PROJECT MANUAL VOLUME TWO SOUTH ORANGETOWN CENTRAL SCHOOL DISTRICT 2022 BOND - PHASE 2

15 Dutch Hill Road, Orangeburg, NY 10962 DIVISIONS 22 THROUGH 28

CPL PROJECT NO.: R22.14457.20 **DOCUMENT ISSUE DATE:** 10/25/24

NEW YORK STATE EDUCATION DEPARTMENT PROJECT CONTROL NUMBER(S): Tappan Zee High School: 50-03-01-06-0-006-033

DESIGN PROFESSIONAL'S CERTIFICATION:

The undersigned certifies that, to the best of his or her knowledge, information and belief, that the "Design conforms to all applicable provisions of the current New York State Uniform Fire Prevention Code, Building Code and Energy Conservation Code, the building standards of the New York State Education Department and that the "Work will involve known or suspected ACBM, and will be done in accordance with Industrial Code Rule #56".

ALTERATION WARNING STATEMENT:

It is a violation of the New York State Education Law and the Commissioner's regulations for any person, unless acting under the direction of a licensed Architect, Engineer or Land Surveyor, to alter an item in any way. If an item bearing the seal of an Architect, Engineer or Land Surveyor is altered, the altering party shall affix to the item, their seal and the notation " ALTERED BY ", followed by their signature and the date of such alteration, and a specific description of the alteration.

ARCHITECT / ENGINEER

CPL

26 IBM Road Poughkeepsie, NY 12601 (800) 274-9000 www.cplteam.com

CONSTRUCTION MANAGER

The Palombo Group

22 Noxon Street, Poughkeepsie, NY 12601

> (845) 868-1239 www.thepalombogroup.com

OWNER

South Orangetown Central School District

15 Dutch Hill Road, Orangeburg, NY 10962

> (845) 680-1000 www.socsd.org



This page intentionally left blank

SECTION 220500 COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Grout.
 - 7. Painting and finishing.
 - 8. Supports and anchorages.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, 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.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Provide: To supply, furnish, install and connect, ready for safe and regular operation of the system or equipment.
- G. Install: To erect, mount and connect complete, with related accessories.
- H. Supply, Furnish: To purchase, procure, acquire and deliever complete, with related accessories.
- I. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
- J. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.04 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Mechanical sleeve seals.
 - 3. Escutcheons.

B. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.07 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate all plumbing piping and equipment with all other trades, including HVAC, electrical, structural and Architectural ceiling elevations.

PART 1 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. 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 (3.2-mm) 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. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

- 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.04 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 - 2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
 - 3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
 - 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Eslon Thermoplastics.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Thompson Plastics, Inc.
- D. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.05 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.

- b. Calpico, Inc.
- c. Metraflex Co.
- d. Pipeline Seal and Insulator, Inc.
- 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- 3. Pressure Plates: Carbon steel. Include two for each sealing element.
- 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.06 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.07 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.1. Finish: Polished chrome-plated and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chromeplated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.08 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive,
 - nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 1 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- 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 to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, castbrass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stampedsteel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
 - g. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw or spring clips.
 - h. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
 - i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).

- b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsumboard partitions.
- 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - 2. Equal to Link-Seal by Garlock.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. 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.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- 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:
 - 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.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

- I. Plastic 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. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.03 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.05 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.06 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.07 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

This page intentionally left blank

SECTION 220523 GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Ball valves.
- B. Check valves.

1.03 RELATED REQUIREMENTS

- A. Section 220553 Identification for Plumbing Piping and Equipment.
- B. Section 220719 Plumbing Piping Insulation.
- C. Section 221005 Plumbing Piping.

1.04 ABBREVIATIONS AND ACRONYMS

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

1.05 REFERENCE STANDARDS

- A. ASME B1.20.1 Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B16.10 Face-to-Face and End-to-End Dimensions of Valves; 2022.
- C. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- D. ASME B31.9 Building Services Piping; 2020.
- E. ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- F. AWWA C606 Grooved and Shouldered Joints; 2022.
- G. MSS SP-67 Butterfly Valves; 2022.
- H. MSS SP-72 Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.
- I. MSS SP-80 Bronze Gate, Globe, Angle, and Check Valves; 2019.
- J. MSS SP-110 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- K. NSF 61 Drinking Water System Components Health Effects; 2020.
- L. NSF 372 Drinking Water System Components Lead Content; 2020.

1.06 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.07 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 - 5. Secure check valves in either the closed position or open position.
 - 6. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

1.09 EXERCISE THE FOLLOWING PRECAUTIONS FOR HANDLING:

- A. Handle large valves with sling, modified to avoid damage to exposed parts.
- B. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- 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. Conbraco Industries Inc.; Apollo Valves.
 - 2. Crane Co.; Crane Valve Group; Crane Valves.
 - 3. Hammond Valve
 - 4. Milwaukee Valve Company
 - 5. NIBCO INC.
 - 6. Red-White Valve Corporation
 - 7. Watts Regulator Co.; a division of Watts Water Technologies. Inc.

2.02 APPLICATIONS

- A. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
- B. Provide the following valves for the applications if not indicated on drawings:
 - 1. Shutoff: Ball, butterfly, ____
 - 2. Dead-End: Single-flange butterfly (lug) type.
 - 3. Throttling: Provide angle, ball, or butterfly.
 - 4. Swing Check (Pump Outlet):
 - a. 2 inch and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. 2-1/2 inch and Larger for Domestic Water: Iron swing check valves with closure control, metal or resilient seat check valves.
- C. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.
- D. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. 2 inch and Smaller: Threaded ends.

- b. 2-1/2 inch to 4 inch: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
- 2. Copper Tube:
 - a. 2 inch and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - b. 2-1/2 inch to 4 inch: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
- E. Domestic, Hot and Cold Water Valves:
 - 1. 2 inch and Smaller:
 - a. Ball: Two piece, full port, brass with brass trim.
 - b. Bronze Swing Check: Class 125, bronze disc.
 - 2. 2-1/2 inch and Larger:
 - a. Iron Grooved-End Butterfly: 175 CWP.
 - b. Iron Swing Check: Class 125, metal seats.

2.03 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
- D. Insulated Piping Valves: With 2 inch stem extensions and the following features:
 - 1. Gate Valves: Rising stem.
 - 2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- E. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Solder Joint Connections: ASME B16.18.
 - 3. Grooved End Connections: AWWA C606.
- F. General ASME Compliance:
 - 1. Solder-joint Connections: ASME B16.18.
 - 2. Building Services Piping Valves: ASME B31.9.
- G. Potable Water Use:
 - 1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
 - 2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.
- H. Source Limitations: Obtain each valve type from a single manufacturer.

2.04 BRONZE, BALL VALVES

- A. General:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Two Piece, Full Port with Stainless Steel Trim:
 - 1. Comply with MSS SP-110.
 - 2. WSP Rating: 150 psi.
 - 3. WOG Rating: 600 psi.
 - 4. Body: Forged bronze or dezincified-brass alloy.
 - 5. Ends Connections: Pipe thread or solder.
 - 6. Seats: PTFE.
 - 7. Stem: Stainless steel, blowout proof.
 - 8. Ball: Stainless steel, vented.

- 9. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. Watts
 - c. Nibco Equal to 585HP-66-LF

2.05 BRONZE, LIFT CHECK VALVES

- A. General:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125:
 - 1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
 - 2. CWP Rating: 200 psi.
 - 3. Design: Vertical flow.
 - 4. Body: Comply with ASTM B61 or ASTM B62, bronze.
 - 5. End Connections: Threaded.

2.06 BRONZE, SWING CHECK VALVES

- A. General:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125:
 - 1. Pressure and Temperature Rating: MSS SP-80, Type 3.
 - 2. Design: Y-pattern, horizontal or vertical flow.
 - 3. WOG Rating: 200 psi.
 - 4. Body: Bronze, ASTM B62.
 - 5. End Connections: Threaded.
 - 6. Disc: Bronze.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- D. Install check valves where necessary to maintain direction of flow as follows:
 - 1. Lift Check: Install with stem plumb and vertical.
 - 2. Swing Check: Install horizontal maintaining hinge pin level.
 - 3. Orient plate-type into horizontal or vertical position, between flanges.

END OF SECTION

SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Pipe hangers.
- B. Pipe supports, guides, shields, and saddles.
- C. Anchors and fasteners.

1.03 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 055000 Metal Fabrications.

1.04 REFERENCE STANDARDS

- A. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM A181/A181M Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2023.
- D. ASTM A36/A36M Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A47/A47M Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- F. ASTM A283/A283M Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.
- G. ASTM A395/A395M Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
- H. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- I. ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2018a.
- J. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- K. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- L. ASTM E96/E96M Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- M. FM (AG) FM Approval Guide; Current Edition.
- N. MFMA-4 Metal Framing Standards Publication; 2004.
- O. MSS SP-58 Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- P. UL (DIR) Online Certifications Directory; Current Edition.
- Q. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

220529

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.06 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fitting Industry Inc.

1.07 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ACSE/SEI7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, systems contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.08 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.09 QUALITY ASSURANCE

A. Comply with applicable building code.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.
- B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.
- C. Materials for Metal Fabricated Supports: Comply with Section 055000.
 - 1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
 - 2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.

D. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.

2.02 PIPE HANGERS

- A. Band Hangers, Adjustable:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
 - c. Substitutions: See Section 016000 Product Requirements.
 - MSS SP-58 type 7 or 9, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
- B. J-Hangers, Adjustable:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7025: www.fnw.com/#sle.
 - c. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - MSS SP-58 type 5, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
 - 3. Felt-Lined: Provide for uninsulated pipe to reduce noise and prevent static issues.
- C. Swivel Ring Hangers, Adjustable:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7010: www.fnw.com/#sle.
 - c. Substitutions: See Section 016000 Product Requirements.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. MSS SP-58 type 10, epoxy-painted, zinc-colored.
 - 3. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
 - 4. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.
- D. Clevis Hangers, Adjustable:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7005: www.fnw.com/#sle.
 - c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. Copper Tube: MSS SP-58 type 1, epoxy-plated copper.
 - 3. Felt-Lined: MSS SP-58 type 1, zinc-plated, silicone-free carbon steel.
 - 4. Light-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.
 - 5. Standard-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.
 - 6. UL (DIR) listed: Pipe sizes 2-1/2 to 8 inch.
 - 7. FM (AG) listed: Pipe sizes 2-1/2 to 8 inch.

2.03 PIPE CLAMPS

- A. Riser Clamps:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7020: www.fnw.com/#sle.
 - c. nVent Caddy, a brand of nVent: www.erico.com/#sle.

220529

- d. Substitutions: See Section 016000 Product Requirements.
- 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- 3. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
- 4. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
- 5. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
- 6. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.
- B. Extension Split Pipe Clamp:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7001: www.fnw.com/#sle.
 - c. nVent Caddy, a brand of nVent: www.erico.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. MSS SP-58 type 12, hinged split ring and yoke roller hanger with epoxy copper or plain finish.
 - 3. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
 - 4. Provide hanger rod and nuts of the same type and material for a given pipe run.
 - 5. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- C. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- D. Strut Clamps:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7815: www.fnw.com/#sle.
 - c. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.

2.04 PIPE SUPPORTS, GUIDES, SHIELDS, AND SADDLES

- A. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.
- B. Stanchions:
 - 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com/#sle.
 - b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - c. nVent Caddy, a brand of nVent: www.erico.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 3. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- C. U-Bolts:

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND

14457.20

EQUIPMENT

- 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. FNW; 7610: www.fnw.com/#sle.
 - c. nVent Caddy, a brand of nVent: www.erico.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
- 2. MSS SP-58 type 24, carbon steel u-bolt for pipe support or anchoring.
- D. Intermediate Anchors and Pipe Alignment Guides:
 - 1. Manufacturers:
 - a. Anvil International, LLC: www.anvilintl.com/#sle.
 - b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - c. Gregory Industries, Inc: www.gregorycorp.com/#sle.
 - 2. Pipe Sizes 6 inch and Smaller: Minimum clearance of 0.16 inch.
 - 3. Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.
- E. Pipe Alignment Guides, Galvanized steel:
 - 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com/#sle.
 - b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - c. Gregory Industries, Inc: www.gregorycorp.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. Pipe Sizes 8 inch and Smaller: Spider or sleeve type.
 - 3. Pipe Sizes 10 inch and Larger: Roller type.
- F. Pipe Shields for Insulated Piping:
 - 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com/#sle.
 - b. FNW; 7753: www.fnw.com/#sle.
 - c. Gregory Industries, Inc: www.gregorycorp.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. MSS SP-58 type 40, ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
 - 3. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Service Temperature: Minus 40 to 178 degrees F.
 - e. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- G. Pipe Supports:
 - 1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
 - 2. Liquid Temperatures Up to 122 degrees F:
 - a. Overhead Support: MSS SP-58 types 1, 3 through 12 clamps.
 - b. Support From Below: MSS SP-58 types 35 through 38.
- H. Pipe Supports, Thermal Insulated:
 - 1. Manufacturers:
 - a. Buckaroos, Inc: www.buckaroos.com/#sle.

220529

- b. KB Enterprises: www.snappitz.com/#sle.
- 2. General Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Provide pipe supports for 1/2 to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid phenolic foam insulation surrounded by 360 degree, PVC jacketing.
- 3. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with ball bearing hinge and locking seam.
 - b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - c. Minimum Thickness: 60 mil, 0.06 inch.
- I. Copper Pipe Supports:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - c. Substitutions: See Section 016000 Product Requirements.
 - d. Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by single manufacturer.
- J. Overhead Pipe Supports:
 - 1. Manufacturers:
 - a. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - b. nVent Caddy, a brand of nVent: www.erico.com/#sle.
 - c. Substitutions: See Section 016000 Product Requirements.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

- 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
- 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
- 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

This page intentionally left blank

SECTION 220553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe markers.

1.03 RELATED REQUIREMENTS

A. Section 099123 - Interior Painting: Identification painting.

1.04 REFERENCE STANDARDS

- A. ASME A13.1 Scheme for the Identification of Piping Systems; 2020.
- B. ASTM D709 Standard Specification for Laminated Thermosetting Materials; 2017.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Piping: Tags.
- B. Pumps: Nameplates.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
- B. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.
 - 4. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 STENCILS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
- C. Stencil Paint: As specified in Section 099123, semi-gloss enamel, colors complying with ASME A13.1.

2.05 PIPE MARKERS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
- B. Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Color code as follows:
 - 1. Domestic Water, Storm Drainage, Waste & Vent: Green with white letters.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 099123 for stencil painting.

3.02 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 099123.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- G. Use tags on piping 3/4 inch diameter and smaller.
- H. Install labels and/or tags on all pipes as follows:
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION

SECTION 220719 PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.
- D. Supplies and drains for hand
- E. Section includes insulating the following pipe systems
 - 1. Domestic Cold Water Piping
 - 2. Domestic Hot Water Piping
 - 3. Domestic recirculating hot water piping

1.02 RELATED REQUIREMENTS

- A. Section 099123 Interior Painting: Painting insulation jacket.
- B. Section 221005 Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

- A. ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.
- B. ASTM C195 Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- C. ASTM C534/C534M Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2020a.
- D. ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation; 2019.
- E. ASTM C552 Standard Specification for Cellular Glass Thermal Insulation; 2022.
- F. ASTM C585 Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010 (Reapproved 2016).
- G. ASTM C795 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2018).
- H. ASTM D2842 Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2019.
- I. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- J. ASTM E96/E96M Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- K. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- C. Maintain ambient conditions required by manufacturers of each product.
- D. Maintain temperature before, during, and after installation for minimum of 24 hours.

1.05 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.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER

- A. Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
 - 1. K Value: ASTM C177, 0.23 at 75 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perminches.

2.03 CELLULAR GLASS

- A. Manufacturers:
 - 1. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C552, Type II, Grade 6.
 - 1. K Value: 0.35 at 100 degrees F.
 - 2. Service Temperature Range: From 250 degrees F to 800 degrees F.
 - 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
 - 4. Water Absorption: 0.5 percent by volume, maximum.

2.04 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com/#sle.
 - Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

2

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
 - 1. Provide PVC jacket on all exposed piping up to 7' above finished floor (i.e. all piping at domestic hot water system and exposed vertical storm leaders).
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Install cellular melamine with factory-applied jackets with a manufacturer-approved adhesive along seams, both straight lap joints and circumferential lap joints.
 - 1. Install seal over seams with factory-approved room temperature vulcanization (RTV) silicone sealant to ensure a positive vapor barrier seal in outdoor and sanitary washdown environments.
- F. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- G. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- H. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.

3.03 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 Insert dimension thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- 2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water (105-140 F):

- 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.
- C. 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. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - b. Manufactured system with PVC jacket equal to Truebro. Refer also to fixture specification.
- D. Sanitary Waste Piping Where Heat Tracing Is Installed:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.

3.04 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the fieldapplied 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:
- D. Piping, Exposed:
 - 1. PVC: 20 mils thick.

END OF SECTION

SECTION 221005 PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary waste piping, buried beyond 5 feet of building.
- B. Sanitary waste piping, buried within 5 feet of building.
- C. Sanitary waste piping, above grade.
- D. Chemical-resistant sanitary waste piping.
- E. Domestic water piping, buried beyond 5 feet of building.
- F. Domestic water piping, buried within 5 feet of building.
- G. Domestic water piping, above grade.

1.02 RELATED REQUIREMENTS

- A. Section 083100 Access Doors and Panels.
- B. Section 099113 EXTERIOR PAINTING.
- C. Section 220516 Expansion Fittings and Loops for Plumbing Piping.
- D. Section 220553 Identification for Plumbing Piping and Equipment.
- E. Section 312316 Excavation.
- F. Section 312323 Fill.

1.03 REFERENCE STANDARDS

- A. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- B. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- C. ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- D. ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings: DWV; 2021.
- E. ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.
- F. ASME B31.1 Power Piping; 2022.
- G. ASME B31.9 Building Services Piping; 2020.
- H. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2020.
- I. ASTM A74 Standard Specification for Cast Iron Soil Pipe and Fittings; 2021.
- J. ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.
- K. ASTM B32 Standard Specification for Solder Metal; 2020.
- L. ASTM B88 Standard Specification for Seamless Copper Water Tube; 2022.
- M. ASTM B88M Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- N. ASTM B306 Standard Specification for Copper Drainage Tube (DWV); 2020.
- O. ASTM B813 Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.
- P. ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.
- Q. ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.

- R. ASTM C1277 Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- S. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- T. AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings; 2012.
- U. AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.
- V. AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).
- W. AWWA C651 Disinfecting Water Mains; 2014, with Addendum (2020).
- X. CISPI 301 Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- Y. CISPI 310 Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.
- Z. NSF 61 Drinking Water System Components Health Effects; 2020.
- AA. NSF 372 Drinking Water System Components Lead Content; 2020.
- BB. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
- B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.02 SANITARY WASTE PIPING, BURIED BEYOND 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 extra heavy weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.

2.03 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 extra heavy weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

2.04 SANITARY SEWER AND SANITARY VENT PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- B. Copper Tube: ASTM B306, DWV.
 - 1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, sovent.
 - 2. Joints: ASTM B32, alloy Sn50 solder.

2.05 DOMESTIC WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING

- A. Ductile Iron Pipe: AWWA C151/A21.51.
 - 1. Fittings: AWWA C110/A21.10, ductile or gray iron, standard thickness.
 - 2. Joints: AWWA C111/A21.11, styrene-butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.

2.06 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Ductile Iron Pipe: AWWA C151/A21.51.
 - 1. Fittings: Ductile or gray iron, standard thickness.
 - 2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.

2.07 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.

2.08 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.1.
 - 3. Paint all exposed exterior natural gas piping. Confirm color with Architect. Grey, Yellow or as otherwise prescribed.

2.09 PIPE FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 inch and Under:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.
 - 2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.
- B. No-Hub Couplings:
 - 1. Testing: In accordance with ASTM C1277 and CISPI 310.
 - 2. NSF Certification
 - 3. Gasket Material: Neoprene complying with ASTM C564.
 - 4. Band Material: Stainless steel.
 - 5. Eyelet Material: Stainless steel.
 - 6. Manufacturers:
 - a. MIFAB, Inc; MI-QHUB: www.mifab.com/#sle.
 - b. Charlotte Pipe and Foundry
 - c. Ideal Tridon

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 220516.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- G. Provide access where valves and fittings are not exposed.1. Coordinate size and location of access doors with Section 083100.
- H. Establish elevations of buried piping outside the building to ensure not less than 5 ft of cover for pipes that require freeze protection.
- I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; see Section
- J. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
 1. See Section 099113 for painting of exterior plumbing systems and components.
- K. Excavate in accordance with Section 312316.
- L. Backfill in accordance with Section 312323.
- M. Install valves with stems upright or horizontal, not inverted. See Section 220523.
- N. Install water piping to ASME B31.9.
- O. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
- P. Sleeve pipes passing through partitions, walls, and floors.
- Q. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- R. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches of each horizontal elbow.
 - 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Provide copper plated hangers and supports for copper piping.

- 8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- S. Pipe Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 - 3. Locate piping in center of sleeve or penetration.
 - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 5. Tighten bolting for a watertight seal.
 - 6. Install in accordance with manufacturer's recommendations.

3.04 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- D. Provide spring-loaded check valves on discharge of water pumps.

3.05 FIELD TESTS AND INSPECTIONS

- A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.
- B. Domestic Water Systems:
 - 1. Perform hydrostatic testing for leakage prior to system disinfection.
 - 2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
 - 3. General:
 - a. Fill the system with water and raise static head to 10 psi above service pressure. Minimum static head of 50 to 150 psi. As an exception, certain codes allow a maximum static pressure of 80 psi.
- C. Gas Distribution Systems:
 - 1. Test Preparation: Close each appliance valve or disconnect and cap each connected appliance.
 - 2. General Systems:
 - a. Inject a minimum of 10 psi of compressed air into the piping system for a duration of 15 minutes and verify with a gauge that no perceptible pressure drop is measured.
 - b. Ensure test pressure gauge has a range of twice the specific pressure rate selected with an accuracy of 1/10 of 1 pound.
 - 3. Welded Pipes or Systems with Service Pressures Above 14 in-wc:
 - a. Inject a minimum of 60 psi of compressed air into the piping system for a duration of 30 minutes and verify with a gauge that no perceptible pressure drop is measured.
 - b. Ensure test pressure gauge has a range of twice the specific pressure rate selected with an accuracy of 1/10 of 1 pound with 1 psi increments.
- D. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed, and clean.
- B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.

- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 DISINFECTION OF DOMESTIC WATER PIPING - NYS DOH

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of the existing piping that have been altered, extended, or repaired, before putting back into use.
 - 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. OR
 - 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 (above normal potable water limites) is in water coming from system after the standing time.
 - d. Repeat procedures if biologival examination shows contaimination.
 - e. Submit water sampes in sterile bottles to NYS Department of Health approved lab with results sent to the DOH and to the architect/engineer of record as project submittal.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water sample approval from NYS Department of Health approved lab.
- C. Where new fixture have been added to nYS K-12 school buildings, test samples shall be taken at all new fixtures in accordance with SED testing protocol for Lead. Submit test results to Arch/Engineer./District.

3.08 SERVICE CONNECTIONS

- A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve, and sand strainer.
 - 1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

END OF SECTION

SECTION 224000 PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sinks.
- B. Emergency showers.

1.02 RELATED REQUIREMENTS

- A. Section 064100 Architectural Wood Casework: Counters for sinks and lavatories.
- B. Section 079200 Joint Sealants: Sealing joints between fixtures and walls and floors.
- C. Section 221005 Plumbing Piping.

1.03 REFERENCE STANDARDS

- A. ADA Standards Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ASME A112.6.1M Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
- C. ASME A112.18.1 Plumbing Supply Fittings; 2018, with Errata.
- D. ASME A112.18.9 Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures; 2011 (Reaffirmed 2022).
- E. ASME A112.19.1 Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures; 2018.
- F. ASME A112.19.2 Ceramic Plumbing Fixtures; 2018, with Errata.
- G. ASME A112.19.3 Stainless Steel Plumbing Fixtures; 2022.
- H. ASME A112.19.4M Porcelain Enameled Formed Steel Plumbing Fixtures; 1994 (Reaffirmed 2009).
- I. ASME A112.19.5 Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2022.
- J. ASME A112.19.15 Bathtubs/Whirlpool Bathtubs with Pressure Sealed Doors; 2012 (Reaffirmed 2022).
- K. ASSE 1014 Performance Requirements for Backflow Prevention Devices for Hand-Held Showers; 2020.
- L. ASSE 1070 Performance Requirements for Water Temperature Limiting Devices; 2020.
- M. ASTM C1822 Standard Specification for Insulating Covers on Accessible Lavatory Piping; 2021.
- N. ICC A117.1 Accessible and Usable Buildings and Facilities; 2017.
- O. NSF 61 Drinking Water System Components Health Effects; 2020.
- P. NSF 372 Drinking Water System Components Lead Content; 2020.
- Q. UL (DIR) Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Manufacturer's Instructions: Indicate installation methods and procedures.
- D. Sustainable Design Documentation: Submit appropriate evidence that materials used in potable water systems comply with the specified requirements.
- E. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on-site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.07 WARRANTY

- A. See Section 017800 Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
- B. Water Efficiency: EPA WaterSense label is required for all water closets, urinals, lavatory faucets, and showerheads.

2.02 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for installation of plumbing systems.
- B. Comply with UL (DIR) requirements.
- C. Perform work in accordance with local health department regulations.
- D. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation.

2.03 PLUMBING FIXTURES

- A. See Plumbing Plans for Plumbing Fixture Schedule
 - 1. Provide Plumbing Fixtures and all accessories as indicated on the plumbing fixture schedule on the drawings. Acceptable manufacturer are indicated below.
 - a. American Standard, Inc: www.americanstandard-us.com/#sle.
 - b. Delany Products: www.delanyproducts.com/#sle.
 - c. DXV by American Standard, Inc: www.dxv.com/#sle.
 - d. Sloan Valve Company: www.sloanvalve.com/#sle.
 - e. Kohler Company: www.kohler.com/#sle.
 - f. Viega LLC: www.viega.us/#sle.
 - g. Zurn Industries, Inc: www.zurn.com/#sle.
 - h. _____
 - i. Substitutions: See Section 016000 Product Requirements.

2.04 SINKS - ADA (SK-1) SINGLE BOWL

- A. Single Compartment Bowl
 - 1. ASME A112.19.3; 25 by 19-1/2" by 5-1/2" inch outside dimensions 20 gauge, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
- B. See Plumbing Schedule for Model Information
- C. Faucet: ASME A112.18.1; chrome plated combination supply fitting with pop-up waste, water economy aerator with maximum flow of 2.2 gallons per minute, indexed handles.
2.05 SINKS - ADA (SK-2) SINGLE BOWL

- A. Substitutions: See Section 016000 Product Requirements.
- B. See Plumbing Schedule for Model Information
- C. Single Compartment Bowl: ; 15" by 17-1/2" by 6" inch outside dimensions 20 gauge, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
 - 1. Drain: 1-1/2 inch chromed brass drain.
 - 2. Drain: 3-1/2 inch crumb cup and tailpiece.
- D. Faucet: ASME A112.18.1; chrome plated combination supply fitting with open grid strainer, water economy aerator with maximum flow of 2.2 gallons per minute, indexed handles.
- E. Substitutions: See Section 016000 Product Requirements.

2.06 UNDER-LAVATORY PIPE SUPPLY COVERS

- A. Manufacturers:
 - 1. Plumberex Specialty Products, Inc: www.plumberex.com/#sle.
 - 2. Truebro
 - 3. Oatey
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. General:
 - 1. Insulate exposed drainage piping, as well as, hot, cold and tempered water supplies under lavatories or sinks per ADA Standards.
 - 2. Construction: 1/8 inch PVC with antimicrobial, antifungal and UV resistant properties.
 - a. Comply with ASME A112.18.9 for covers on accessible lavatory piping.
 - b. Comply with ICC A117.1.
 - 3. Color: High gloss white.
 - 4. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces. No cable ties allowed.

2.07 EMERGENCY SHOWERS (EMS-1)

- A. Manufacturers:
 - 1. Haws Corporation: www.hawsco.com/#sle.
 - 2. Guardian Equipment: https://www.gesafety.com/.
- B. Emergency Shower: ANSI Z358.1; free standing, self- cleaning, nonclogging 8 inch diameter stainless steel deluge shower head with elbow, one inch full flow valve with pull chain and 8 inch diameter ring, one inch interconnecting fittings.
- C. Thermostatic Mixing Valve: Thermostatic mixing valve, ASSE 1070 listed, with combination stop, strainer, and check valves, and flexible stainless steel connectors.
 - 1. Manufacturers:
 - a. Acorn Engineering Company: www.acorneng.com/#sle.
 - b. Guardian Equipment: https://www.gesafety.com/.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.
- C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome-plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports and bolts.
- E. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

- A. Clean plumbing fixtures and equipment.
- B. See Section 017419 Construction Waste Management and Disposal for additional requirements.

3.07 PROTECTION

- A. Protect installed products from damage due to subsequent construction operations.
- B. Do not permit use of fixtures by construction personnel.
- C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 230000 GENERAL PROVISIONS FOR MECHANICAL WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Requirements of this Section apply to work in every Section of Division 23 equally as if incorporated therein.

1.02 WORK INCLUDED

A. Work included in Division 23 - Mechanical: Materials, equipment, fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for Mechanical Work covered by all sections within this Division.

1.03 SCOPE

- A. Division of the Specification into sections is for the purpose of simplification alone. Responsibility for the work of various trades shall rest with the Contractor. Various sections of this Division are related to each other as well as the mechanical drawings. Examine all drawings and read all applicable parts of the project manual in order to ensure complete execution of all work in this Division, coordinating where required with other trades in order to avoid conflicts.
- B. These specifications and accompanying drawings are intended to cover the furnishing of all labor, materials, equipment and services necessary for the complete installation and acceptable performance of the mechanical systems. Small items of material, equipment and appurtenances not mentioned in detail or shown on the drawings, but necessary for complete and operating systems shall be provided by this contractor without additional charge to the Owner and shall be included under this contract.
- C. In general, specifications establish the quality of material, equipment and workmanship. The contract documents are intended to secure for the Owner, a first-class installation in every respect. Labor shall be performed by skilled mechanics, and the entire facility, when delivered to the Owner, shall be ready for satisfactory and efficient operation.
- D. The Contractor shall carefully examine the drawings and specifications before accepting the contract. He shall call attention to any changes or additions which, in his opinion, are necessary to make possible the fulfillment of any guarantee called for by these specifications; failing which, it shall be deemed that he has accepted full responsibility for all such guarantees.
- E. The contractor shall put his work in place as fast as is reasonably possible. He shall, at all times, keep a competent foreman in charge of the work, to make decisions necessary for the diligent advancement of the work. The Contractor shall facilitate the inspection of the work by the Owner's Representative.
- F. The Contractor shall coordinate all work in the building in order to facilitate intelligent execution of the work. He shall also remove any rubbish as expeditiously as possible.
- G. Materials or products specified herein and/or indicated on the drawings by trade's names, manufacturer's names, model number or catalog numbers establish the quality of materials or products to be furnished. Model numbers are to be confirmed by the manufacturer to provide required capacities and material to meet the specifications and design intent. In no instance shall an obsolete, incomplete or inaccurate trade name, manufacturer name, model number or catalog number indicated on the drawings, result in additional charges to the owner.
- H. Points of connection or continuation of work under this contract are so marked on drawings or herein specified. In case of any doubt as to the required exact location of such points, the Owner's Representative shall decide and direct.

I. The plumbing contractor shall provide water services to within two (2) feet of HVAC equipment requiring same, and shall terminate service with a shutoff valve. The mechanical contractor shall make the final connection to the equipment.

1.04 REFERENCE STANDARDS, CODES AND REGULATIONS

- A. Requirements of Regulatory Agencies:
 - 1. Nothing contained in these specifications or shown on the drawings shall be construed to conflict with any State or local laws, ordinances, rules and regulations, the UL and NFPA regulations. The Contractor shall make all changes required by the enforcing authorities. Where alterations to and / or deviations from the Contract Documents are required by the authorities having jurisdiction, report the requirements to the Engineer and secure acceptance before work is started. All such changes shall be made in a manner acceptable to the Engineer and shall be made without cost to the Owner.
 - 2. When drawings or specifications exceed requirements of applicable laws, ordinances, rules and regulations, comply with documents establishing the more stringent requirement. All work shall be done in full conformity with the requirements of all authorities having jurisdiction. Installation shall be made in compliance with all applicable regulations, and utility company rules, all of which shall be considered a part of this specification and shall take precedence in the order of listing.
 - 3. It is not the intent of drawings or specifications to repeat requirements of codes except where necessary for completeness in individual sections.
- B. Published specifications, standards, tests or recommended method of trade, industry or governmental organizations as listed below apply to all work in this Division, in addition to other standards which may be specified in individual sections:
 - 1. Associated Air Balance Council
 - 2. Air Diffuser Balance Council
 - 3. Air Moving and Conditioning Association
 - 4. American Gas Association
 - 5. American National Standards Institute
 - 6. Air Conditioning and Refrigeration Institute
 - 7. American Society of Heating, Refrigeration and Air Conditioning Engineers
 - 8. American Society of Mechanical Engineers
 - 9. American Society for Testing and Materials
 - 10. Cast Iron Soil Pipe Institute
 - 11. ETL Testing Laboratories
 - 12. Factory Mutual Engineering and Research Corporation
 - 13. National Standard Plumbing Code
 - 14. National Electrical Manufacturer's Association
 - 15. National Fire Protection Association
 - 16. National Board of Fire Underwriters
 - 17. National Electric Code
 - 18. Occupational Safety and Health Administration
 - 19. Plumbing Drainage Institute
 - 20. Sheet Metal & Air Conditioning Contractors National Association
 - 21. Underwriters Laboratories, Inc.
- C. Furnish and file with the proper authorities, all drawings required by them in connection with the work. Contractor shall secure and obtain all approvals, permits, licenses and inspections and pay all legal and proper fees and charges in this connection, before commencing work in order to avoid delays during construction. He shall deliver the official records of the granting of the permits, etc., to the Owner's Representative.

1.05 QUALITY ASSURANCE

A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.

- B. Supply all equipment and accessories new and free from defects.
- C. Supply all equipment and accessories in compliance with the applicable standards listed in Article 1.4 of this section with all applicable national, state and local codes.
- D. All items of a given type shall be the product of same manufacturer.

1.06 DESCRIPTION OF BID DOCUMENTS

- A. Specifications:
 - 1. Specifications, in general, describe quality and character of materials and equipment.
 - 2. Specifications are of simplified form and include incomplete sentences.
 - 3. Words or phrases such as "The Contractor shall", "shall be", "furnish", "provide", "a", "an", "the", and "all" may have been omitted for brevity.
- B. Drawings: Mechanical drawings under this contract are made a part of these specifications. Deviations from these specifications as noted below must have the approval of the Engineer or Construction Manager without an increase in contract price.
 - 1. The drawings shall be considered as being diagrammatic and for bidding purposes only. Intention is to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement. The attention of the contractor is called to the fact that while these drawings are generally to scale and are made as accurately as the scale will permit, all critical dimensions shall be determined in the field. They are not to be considered as erection drawings.
 - 2. The drawings do not indicate every fitting, elbow, offset, valve, etc. which is required to complete the job. Contractor shall prepare field erection drawings as required for the use of his mechanics to insure proper installation.
 - 3. Scaled and figured dimensions are approximate and are for estimating purposes only. Indicated dimensions are limiting dimensions.
 - 4. Before proceeding with work check and verify all dimensions in field.
 - 5. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
 - 6. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
 - 7. For exact locations of building elements, refer to dimensional Architectural/Structural drawings.
- C. Description of systems: Provide all materials to provide functioning systems in compliance with performance requirements specified, and any modifications resulting from reviewed shop drawings and field coordinated drawings.
 - 1. Installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawings.
- D. Do not use equipment exceeding dimensions indicated or equipment or arrangements that reduce required clearances or exceed specified maximum dimensions.
- E. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect for his interpretation and decision as early as possible, including during bidding period.
 - 1. Do not proceed with work without Engineer's decision.

1.07 EQUIPMENT MANUFACTURERS

A. The first named manufacturer is used as the basis of design. Other named manufacturers are identified as equivalent manufacturers, not equivalent products. Naming other manufacturers does not necessarily imply conformance of any specific product with the written specifications.

- B. The contractor is required to verify that equipment and material to be used on the project meets the requirements of the specifications and will physically fit the available space, clearance and service requirements of the particular piece of equipment and include all pertinent information when he submits material for acceptance. Contractor shall also be responsible for and bear the cost of any modifications to openings available or anticipated as being available for rigging equipment to its final installation place. This shall include openings in exterior envelope, walls and roofs, interior walls, corridors, passage ways or door openings. Any on site dismantling and any reassembly of equipment made necessary by impediment to the rigging of said equipment shall be the sole responsibility of the contractor.
- C. Contract document indicates power and physical requirements based on the equipment manufacturer's data as first named. If equipment requiring more system capacity is furnished, the contractor shall be responsible for the cost associated with modifying the design and installation of associated services, including any redesign costs associated with the engineer's review.

1.08 DEFINITIONS

- A. "Provide": To supply, furnish, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.
- B. "Install": To erect, mount and connect complete with related accessories.
- C. "Supply", "Furnish": To purchase, procure, acquire and deliver complete with related accessories.
- D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- E. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
- F. "Wiring": Raceway, fittings, wire, boxes and related items.
- G. "Concealed": Items referred to as hidden from normal sight, embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.
- H. "Exposed": Not installed underground or "concealed" as defined above.
- I. "Indicated", "Shown", or "Noted": As indicated, shown or noted on drawings or specifications.
- J. "Directed": Directed by Engineer.
- K. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified product.
- L. "Reviewed", "Satisfactory", or "Directed": As reviewed, satisfactory, or directed by or to Engineer.
- M. "Motor Controllers": Manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.
- N. "Control or Actuating Devices": Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
- O. "Remove": Dismantle, demolish and take away from the site and dispose of in accordance with all applicable rules and regulations or, should the Owner so require, deliver to a location as designated by the Owner for the use of the Owner, at no additional cons to the Owner.
- P. "Replace": Remove existing and provide an equivalent product or material as specified.
- Q. "Extract (and Reinstall) ": Carefully disassemble, dismantle existing, save or store where directed by the Owner, in such a manner as to preserve the existing condition and reinstall as indicated on the drawings or as described in the specifications.
- R. Where any device or piece of equipment is referred to in the singular number, such reference shall be deemed to apply to as many devices as are required to complete the installation.

1.09 JOB CONDITIONS

- A. This contractor shall investigate all conditions affecting his work and shall provide such offsets, fittings, valves, sheet metal work, etc., as may be required to meet conditions at the building.
- B. The contractor shall verify all measurements at the building site and shall be responsible for the correctness of same before ordering materials or before starting work of any Section.
 - 1. Report to Architect, in writing, conditions which will prevent proper provision of this work.
 - 2. Beginning work of any Section without reporting unsuitable conditions to Architect constitutes acceptance of conditions by Contractor.
 - 3. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to Owner.
- C. Piping and ductwork shall be concealed or run behind furring in finished spaces unless otherwise noted to be run exposed.
- D. Horizontal piping and ductwork not run below slabs on grade shall be run as close as possible to underside of roof or floor slab above and parallel to building lines. Maintain maximum headroom in all areas.
- E. Determine possible interference between trades before the work is fabricated or installed. The contractor must coordinate his work to insure that erection will proceed without such interference. Coordination is of paramount importance and no request for additional payment will be considered where such request is based upon interference between trades.
- F. Connections to Existing Work:
 - 1. Install new work and connect to existing work with minimum of interference to existing facilities.
 - 2. Temporary shutdowns of existing services:
 - 3. At no additional charges
 - a. At times not to interfere with normal operation of existing facilities.
 - b. Only with written consent of Owner.
 - 4. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
 - 5. Restore existing disturbed work to original condition.
- G. Removal, extraction and relocation of existing work.
 - 1. The work includes demolition or removal of all construction indicated or specified. All materials resulting from demolition work, except as indicated or specified otherwise, shall become the property of the Contractor and shall be removed from the site. Rubbish and debris shall be removed from the site daily unless otherwise directed so as to not allow accumulation inside or outside the building. Materials that cannot be removed daily shall be stored in areas specified by the Owner.
 - 2. Title to all materials and equipment to be demolished, excepting Owner salvage and historical items, is vested in the Contractor upon receipt of notice to proceed. The Owner will not be responsible for the condition, loss or damage to such property after notice to proceed.
 - 3. The Owner reserves the "Right of First Refusal" on all material for salvage. Material for salvage shall be stored as approved by the Owner. Salvage materials shall be removed from the site before completion of the Contract. Material for salvage shall not be sold on the site.
 - 4. Property of the Owner: Salvaged items remaining the property of the Owner shall be removed in a manner to prevent damage and packed or crated to protect the items from damage while in storage or during shipment and relocated by the contractor at no cost, to the Owners designated storage facility on the site. Containers shall be properly identified as to contents.
 - 5. Damaged Items: Items damaged during removal or storage shall be repaired or replaced to match existing.

- 6. Disconnect, remove or relocate material, equipment, plumbing fixtures, piping and other work noted and required by removal or changes in existing conditions.
- 7. Where existing pipes, conduits and/or ducts which are to remain prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits, and/or ducts.
- 8. Provide new material and equipment required for relocated equipment.
- 9. Plug or cap active piping or ductwork behind or below finish.
- 10. Do not leave long dead-end branches.
 - a. Cap or plug as close as possible to active line.
- 11. Remove unused piping, ductwork and equipment.
- 12. Dispose of unusable piping, ductwork and material.

1.10 CLEARANCE FROM ELECTRICAL EQUIPMENT

- A. Piping or ductwork:
 - 1. Prohibited, except as noted, in:
 - a. Electric rooms and closets.
 - b. Telephone rooms and closets.
 - c. Elevator machine rooms.
 - d. Electric switchboard room.
 - 2. Prohibited, except as noted, over or within 5 ft. of:
 - a. Transformers.
 - b. Substations.
 - c. Switchboards.
 - d. Motor control centers.
 - e. Standby power plant.
 - f. Bus ducts.
 - g. Electrical panels.
 - 3. Drip pans under piping:
 - a. Only where unavoidable and approved.
 - b. 18 gauge galvanized steel.
 - 1) With bituminous paint coating.
 - c. Reinforced and supported.
 - d. Watertight.
 - e. With 1-1/4 inch drain outlet piped to floor drain or service sink.

1.11 TEMPORARY FACILITIES

A. Temporary facilities are not included within this Section.

1.12 SPECIAL TOOLS

- A. Furnish to Owner at completion of work:
 - 1. One set of any special tools required to operate, adjust, dismantle or repair equipment furnished under any section of the Division.
 - 2. "Special tools": those not normally found in possession of mechanics or maintenance personnel.
 - 3. One pressure grease gun for each type of grease required.
 - a. With adapters to fit all lubricating fittings on equipment.
 - b. Include lubricant for lubricated plug valves.

1.13 PRODUCT DELIVERY, HANDING AND STORAGE

- A. Provide adequate and secure storage facilities for materials and equipment during the progress of the work.
- B. Contractor shall be responsible for the condition of all materials and equipment employed in the mechanical installation until final acceptance by the Owner. Protect same from any cause whatsoever.

- C. Where necessary, ship in crated sections of size to permit passing through available space.
- D. Ship equipment in original packages, to prevent damaging or entrance of foreign matter.
- E. Handle and ship in accordance with manufacturer's recommendations.
- F. Provide protective coverings during construction.
- G. Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by Engineer.
- H. Tag all items with weatherproof tag, identifying equipment by name and purchase order number.
- I. Include packing and shipping lists.
- J. Adhere to special requirements as specified in individual sections.

1.14 PROTECTION OF MATERIALS

- A. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed.
- B. Provide temporary storage facilities for materials and equipment.
- C. Material, equipment or apparatus damaged because of improper storage or protection will be rejected.
 - 1. Remove from site and provide new, duplicate, material, equipment, or apparatus in replacement of that rejected.
- D. Cover motors and other moving machinery to protect from dirt and water during construction. Rotate moving equipment, shafts, bearings, motors etc. to prevent corrosion and to circulate lubricants.
- E. Protect premises and work of other Divisions from damage arising out of installation of work of this Division.
 - 1. Contractor shall be responsible for the replacement of all damaged or defective work, materials or equipment. Do not install sensitive or delicate equipment until major construction work is completed.
 - 2. Remove replaced parts from premises.
- F. Make good any damage to the work caused by floods, storms, accidents, acts of God, acts of negligence, strikes, violence or theft up to time of final acceptance by the Owner.
- G. Do not leave any mechanical work in a hazardous condition, even temporarily.

1.15 REVIEW OF CONSTRUCTION

- A. Work may be reviewed at any time by representative of the Engineer.
- B. Advise Architect and Engineer that work is ready for review at following times:
 - 1. Prior to backfilling buried work.
 - 2. Prior to concealment of work in walls and above ceilings.
 - 3. When all requirements of Contract have been completed.
- C. Neither backfill nor conceal work without Engineer's consent.
- D. Maintain on job a set of Specifications and Drawings for use by Engineer's representatives.

1.16 SCHEDULE OF WORK

- A. Arrange work to conform to schedule of construction established or required to comply with Contract Documents.
- B. In scheduling, anticipate means of installing equipment through available openings in structure.
- C. Confirm in writing to Architect and Engineer, within 30 days of signing of contract, anticipated number of days required to perform test, balance, and acceptance testing of mechanical systems.

- 1. This phase must occur after completion of mechanical systems, including all control calibration and adjustment, and requires substantial completion of the building, including closure, ceilings, lighting, partitioning, etc.
- 2. Submit for approval at this time, names and qualifications of test and balancing agencies to be used.
- D. Arrange with Owner schedule for work in each area.
- E. Unless otherwise directed by Owner, perform work during normal working hours.
- F. Work delays:
 - 1. In case noisy work interferes with Owner's operations, Owner may require work to be stopped and performed at some other time, or after normal working hours.

1.17 ACCESS TO MECHANICAL WORK

- A. Access doors in walls and ceilings.
- B. Access Units Fire-Resistance Ratings: Where fire-resistance rating is indicated for construction penetrated by access units, provide UL listed-and-labeled units, except for units which are smaller than minimum size requiring ratings as recognized by governing authority.
- C. Product Data, Access Units: Submit manufacturer's technical data and installation instructions for each type of access door assembly, including setting drawings, templates, instructions and directions for installation of anchorage devices.
- D. Furnish to the general contractor all access doors necessary for access through inaccessible wall or ceiling construction, for installation by the general contractor. Information on the size and location of the subject access doors is to be communicated in writing to the general contractors during the bidding period.

1.18 CONCRETE FOR MECHANICAL WORK

- A. Concrete for Mechanical Work
 - 1. Basins and curbs for mechanical equipment.
 - 2. Mechanical equipment foundations and housekeeping pads.
 - 3. Inertia bases for isolation of mechanical work.
 - 4. Rough grouting in and around mechanical work.
 - 5. Patching concrete cut to accommodate mechanical work.
- B. Quality control testing for concrete is required as work of this section.
- C. Concrete Work Codes and Standards:
 - 1. Comply with governing regulations and, where not otherwise indicated, comply with the following industry standards; whichever is the most stringent in its application to work in each instance.
 - a. ACI 301: "Specifications for Structural Concrete for Buildings"
 - b. ACI 311: "Recommended Practice for Concrete Inspection"
 - c. ACI 318: "Building Code Requirements for Reinforced Concrete"
 - d. ACI 347R: "Recommended Practice for Concrete Form work"
 - e. ACI 304R: "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete"
 - f. Concrete Reinforcing Steel Institute's, "Manual of Standard Practice"
- D. Submittals: Shop Drawings, Mechanical Concrete Work: Submit shop drawings for structural type concrete work, showing dimensions of formed shapes of concrete; bending, placement, sizes and spacing of reinforcing steel; location of anchors, isolation units, hangers and similar devices to be integrated with concrete work; and piping penetrations, access openings, inlets and other accessories and work to be accommodated by concrete work.
- E. Laboratory Test Reports, Mechanical Concrete Work: Submit laboratory test reports for concrete work materials, and for tested samples of placed concrete (where required as work of this section).

1.19 NOISE REDUCTION

- A. Cooperate in reducing objectionable noise or vibration caused by mechanical systems.
 1. To extent of adjustments to specified and installed equipment and appurtenances.
- B. Correct noise problems caused by failure to install work in accordance with Contract Documents.
 - 1. Include labor and materials required as result of such failure.

1.20 CUTTING AND PATCHING

- A. Provide all carpentry, cutting and patching required for proper installation of material and equipment specified.
- B. Do not cut or drill structural members without consent of Architect.

1.21 COORDINATION DRAWINGS

- A. Layout Shop Drawings Required:
 - 1. Prepare layout shop drawings for all areas; minimum 3/8 inch scale.
 - 2. Individual coordinated trade layout drