to City of Madison-Information Technology (CoM-IT) servers and equipment.
      a. Include any mounting brackets required for mounting camera equipment to the structure.
      b. The Contractor shall be responsible for the bridge supports identified in Section 2.2.C below.
   2. Verification of Owner installation requirements prior to installing equipment and accessories.
   3. Provide all ancillary materials and equipment required to complete the installation.

C. CoM-IT shall be responsible for all of the following:
   1. The CoM-IT shall be responsible for the ExacQ system licenses.
   2. Provide connection to servers and other hardware necessary to bring installed equipment on line.
   3. Assist in final testing of equipment and equipment functions installed under this specification.

1.4. SUBMITTALS

A. The Contractor shall provide submittals of the following:
   1. All applicable certifications and licenses of the Contractor and the Contractor's installation team. Applicable certifications and licenses shall be current from the start of the contract through the end of the warranty period.
   2. One (1) submittal for all ancillary A/V and A/V Contractor provided equipment required for a complete A/V installation as follows:
      a. Product information sheets and shop drawings indicating each type/size/model of A/V accessory required for a complete A/V installation. Information sheets shall include the following information:
         i. Performance data for the item
         ii. Plan identification number(s) where applicable
         iii. Quantity required for each model

1.4. WARRANTY

A. The Contractor shall warrant for one year the complete installation of equipment and components associated with this contract and installation. Contractors warranty shall be in the form of a written letter on company letterhead referring to the contract information, dates of installation and acceptance, signed by an authorized representative of the Contractors Company.
   1. The Contractors warranty shall include but not be limited to the following:
      a. Transportation to and from the location as often as needed during the warranty period.
      b. All labor and materials necessary to properly and thoroughly trouble shoot the system.
      c. All fees associated with the shipping of any component that needs to be returned or supplied by the manufacturer for repair or replacement.
      d. All labor and materials required to remove, repair, replace, or re-install of any component.

B. The Contractor shall also provide all manufacturers warranties/guarantees associated with installed components of the completed installation.

PART 2 - PRODUCTS

2.1. EXTERIOR SURVEILLANCE LOCATIONS

A. The exterior camera shall be a high quality outdoor ready PTZ (pan/tilt/zoom) camera as follows:
   1. AXIS Communications, PTZ Dome Network Camera with the minimum requirements listed below:
      a. HDTV minimum 1920 x 1080p
      b. Certified compatible with Exacq Technologies exacqVision Video Management System
      c. 3 year AXIS extended warranty option

B. Exterior camera mounting accessories shall of high quality and rated for outdoor environments.
   1. AXIS Communications, models as required for the installation of the above noted camera and locations as indicated in the plans and specifications, any substitutions in camera placement to be reviewed and approved by City of Madison Department of Information Technology, with all standard features including the following:
      a. 3 year AXIS extended warranty option

2.2. INTERIOR SURVEILLANCE LOCATIONS

A. The interior camera shall be a high quality indoor ready PTZ (pan/tilt/zoom) camera as follows:
   1. AXIS Communications, PTZ Dome Network Camera with the minimum requirements listed below:
      a. HDTV minimum 1920 x 1080p
      b. Certified compatible with Exacq Technologies exacqVision Video Management System
      c. 3 year AXIS extended warranty option

B. Interior camera mounting accessories shall of high quality and rated for indoor environments,
   1. AXIS Communications, models as required for the installation of the above noted camera and locations as indicated in the plans and specifications, any substitutions in camera placement to be reviewed and approved by City of Madison Department of Information Technology, with all standard features including the following:
      a. 3 year AXIS extended warranty option
      b. Surface mount as per plans
      c. Drop ceiling mount as per plans

C. All drop ceiling mount locations shall include tile bridge supports

1. ERICO, SCMKC Security Camera Mounting Kit
2. Pre-approved equal

PART 3 - EXECUTION

3.1. COOPERATION OF THE CONTRACTOR

A. All line voltage installations that may be required under this specification shall be installed by the Electrical Contractor. Power shall come from the nearest power panel where the equipment is being installed. Label boxes with panel and circuit number for future reference. Installation shall include any fire stopping as required by code.

B. Data cables shall be installed by the Cabling Contractor as required for this installation. Data cables shall come from the nearest Telecom Room where the equipment is being installed. Installation shall include any fire stopping as required by code.

C. The Contractor shall install all security cameras, mounting hardware, boxes and other equipment necessary for a complete installation of the surveillance system.

3.2. EXTERIOR INSTALLATIONS

A. Provide and install all camera mounting hardware, fastening hardware and anchors as needed for a strong, secure and stable installation as necessary for the building materials being mounted to.

B. Provide and install a high grade clear silicone sealant around all mounting hardware.

C. Provide sufficient cable and install a drip loop if cable is exposed outside of the mounting hardware.

D. Label camera end of data cable with permanent data tag indicating switch location connection id.

E. Label switch end of data cable with permanent data tag indicating camera location.

3.3. INTERIOR INSTALLATIONS

A. Provide and install all camera mounting hardware, fastening hardware and anchors as needed for a strong, secure and stable installation as necessary for the building materials being mounted to.

B. Install tile bridge supports at all drop ceiling locations.

C. Label camera end of data cable with permanent data tag indicating switch location connection id.

D. Label switch end of data cable with permanent data tag indicating camera location.

3.4. INSTALLATION TESTING AND ACCEPTANCE

A. Any required system programming (by CoM-IT or Contractor) shall be completed prior to doing any installation testing and acceptance.

B. It is the sole responsibility of the Contractor to notify CoM-IT no less than two (2) weeks in advance of completing the installation to coordinate all final testing of the completed system.

C. The Contractor and CoM-IT shall test each surveillance camera installation to ensure the installed components work per the specifications.

1. All installed components shall be inspected as follows:
   a. All connections are tight, exterior installations are weather proof with clear silicone sealant.
   b. All components are clean and free of dust, finger prints and other general dirt.
   c. Camera lenses and domes are clean and free of lint, dust and finger prints.
   d. Cameras are free to rotate.
   e. All network connectivity is complete and installed properly.
2. Each camera installation at the project site shall be tested from an off site computer to ensure all pan/tilt/zoom features, focus and other functions are fully operational.

E. A completed and accepted installation shall pass all of the above tests for each installed camera location.

F. The warranty period for the completed and accepted installation shall not begin until the date of the accepted general contract. The Contractor shall coordinate this date with the General Contractor.

END OF SECTION

SECTION 283111
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Fire-alarm control unit.
   2. Manual fire-alarm boxes.
   3. System smoke detectors.
   4. Heat detectors.
   5. Notification appliances.
   6. Remote annunciator.
   7. Addressable interface device.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.
B. FACP: Fire Alarm Control Panel.
C. HLI: High Level Interface.
D. NICET: National Institute for Certification in Engineering Technologies.
E. PC: Personal computer.
F. VESDA: Very Early Smoke-Detection Apparatus.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, details, and attachments to other work.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
   4. Detail assembly and support requirements.
   5. Include voltage drop calculations for notification-appliance circuits.
   6. Include battery-size calculations.
   7. Include input/output matrix.
   8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
   9. Include performance parameters and installation details for each detector.
   10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
   12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
      a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
      b. Show field wiring required for HVAC unit shutdown on alarm.
      c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
      d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
      e. Locate detectors according to manufacturer's written recommendations.
      f. Show air-sampling detector pipe routing.
   13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
   14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:
   1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
   2. Shop Drawings shall be prepared by persons with the following qualifications:
      a. Trained and certified by manufacturer in fire-alarm system design.
      b. NICET-certified, fire-alarm technician; Level III minimum.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
      b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
      c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
      d. Riser diagram.
      e. Device addresses.

f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
g. Record copy of site-specific software.
h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
1) Equipment tested.
2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.
i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 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.
1. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
3. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
4. Keys and Tools: One extra set for access to locked or tamper-proofed components.
5. Audible and Visual Notification Appliances: One of each type installed.
6. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.8 PROJECT CONDITIONS

A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.
B. Automatic sensitivity control of certain smoke detectors.
C. All components provided shall be listed for use with the selected system.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:
   1. Manual stations.
   2. Heat detectors.
   3. Smoke detectors.
   4. Duct smoke detectors.
   5. Automatic sprinkler system water flow.
   6. Dry system pressure flow switch.

B. Fire-alarm signal shall initiate the following actions:
   1. Continuously operate alarm notification appliances.
   2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
   3. Transmit an alarm signal to the remote alarm receiving station.
   4. Unlock electric door locks in designated egress paths.
   5. Release fire and smoke doors held open by magnetic door holders.
   6. Activate voice/alarm communication system.
   7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
   8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
   9. Recall elevators to primary or alternate recall floors.
   10. Activate elevator power shunt trip.
   11. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch.
   2. High- or low-air-pressure switch of a dry-pipe sprinkler system.
   3. Elevator shunt-trip supervision.
   4. User disabling of zones or individual devices.
   5. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
   4. Loss of primary power at fire-alarm control unit.
   5. Ground or a single break in internal circuits of fire-alarm control unit.
   6. Abnormal ac voltage at fire-alarm control unit.
   7. Break in standby battery circuitry.
   8. Failure of battery charging.
   9. Abnormal position of any switch at fire-alarm control unit or annunciator.
   10. Voice signal amplifier failure.

E. System Supervisory Signal Actions:
   1. Initiate notification appliances.
   2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
   3. Record the event on system printer.
   4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 FIRE-ALARM CONTROL UNIT

A. MANUFACTURED UNITS
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE UTC Fire & Security.
      b. Notifier.
      c. Siemens Industry, Inc.
      d. Simplex Grinnell.
      e. **Gamewell/FCI (Addendum 5)**

B. General Requirements for Fire-Alarm Control Unit:
   1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
b. Include a real-time clock for time annotation of events on the event recorder and printer.
c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
d. The FACP shall be listed for connection to a central-station signaling system service.
e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
1. Pathway Class Designations: NFPA 72, Class A.
2. Pathway Survivability: Level 1.
3. Install no more than 50 addressable devices on each signaling-line circuit.
4. Serial Interfaces:
a. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
b. One RS 232 port for voice evacuation interface.

E. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Sound general alarm if the alarm is verified.
4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

F. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Elevator Recall:
1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
a. Elevator lobby detectors except the lobby detector on the designated floor.
b. Smoke detector in elevator machine room.
c. Smoke detectors in elevator hoistway.
2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory signals shall be powered by 24-V dc source.
   1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
   1. Batteries: Sealed lead calcium.

2.4 MANUAL FIRE-ALARM BOXES

A. MANUFACTURED UNITS
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE UTC Fire & Security.
      b. Notifier.
      c. Siemens Industry, Inc.
      d. Simplex Grinnell.
      e. Gamewell/FCI

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
   2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

A. MANUFACTURED UNITS
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE UTC Fire & Security.
      b. Notifier.
      c. Siemens Industry, Inc.
      d. Simplex Grinnell.
      e. Gamewell/FCI

B. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
   3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   5. Integral Visual-Indicating Light: LED type, indicating detector has operated.
   6. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition.
      a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
      b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
      c. Multiple levels of detection sensitivity for each sensor.
      d. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.

c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

A. MANUFACTURED UNITS
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. GE UTC Fire & Security.
b. Notifier.
c. Siemens Industry, Inc.
d. Simplex Grinnell.
e. Gamewell/FCI

B. General Requirements for Heat Detectors: Comply with UL 521.
1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

A. MANUFACTURED UNITS
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. GE UTC Fire & Security.
b. Notifier.
c. Siemens Industry, Inc.
d. Simplex Grinnell.
e. Gamewell/FCI

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
   1. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.
   2. Mounting: Wall mounted unless otherwise indicated.
   3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   4. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Strobe Leads: Factory connected to screw terminals.
   6. Mounting Faceplate: Factory finished, white.

2.8 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.9 ADDRESSABLE INTERFACE DEVICE

A. General:
   1. Include address-setting means on the module.
   2. Store an internal identifying code for control panel use to identify the module type.
   3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall, or to circuit-breaker shunt trip for power shutdown.
   1. Allow the control panel to switch the relay contacts on command.
   2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:
   1. Operate notification devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
   1. Devices placed in service before all other trades have completed cleanup shall be replaced.
   2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

C. Manual Fire-Alarm Boxes:
   1. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing:
   1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
   2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
   1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

A. Pathways shall be installed in EMT.

B. In exposed areas conduit shall be painted to match the surrounding surface, and junction boxes shall be painted red.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Smoke dampers in air ducts of designated HVAC duct systems.
   2. Magnetically held-open doors.
   3. Electronically locked doors and access gates.
   4. Alarm-initiating connection to elevator recall system and components.
   5. Supervisory connections at valve supervisory switches.
   6. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
   7. Supervisory connections at elevator shunt-trip breaker.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction and building owner.

B. Perform tests and inspections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.
F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.
B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 31 10 00
SITE CLEARING AND REMOVALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. All work shall be in accordance with Part II of the City of Madison Standard Specifications for Public Works Construction, Current Edition, except as noted below. It is the responsibility of the Contractor to confirm most recent revisions to City specifications are being followed.

1.3 EXCEPTIONS

A. Section 203.2 – Construction Methods:
   1. All items indicated for salvage and reuse shall be removed in a careful manner and temporarily stored and protected for reuse per direction from Owner/Engineer.
   2. Locate, identify, and protect utilities indicated to remain, from damage. Contractor shall coordinate with the Owner/Engineer prior to completing any removals.
   3. Protect trees, plant growth, concrete, signs, railings, poles, and other features designated to remain, as final conditions.
   4. Protect bench marks, survey control points, and existing structures from damage or displacement.
   5. Confine work to limits indicated on Sheets C100 and C103 of the Plans.

B. Section 204.1 – Description:
   1. Site clearing shall include complete removal and disposal of existing vegetation and organic material, including ground cover, roots, sucker shoots, and other deleterious material.

C. Section 204.2 – Construction Methods:
   1. Contractor shall choose methods of removal of vegetated top-growth and subgrade material which will eradicate vegetation from returning as a nuisance.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 31 23 00
FOUNDATION EXCAVATING AND BACKFILLING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The General and Supplementary Conditions of the Construction Contract and Division 1 - General Requirements apply to the work specified in this section.

B. This section shall include, but is not limited to the following foundation, excavating and backfilling within five feet of the building perimeter.

1. Removal of all unacceptable soil.

2. Furnish and install acceptable fill as specified herein and on the drawings.

3. Prepare subgrade for footings and slab on grade.

C. The following items are not a part of this specification:

1. Utility trenching and related backfilling outside the building footprint.

2. Subgrade for exterior walks and paving.

D. Structural notes indicated on the drawings regarding foundation excavating and backfilling should be considered part of this specification.

1.2 QUALITY ASSURANCE

A. Codes and Standards: Comply with the provisions of the following codes, specifications and standards, except where more stringent requirements are shown or specified.

1. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

2. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbs/ft^3)

3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

4. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

5. ASTM D4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

6. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. Comply with all applicable local, state and federal codes.

1.3 SUBMITTALS

A. Material Test Reports: Provide the Owner and Architect with the on-site material test reports from the Inspection Agency indicating the interpreting test results for compliance with this specification.

B. LEED Certification: Submit manufacturer's certification for each engineered fill material including the following:

1. LEED Credit MRc 4.1/4.2 – Recycled content including percentage of pre-consumer (post-industrial) and post-consumer recycled content. Also provide manufacturer's name and product cost.

2. LEED Credit MRc 5.1/5.2 – Location of manufacturing plant, manufacturer's name, product cost and location of extraction or harvest of raw materials.

1.4 TESTING AND INSPECTION

A. Inspection and Testing:

1. The Owner shall employ an Inspection Agency to perform the duties and responsibilities specified below.

2. Refer to architectural, civil, mechanical, and electrical specifications for testing and inspection requirements of non-structural components.

3. Duties of the Inspection Agency:

a. Perform all testing and inspection required per the Testing and Inspection Schedule indicated below.

b. Furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work.

c. Submit a final signed report stating whether the work requiring Inspection was, to the best of the Inspection Agency's knowledge in conformance with the approved plans and specifications.

4. Structural Component Testing and Inspection Schedule for Section 31 23 00 is as follows:

Foundation Preparation	Continuous	Periodic
Verify materials below shallow footings are adequate to achieve the design bearing capacity.		X

Foundation Preparation	Continuous	Periodic
Verify excavations are extended to proper depth and have reached proper material.		X
Perform classification and testing of compacted fill materials.		X
Verify use of proper materials, densities, and lift thicknesses during placement and compaction of compacted fill.	X	
Prior to placement of compacted fill, observe subgrade and verify that the site has been properly prepared.		X

B. Minimum testing frequency and locations:

1. Laboratory Testing:

a. Granular fill: One representative gradation test for each type of material.

b. Cohesive soils: One representative moisture density test for each type of material used.

c. Non-cohesive soils: One representative moisture density test for each type of material used.

2. Field Testing:

a. The Inspector shall determine the location of testing.

b. Testing of final utility trench backfill shall begin at a depth of 2 feet above the top of the pipe.

c. In-place field density test and moisture content tests shall be performed as follows:

1) Fills not within the influence of building foundations and slab on grade: Per civil specifications.

2) Fills within the influence of building foundations and slab on grade, the following criteria shall apply: One test for each 8 inch vertical lift of compacted fill placed per 2,500 square feet of fill area (minimum of two tests per lift per structure for areas smaller than 5,000 square feet).

d. Additional testing may be required by the Inspector if noncompliance or a change in conditions occurs.

e. If a test fails, the Contractor shall rework the material, recompact and retest as necessary until specific compaction is achieved in all areas of the trench. All costs associated with this work, including retesting, shall be the responsibility of the Contractor.

1.5 PROTECTION

A. Contractor shall provide for design, permits and installation of all cribbing, bracing, shoring and other methods required to safely retain earth banks and excavations.

B. Notify the Architect immediately and discontinue work in affected area if adjacent existing footings are encountered during excavation. Underpin other adjacent structures that may be damaged by excavation work, including service utilities and pipe chases.

C. Notify the Architect of unexpected subsurface conditions and discontinue work in affected areas until notification to resume.

D. Protect benchmarks, existing structures, fences, sidewalks, paving, curbing, etc., from excavation equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities that are to remain.

F. Provide temporary heating or protective insulating materials to protect subgrades and foundations soils against freezing temperatures or frost during cold weather conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide borrow soil materials when sufficient acceptable soil materials are not available from excavations.

B. Acceptable soils shall comply with the following:

1. Meet ASTM D2487 soil classification groups GW, GP, GM, SW, SP, SM or a combination of these group symbols;

2. Be free of rock or gravel larger than 3 inches in any dimension;

3. Be free of debris, waste, frozen materials, vegetation and other deleterious materials;

4. Have a liquid limit less than 45 and a plasticity index less than 20.

5. Be approved by the Inspection Agency.

C. Unacceptable soils shall be defined as following:

1. ASTM D2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, PT or a combination of these group symbols.

2. Unacceptable soils also to include acceptable soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Free-Draining Granular Fill: Free-draining granular fill shall comply with the following:

1. Be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone.

2. Be clean and free of fines.

3. Comply with ASTM D2940.

4. Be uniformly graded as follows:

COARSE AGGREGATE GRADATIONS						
SIEVE SIZE - PERCENT PASSING						
Grade No.	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4
CA7	100	95 ± 5	-	45 ± 15	-	5 max

5. Be approved by the Inspection Agency.

E. Engineered Fill and Utility Base Course shall comply with the following:

1. Be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, natural or crushed sand; be a recycled concrete crushed to meet the gradation requirements of CA6;

2. Comply with ASTM D2940;

3. Be uniformly graded as follows:

COARSE AGGREGATE GRADATIONS						
SIEVE SIZE - PERCENT PASSING						
Grade No.	1-1/2"	1"	1/2”	No. 4	No. 16	No. 200
CA6	100 to 90	95 ± 5	75 ± 15	43 ± 13	25 ± 15	8 ± 4

4. Be approved by the Inspection Agency.

F. Material Applications: Provide and install material meeting with the above requirements as follows:

1. General fill: Acceptable soils.

2. Backfill against basement and retaining walls: Free-draining granular fill.

3. Backfill at over-excavated areas beneath footings: Engineered fill.

4. Sub-grade layer beneath slabs-on-grade: Refer to Drawings.

2.2 LEED CREDIT

A. LEED Credit MRc 4.1/4.2 – All engineered fill shall contain 100% recycled content.

B. LEED Credit MRc 5.1/5.2 – All fill materials shall be procured from within 500 miles of the project site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Identify and verify required lines, levels, contours and benchmark elevations for the work are as indicated.

B. Protect plant life, lawns, other features and vegetation to remain as a portion of the final landscaping.

C. Contractor shall provide for de-watering of excavations from surface water, ground water or seepage.

D. Identify known underground utility locations with stakes and flags.

3.2 EXCAVATION

A. All excavations shall be safely and properly backfilled.

B. All abandoned footings, utilities and other structures that interfere with new construction shall be removed.

C. All unacceptable material and organic material shall be removed from below all proposed slabs-on-grade and the exposed natural soil shall be proof rolled and the compaction verified by the soils testing firm prior to placing fill. Proof-roll with a loaded tandem dump truck, loaded ready-mix truck, roller, or equivalent weight vehicle. Materials exhibiting weakness, such as those exhibiting rutting or pumping, shall be removed and replaced with acceptable compacted fill material.

D. Do not excavate within the 45-degree bearing splay of any adjacent foundations.

E. Outside 45-degree bearing splay of foundations, correct areas over excavated with aggregate at no additional cost to the Owner.

F. Within the 45-degree bearing splay of foundations, correct areas over excavated with 2000 psi concrete fill at no additional cost to the Owner. Notify the Architect prior to performing such work.

G. Hand trim final excavation to remove all loose material.

H. Contractor shall form all dams and perform other work necessary for keeping the excavation clear of water during the progress of the work and, at his own expense, shall pump or otherwise remove all surface and perched water which accumulates in the excavations. Perched water that cannot be de-watered in 48 hours of continuous pumping at a minimum rate of 60 gpm in dry weather shall be considered ground water.

I. Stockpile excavated material in the area designated and remove excess material not being used, from the site.

3.3 BACKFILLING

A. Verify foundation perimeter drainage system is complete and has been inspected prior to backfilling against foundation walls.

B. Support pipe and conduit during placement and compaction of bedding fill.

C. Systematically backfill to allow necessary time for natural settlement. Do not backfill over porous, wet, spongy or frozen subgrade surfaces.

D. Backfill areas to contours and elevations with unfrozen materials.

E. Unless noted otherwise on the Drawings, make grade changes gradual.

F. Unless noted otherwise on the Drawings, slope grade away from the building a minimum of 2 inches in 10 feet.

G. Contractor shall procure the approval of the subgrade from the Inspection Agency prior to the start of any filling or bedding operations.

H. Place a minimum width of 24 inches of free-draining granular fill (CA-7) against all basement and retaining walls for the full height of the wall.

I. Do not begin any backfill operations against any concrete walls until the concrete has achieved its specified strength.

J. Do not backfill against below grade walls without necessary bracing to support the walls or until supporting slab or framing is installed and has been anchored to the wall per the Drawings.

K. Place and mechanically compact granular fill in continuous layers not to exceed 6 inches compacted depth.

L. Employ a placement method that does not disturb or damage adjacent utilities, vapor barriers, foundation perimeter drainage and foundation waterproofing.

M. All surplus fill materials are to be removed from the site.

N. Fill material stockpiles shall be free of unacceptable soil materials.

O. After work is complete, remove all excess stockpile material and repair stockpile area to its original condition.

3.4 COMPACTION

A. Compact all fill that will support building footings or floor slabs to 98 percent of the maximum dry density in accordance with ASTM D698. For relative cohesionless fill materials, where the percent passing the #200 sieve is less than 10 and the moisture density curve indicates only slight sensitivity to changing moisture content, compaction requirements should be changed to 75 percent relative density in accordance with ASTM D4253 and ASTM D4254.

B. Compact all fills that support paving and landscape per civil specifications.

3.5 FOUNDATIONS

A. Each footing excavation should be cleared of all obstructions and other organic or deleterious materials.

B. Localized areas of unstable or unacceptable material may be discovered during the stripping and excavation operation and may require over-excavation and backfilling. The Inspection Agency shall be present during the proof rolling to evaluate any localized areas and make recommendations regarding over-excavation, backfilling and recompaction of these areas. Fill placement and compaction shall be inspected and tested by the Inspection Agency.

C. Footing elevations shown on the Drawings designate a minimum depth of footing where a safe soil bearing pressure is expected. Footings, piers and/or walls shall be lowered or extended as required to reach soil meeting the design bearing pressure. This work shall be performed under direct supervision of the Inspection Agency.

D. All footing excavations shall be recompacted by hand-operated, vibratory compaction equipment.

E. All excavation and recompacted surfaces shall be inspected and tested to a depth of 2.0 feet below the excavated elevation by the Inspection Agency. Additional field density tests should be performed for each one foot of fill material placed. Any areas not in compliance with the compaction requirements should be corrected and re-tested prior to placement of fill material.

F. For foundation areas where over excavation is performed, place and mechanically compact Engineered fill material in continuous layers not to exceed 6 inches compacted depth.

3.6 SLAB-ON-GRADE

A. All disturbed areas after the clearing and stripping operation should be proof-rolled and recompacted with a heavy vibratory drum roller (approved by the Inspection Agency) in the static mode. The compactor should make a minimum of 10 passes, with a minimum of one foot overlap of each pass. The compactor speed should be less than 0.2 MPH.

B. The Inspection Agency shall monitor proof-rolling and compaction operations. This area should then be tested for compaction to a depth of 2.0 feet below the compacted surface prior to the placement of any structural fill material.

C. Refer to Drawings for required sub-grade preparation beneath slabs-on-grade.

3.7 UTILITY TRENCH BACKFILL (AT SLAB ON GRADE LOCATIONS)

A. Excavate and backfill utility trenches under wall footings as shown on the Drawings

B. Place utility base course on subgrades free of mud, frost, snow, or ice.

C. Place and compact utility base course on trench bottoms and where indicated.

D. Lay underground utilities on 6” sand bedding, which meets the acceptable criteria of Section 2.1,B.

E. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

F. After connection joints are made, any misalignment can be corrected by tamping the sand around the utilities.

G. Place and compact initial backfill of acceptable sand to a height of 6 inches over the utility pipe or conduit in 6 inches layer meeting specified compaction requirements.

H. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit.

I. Place and compact final backfill using acceptable soil to final subgrade elevation meeting specified compaction requirements.

J. Backfill voids with acceptable soil while installing and removing shoring and bracing.

K. Inspection Agency shall monitor and test compacted backfill to verify final compaction meets the specified requirement.

3.8 TOLERANCES

A. Top surface of backfilling under paved areas: Plus or minus ½ inch from required elevation.

B. Top surface of general backfilling: Plus or minus 1 inch from required elevation.

END OF SECTION

SECTION 31 25 13
EROSION CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. All work shall be in accordance with Part II of the City of Madison Standard Specifications for Public Works Construction, Current Edition, except as noted below. It is the responsibility of the Contractor to confirm most recent revisions to City specifications are being followed.

1.3 EXCEPTIONS

A. None.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. All work shall be in accordance with Part IV of the City of Madison Standard Specifications for Public Works Construction, Current Edition, except as noted below. It is the responsibility of the Contractor to confirm most recent revisions to City specifications are being followed.

1.3 EXCEPTIONS

A. None.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 32 13 00
PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. All work shall be in accordance with Part III and IV of the City of Madison Standard Specifications for Public Works Construction, Current Edition, except as noted below. It is the responsibility of the Contractor to confirm most recent revisions to City specifications are being followed.

1.3 EXCEPTIONS

A. Section 303.2(c) – Placing and Finishing Concrete:
   1. Sidewalk shall be finished to match the appearance of adjacent existing sidewalk. Procedures and/or additives used shall not impose detrimental impacts to the concrete and shall be approved by Engineer prior to application.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 32 91 13
SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes preparation of subgrades under lawn and planting areas, suitable topsoil material(s), and planting soils.

B. Related Requirements:
   1. Division 31 Section "Site Clearing and Removals" for topsoil stripping and stockpiling.
   2. Division 32 Section "Turf and Grasses" for placing topsoil for lawn areas.
   3. Division 32 Section "Plants" for placing planting soil for plantings.

1.3 REFERENCES

A. City of Madison Standard Specifications for Public Works Construction (herein referred to as MSN-SSPWC). Current edition.

B. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction. Current edition.

C. Wisconsin DNR CPS S100 “Compost”.

1.4 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

B. CEC: Cation exchange capacity.

C. 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.

D. Imported Soil: Soil that is transported to Project site for use.

E. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

F. 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."

G. 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.

H. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

I. SSSA: Soil Science Society of America.

J. 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.
K. 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.
L. 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.
M. USCC: U.S. Composting Council.

1.5 SUBMITTALS

A. Product Data: For each type of pre-packaged or bulk soil amendment product used.
B. Submit a one-page typewritten document for coordinating soil sample collection at least ten (10) working days in advance of topsoil sample collection. The document shall include the name of the contractor, the date, the name of the quarry or property owner where topsoil will be mined if using mined material, the source of the topsoil stockpile if using stockpiled material, the location within the project site where topsoil will be obtained for any stripped and salvaged topsoil, the current and historic use of each of the sites/locations where intended topsoil collection will occur, and the approximate quantities the Contractor intends to use from each different source. The document shall include maps of the areas where intended topsoil will be taken from with notation indicating the context as well as the exact locations where topsoil mining or stripping and stockpiling will occur. General sampling instructions can be found online at: learningstore.uwex.edu/Assets/pdfs/A2166.pdf
C. Submit topsoil testing results for individual components listed in paragraph 1.6 E. of this Section.
D. Submit testing results indicating that the compost and sand, if used on this project, meets the individual requirements outlined WDNR CPS 1004 and CPS S100.

1.6 QUALITY ASSURANCE

A. The Contractor is responsible for conducting testing and sending in samples for analysis of salvaged and imported topsoil, reviewing topsoil results, and submitting testing results to Landscape Architect for review and approval before any salvaged or imported topsoil materials can be used independently or as part of any soil mix on the project.
B. Soil-Testing Laboratory: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed. Preferred vendor is the University of Wisconsin Soil Testing Laboratories: uwlab.soils.wisc.edu.
C. The Landscape Contractor is responsible for collection of soil specimens. Collection shall be completed in accordance with accepted industry standards of care and acceptable practices; each separate source or location will require a separate sample and analysis. General sampling instructions can be found online at: learningstore.uwex.edu/Assets/pdfs/A2166.pdf.
D. Soil Analysis: Follow submission form instructions and submit samples for all topsoil intended to be used individually or as a component of a soil mixture for the project to the qualified soil-testing laboratory. Sample forms and instructions can be found at: uwlab.soils.wisc.edu/home-owners/lawn-garden/.
E. Provide results for the following categories for each individual sample submitted:
    1. Lawn – New From Seed
    2. Mixed Beds – Perennial Flowers & Shrubs
    3. Include the following additional tests: Soluble Salts, Texture, Heavy Metals Testing (see list of individual metals below).

PART 2 - <u>PRODUCTS</u>

2.1 TOPSOIL

A. Clean, salvaged, or imported material capable of passing the 1" sieve and meeting the minimum requirements of Section 625.2(1-2) of the Standard Specifications for Highway Construction. The material shall be free of rocks, gravel, wood, debris, and of noxious weeds and their seeds and within the following acceptable ranges:
    1. pH: 5.5 - 7.5
    2. USDA soil texture classification: Loam, Sandy Loam
    3. Amount of Phosphorous (P): 6 – 10 ppm
    4. Amount of Potassium (K): 51 – 100 ppm
    5. Percent Organic Matter: 5% – 8%
    6. C:N Ratio: 12:1 to 15:1
    7. Soluble Salts (in ds/M): 0-2 dS/m

8. Gravimetric Field Moisture Capacity (expressed as grams of water per 100 grams of oven dry soil): >15%
9. Heavy Metal (Cd): 0.01 – 3.0 ppm
10. Heavy Metal (Co): 1.0 – 40.0 ppm
11. Heavy Metal (Cr): 5.0 – 1000.0 ppm
12. Heavy Metal (Cu): 2.0 – 100.0 ppm
13. Heavy Metal (Fe): 10,000 – 50,000 ppm
14. Heavy Metal (Mn): 100 – 4,000 ppm
15. Heavy Metal (Mo): 0.5 – 40.0 ppm
16. Heavy Metal (Ni): 1.0 – 200.0 ppm
17. Heavy Metal (Pb): 2.0 – 200.0 ppm
18. Heavy Metal (Zn): 10 – 300 ppm
19. Heavy Metal (Li):1.2 – 98.0 ppm

B. Of particular importance is the control of invasive species on this project; the Contractor must ensure that topsoil materials used alone or as part of a planting soil blend do not contain any roots, stems, seeds or other parts of any invasive or noxious species. Additional information on invasive species in the State of Wisconsin and additional information on their control can be found at the Wisconsin DNR Invasive Species Web Resource: dnr.wi.gov/topic/invasives

C. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones ½-inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes; grubs; or other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

D. Topsoil shall meet all of the requirements outlined in this Section and topsoil results shall be reviewed and approved by the Landscape Architect before topsoil delivery to site or use in any soil mixture for the project.

E. Any adjustments to pH, nutrient content, or soil texture class shall be performed off-site and pre-blended before spreading; re-testing of adjusted topsoil will be required in order to confirm conformance with the ranges outlined in this Section.

F. Final topsoil is subject to approval by Landscape Architect based on laboratory soil test results. Landscape Architect reserves the right to reject any topsoil source that does not meet the specific ranges and requirements listed in this Section or that can be easily amended to fall within the ranges. A different topsoil source may be required if test results indicate that topsoil falls too far outside of acceptable ranges; new sources will require testing, review and approval for use, at no additional cost to the project, prior to acceptance and delivery to the project site or use in any soil mixes.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
1. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.
2. Provide lime in form of ground dolomitic limestone.
3. Application amounts of lime will be governed by the recommendations of the independent testing firm's soil testing results.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
1. Application amounts of sulfur will be governed by the recommendations of the independent testing firm's soil testing results.

C. Sand: Clean, washed, natural or manufactured, and free of toxic materials. 50% Mineral (SiO_2). All sand shall be washed to remove clay and silt particles, and be well-drained prior to mixing. Sand shall meet one of the following gradation requirements:
1. USDA Coarse Sand (.02-.04 inches).
2. ASTM C33 (Fine Aggregate Concrete Sand).
3. WIS DOT Standard & Specifications for Highway and Structure Construction, Current Edition, Section 501.2.5.3.4 (Fine Aggregate Concrete Sand).

2.3 ORGANIC SOIL AMENDMENTS

A. Mycorrhizal Inoculant: CPR #1 Mycorrhizal Root Inoculant from BioGreen LLC, 30937 Gilmer Road, Volo, IL; (847) 740-9637, or approved equal. Rates, method(s), and timing of application shall be per BioGreen's written instructions for this specific site and micro-application based on planting type and locationRetain one of or both "Sulfur" and "Iron Sulfate" paragraphs below if required. Do not use aluminum sulfate. Revise descriptions and insert proprietary products if required.

B. Compost meeting WDNR CPS S100:

1. Compost is a mixture that consists largely of aerobically decayed organic waste. This specification outlines the minimum material requirements for compost intended to be used in accordance with the criteria WDNR CPS S100. Compost meeting this specification is appropriate for use for compaction mitigation and as the component of an engineered soil mixtures and planting soil mixtures.
2. The following material requirement shall be met:
    a. Particle Size: 98% of the compost shall pass through a 0.75-inch screen.
    b. Physical Contaminants: Less than 1% combined glass, metal and plastic.
    c. Organic Matter/Ash Content: At least 40% organic matter, less than 60% ash content.
    d. Carbon to Nitrogen Ratio: 10-20:1 C:N ratio.
    e. pH: Between 6 and 8.
    f. Soluble Salts: Electrical conductivity below 10 dS m-1 (mmhos cm-1).
    g. Moisture Content: Between 35% and 50% by weight.
    h. Maturity: The compost shall be resistant to further decomposition and free of compounds such as ammonia and organic acids, in concentrations toxic to plant growth.
    i. Residual Seeds and Pathogens: Pathogens and noxious seeds shall be minimized.
    j. Pathogens: The compost shall meet the Class A requirements for pathogens as specified in s. NR 204.07(6)(a), Wis. Adm. Code.
    k. Other Chemical Contaminants: The compost shall meet the high quality pollutant concentrations as specified in s. NR 204.07(5)(c), Wis. Adm. Code.
3. DO NOT USE LEAF COMPOST ON THIS PROJECT.

C. Of particular importance is the control of invasive species on this project; the Contractor must ensure that any compost materials used alone or as part of a planting soil blend do not contain any roots, stems, seeds or other parts of any invasive or noxious species. Additional information on invasive species in the State of Wisconsin and additional information on their control can be found at the Wisconsin DNR Invasive Species Web Resource: dnr.wi.gov/topic/invasives.

2.4 FERTILIZERS

A. The use of fertilizer type, composition and application for planting beds and lawn areas for this project will be dictated by the written results of the soil tests and must meet the requirements of the State of Wisconsin Statutes. Fertilizers could include:

1. 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 a composition recommended by the soil test results.
2. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in a composition and application rate recommended by the soil test results.

2.5 PLANTING SOIL FOR PLANT BEDS

A. Planting Soil will be produced by utilizing approved topsoil and amendments and will be used in all planting beds and will be a blend of the following:

1. 6 part topsoil meeting the requirements of this section and approved for use on the project.
2. 1 part sand.
3. 2 parts compost.
4. Mychorrhizal inoculant, see "Products", this Section.
5. Other amendments and fertilizer as recommended by the soil test results specific to establishing plant material.

B. Thoroughly blend Planting Soil off-site before spreading. Any adjustments to pH, nutrient content, or soil texture class shall be pre-blended before spreading.

C. Final Planting Soil mix composition and ratios are subject to modification by the Landscape Architect based on topsoil testing results.

2.6 TOPSOIL FOR LAWNS

A. Provide topsoil meeting the requirements of this section and approved for use on the project and include other amendments and fertilizer as recommended by the soil test results specific to establishing new lawns.

B. Any adjustments to pH, nutrient content, or soil texture class shall be made off-site prior to delivery and installation.

PART 3 - EXECUTION

3.1 SUBGRADE SOIL PREPARATION

A. Soil Materials: Planting Soil or Topsoil.

B. Remove all vegetation as needed with broad spectrum herbicide such as Round-Up or other organic method of noxious weed removal for site preparation. Remove all rocks, debris, and litter.

C. Subgrades are those grades present on-site during construction. Compacted subgrades shall be excavated and removed in order to install Planting Soil, Topsoil and Engineered Soil Mixture materials to depths indicated in this Section and to achieve final grades as indicated in Working Drawings.

D. If site subgrades are compacted due to construction operations, rip, fracture, or disc the subsoil to a depth of 12" to 18" to allow aeration. Remove any and all stones greater than 6" that rise to the surface during subsoil decompaction operations.

E. Contractor shall examine all subgrades prior to the delivery or installation of soil materials for any and all detrimental conditions including compaction, contamination by deleterious materials, presence of large construction debris, and/or any other negative conditions. Contractor shall notify Owner's Project Representative of any and all subgrade preparation inadequacies immediately and soil materials shall not be placed until all subgrade deficiencies have been corrected. Contractor will be held responsible for negative results from improper subgrade preparation if soil materials are placed with disregard to inadequately prepared subgrades.

F. Do not apply any soil materials to saturated or frozen subgrades.

3.2 PLACING SOIL MATERIALS

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by soil material installation operations.

B. Contractor shall account for settling when determining amounts for initial placement of soil materials; depths indicated in this Section represent final proposed depths after settling has occurred.

C. Install soil materials in 6 inch lifts. After the first lift is installed in all areas, Contractor shall work soil materials into top 2 to 4 inches of decompacted subgrades to blend. Any additional soil materials shall be installed in subsequent lifts of no more than 6 inches to achieve final depths indicated in this Section and final grades indicated in the Drawings.

D. Soil Material Depths: Place soil materials for each individual area in the following depths:
   1. Place 6" of Topsoil in all lawn areas.
   2. Place 18" of Planting Soil in all planting beds.

E. Do not apply Topsoil or Planting Soil to saturated or frozen subgrades.

F. Stockpile any additional amended soil materials on site for fine grading operations, to repair areas which may settle, and to backfill planting holes if additional soil material is needed.

3.3 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 soil materials or subgradse are overcompacted, 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.

3.4 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 on-site where directed by Owner.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes preparation for and seeding of lawn areas.
B. Related Requirements:
   1. Division 32 Section “Soil Preparation” for suitable topsoil and amendments and for subgrade soil preparation and topsoil depths under lawns.

1.3 REFERENCES

A. City of Madison Standard Specifications for Public Works Construction (herein referred to as MSN-SSPWC). Current edition. Article 207 “Seeding”.

1.4 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.
B. 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 includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
C. 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.
D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Division 32 Section “Soil Preparation”.
E. 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.

1.5 SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

B. Product Certificates: For fertilizers, from manufacturer.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishments from seed on large-scale commercial or municipal projects and with a minimum of five (5) years' experience in turf installation.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
2. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY STORAGE AND HANDLING

A. Seed and Other 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. 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.

1.8 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of seeding completion: April 1 – June 15 or September 1 – October 15.

B. 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.

PART 2 - <u>PRODUCTS</u>

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Grass-Seed Mix:

1. Products: Subject to compliance with requirements, provide "Capital City Parks" Mix by Heritage Seed Company, or approved equal, and in accordance with Article 207 of MSN-SSPWC. Mix includes:
   a. 50% Elite Kentucky Bluegrass Varieties
   b. 25% Elite Perennial Ryegrass Varieties
   c. 13% Elite Creeping Red Fescue
   d. 12% Elite Chewings Fescue

2.2 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.

1. Provide fertilizer of blend recommended by soil tests for establishing lawns from seed in accordance with all State Statutes and Article 207 of the MSN-SSPWC.

2.3 MULCHES

A. Acceptable mulch materials include those outlined in Article 207 of the MSN-SSPWC.

2.4 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be seeded 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. Seed over all disturbed areas. Overseed existing, undisturbed lawn areas as necessary to produce a vigorous, healthy lawn of uniform appearance across the entire project site for both new and existing lawsn upon project completion.

C. It is the responsibility of the Contractor seeding lawn areas to ensure that adequate quality and depth of topsoil has been provided for all lawn areas per Division 32 Section “Soil Preparation” prior to seeding where disturbance has removed existing topsoil.

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

E. 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 Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by seeding operations.

B. Examine erosion-control measures to ensure there will be no erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare seeding area for soil placement and mix planting soil according to Division 32 Section “Soil Preparation” and Article 207 of MSN-SSPWC, whichever is more stringent.

B. Moisten prepared area before seeding if soil is dry. Water thoroughly and allow surface to dry before seeding. Do not create muddy soil.

C. Before planting, obtain Architect's acceptance of finish grading; restore seeding areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

A. Seed and mulch lawn areas in accordance with Article 207 of the MSN-SSPWC.

3.5 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 re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. 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.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. 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.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
   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.
   2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. 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. Schedule initial and subsequent mowings to maintain the following grass height: 2-inches before June 1 or after September 1 or 3-1/2 inches between June and September.

3.6 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:
   1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.7 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of 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.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.8 CLEANUP 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.

3.9 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article, this Section. Begin maintenance immediately after each area is seeded and continue until acceptable turf is established, but for not less than the following periods:
   1. Spring Installations: Seeded areas installed prior to June 15 shall be maintained for the duration of the growing season (until November 1).
   2. Fall Installations: Seeded areas installed after September 1 shall be maintained for the remainder of the growing season (until November 1) AND for the entire growing season of the following year (April 1 – November 1).

END OF SECTION

SECTION 32 93 00
PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Plants Materials
   2. Mulches
B. Related Sections:
   1. Section 32 91 13 “Soil Preparation” for preparation of topsoil suitable for planting operations.
   2. Section 32 92 00 "Turf and Grasses" for site turf grass seeding.

1.3 REFERENCES

A. *American Standards for Nursery Stock,* ANSI Z60.1, current edition. American Association of Nurserymen, Inc.
B. *Standardized Plant Names, Second Edition* (1942). American Joint Committee on Horticulture Nomenclature, Horace McFarland Company, Harrisburg, PA.
C. *American National Standard for Tree Care Operations* – Tree, Shrub and Other Woody Plant Maintenance – Standard Practices, ANSI A300, current edition.
D. State of Wisconsin Department of Transportation, *Standard Specifications for Highway and Structure Construction*, current edition.

1.4 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
B. 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.

C. Finish Grade: Elevation of finished surface of planting soil.
D. 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.
E. 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.
F. Planting Area: Areas to be planted.
G. Planting Soil: Standardized topsoil; existing, on-site soil; imported soil; or manufactured topsoil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
H. 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.
I. 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.
J. 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.

1.5 COORDINATION

A. Coordination with Turf Areas (Lawns): Install plant materials after finish grades are established and before planting turf areas unless otherwise indicated.
   1. When installing plant materials after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.
B. Coordinate all planting operations with other contractors working on site. Contractor shall coordinate specifically to eliminate conflicts in scheduling, materials storage, maintenance and/or other coordination.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated:
   1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials. Provide list(s) for all plant material to Landscape Architect fourteen (14) days in advance of the planting.
B. Samples for Verification: For each type of product indicated:
   1. Mulch: 1 quart of each type of mulch required, in sealed plastic bag, labeled with composition of materials by percentage of weight and source of mulch. Sample shall be typical of the lot of material to be furnished and provide an accurate representation of color, texture, and makeup.
C. Qualification Data: For qualified landscape 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.
D. 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.
E. Warranty: All plant material shall be under warranty for one (1) year from date of substantial completion; the warranty shall correspond to the required maintenance period.
F. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of maintenance and warranty period.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants and similarly designed landscapes.
   1. Experience: Three years' experience in landscape installation in addition to requirements in Division or Section "Quality Requirements"
   2. Installer's Field Supervision: Require installer to maintain an experienced full-time supervisor on Project site at all times when work is in progress.
B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
C. All plant material shall be true to species and variety/hybrid/cultivar specified, and nursery grown in accordance with good horticultural practices, and under climatic conditions similar to those of the site location. Specimens that are nursery-dug to be replanted shall have been freshly dug and properly prepared for planting.
D. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Plants shall conform to the measurements specified within the contract documents. Specified height and spread dimensions will refer to the main body of the plant, and not from branch tip to branch tip. Plants meeting a specified measurement, but judged to lack the balance between height and spread characteristics of the species will be rejected.
2. Herbaceous perennials shall be measured by pot size, not by top growth.
3. All other measurements, such as number of canes, ball sizes, and quality designations, shall conform to *American Standards for Nursery Stock*.

E. Plant Material Observation: Landscape Architect or Project Representative may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect or Project Representative retains right to observe plant material further for size and condition of 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 plant material immediately from Project site.
1. Notify Landscape Architect of sources of planting materials fourteen days in advance of delivery to site.

F. Preinstallation Conference: Conduct conference at Project site.

G. Plants are to be inspected upon delivery to Project site and the Landscape Architect or Owner's Project Representative may reject any specimens no longer meeting the specified standards or that have been damaged in transit.

H. Planting Layouts:
1. Contact Project Representative at least five (5) working days in advance of planting operations to coordinate review and approval of staked locations and to coordinate time(s) for planting bed layouts.
2. Layout all planting beds and obtain approval of the general size, location and herbaceous plant material placement within the beds prior to installation of plant material.

I. Discrepancies:
1. If discrepancies occur between the written Plant List, Plant Schedule, and/or Plant Palette and the actual plant count from the planting symbols on the plans in the Working Drawing set the plans shall govern over the written schedule, or index of units.

1.8 SUBSTITUTIONS

A. The substitution of plant material is not permitted unless authorized in writing by the Landscape Architect. If written proof is submitted that the plant of the specified species, variety, or size is unavailable, consideration will be given towards the nearest available size or variety, or towards an alternate species selection, with a corresponding adjustment of the contract price.

B. Larger plants than those specified can be used upon approval of the Landscape Architect or Owner's Project Representative. The use of larger plants shall not increase the contract price. The container size of the larger specimen shall be proportionally increased, relative to the specified size.

1.9 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. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball or container.

E. 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.

F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
1. Do not remove container-grown stock from containers before time of planting.
2. 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.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of each service or utility.
   2. Do not proceed with interruption of services or utilities without Construction Manager's written permission.

C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance and warranty periods to provide required maintenance from date of Substantial Completion.
   1. Spring Planting: Approximately April 1st – June 15th. Planting shall not commence in the spring until ground has completely thawed.
   2. Fall Planting: September 1st – October 15th

D. 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.

E. Protect all plants, lawns, and grass areas from damage at all times. Damaged plants, lawns or grass areas shall be replaced or treated as required to conform to specifications herein for fresh stock. Work area shall be kept clean and orderly during the installation period. Under no condition shall debris from planting activities result in a safety hazard on-site or to adjacent off-site property. Damage to lawns or grass areas incurred as a result of planting or replacement operations shall be repaired by the Contractor that causes the damage at no cost to the Owner.

1.11 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 or incidents that are beyond the Contractor's control.
      b. Structural failures including plantings falling or blowing over.
      c. Faulty performance of mulches.
   2. Warranty Periods stated below are from the date of substantial completion or project acceptance, whichever is later:
      a. Perennials and mulches: 1 full growing season after project acceptance, timed with and as part of the required maintenance service.
   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.

1.12 MAINTENANCE SERVICE

A. Initial Maintenance Service for all plant material: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. 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. Spring Installations: Plantings installed prior to June 15 shall be maintained for the duration of the growing season (until November 1).
   2. Fall Installations: Plantings installed after September 1 shall be maintained for the remainder of the growing season (until November 1) AND for the entire growing season of the following year (April 1 – November 1).

PART 2 - PRODUCTS

2.1 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. 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.

B. Labeling: Label one plant of each variety and size 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 as shown on the Drawings. Remove all tags and labels once Landscape Architect or Project Representative has reviewed all plantings on-site.

C. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread.

2.2 PLANTING SOIL

A. Refer to Section 32 91 13 “Soil Preparation” for planting soil to be used for all planting beds as well as organic and inorganic soil amendments, fertilizers and topsoil testing requirements.

2.3 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing and consisting of the following:
   1. Shredded Hardwood Bark Mulch: Size range shall be ½ inch to 2 inches with a maximum size for any single piece of no greater than 3 inches. Color shall be natural brown (no dye).

2.4 PESTICIDES

A. General: Employ integrated pest management best management practices (hand-pulling weeds) throughout installation, establishment and maintenance of plants. Any pesticide or herbicide use must be reviewed and approved by Project Representative.

B. 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.

C. 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.

D. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance of the Work.
   1. Verify that sufficient Planting soil has been provided as indicated in Section 32 91 13 “Soil Preparation”. If insufficient depth or material is observed notify the Project Representative immediately to determine course of remedial action. Do not install plantings until all unsatisfactory conditions have been corrected.
   2. 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.
   3. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
   4. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   5. 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 Architect and replace with new planting soil.

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

3.2 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. Contact Project Representative at least seven (7) working days in advance of planting to coordinate plant layout, obtain approval of plant locations and plant bed layouts prior to planting or installation of landscape materials.

3.3 PERENNIAL PLANTING

A. Dig holes large enough to allow spreading of roots.

B. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

C. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

D. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.4 PLANTING BED MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Apply 3-inch average thickness of shredded hardwood bark mulch over surfaces of at-grade planting beds as indicated in Working Drawings and finish to 1” below adjacent pavement surfaces.

3.5 CLEAN-UP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. 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.

C. After installation and inspection by Project Representative or Landscape Architect, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.6 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, trash and debris and legally dispose of them off the Owner’s property.

3.7 LANDSCAPE MAINTENANCE

A. Visit the site at least 2 times per month during the months of April to November to perform acceptable and industry-standard landscape maintenance for the entire project for the duration of the stated maintenance period.

B. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

C. 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.

D. Refresh organic mulch on an annual basis or as necessary to maintain installed depths and a clean, finished appearance. In addition refresh mulch just prior to end of the maintenance period.

E. Use integrated pest management practices including physical controls such as hosing off foliage, mechanical controls such as traps and biological control agents.

F. Hand-weed all planting beds to remove germinating annual, biennial and/or perennial weeds. The use of broad-spectrum herbicides must be approved by Project Representative.

G. Replace any and all landscape materials deemed to be damaged or that fail during the maintenance period.

END OF SECTION

SECTION 33 12 13
WATER SERVICE CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. All work shall be in accordance with Part VII of the City of Madison Standard Specifications for Public Works Construction, Current Edition, except as noted below. It is the responsibility of the Contractor to confirm most recent revisions to City specifications are being followed.

1.3 EXCEPTIONS

A. None.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 33 31 00
SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. All work shall be in accordance with Part V of the City of Madison Standard Specifications for Public Works Construction, Current Edition, except as noted below. It is the responsibility of the Contractor to confirm most recent revisions to City specifications are being followed.

1.3 EXCEPTIONS

A. None.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 33 41 00
STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. All work shall be in accordance with Part V of the City of Madison Standard Specifications for Public Works Construction, Current Edition, except as noted below. It is the responsibility of the Contractor to confirm most recent revisions to City specifications are being followed.

1.3 EXCEPTIONS

A. None.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION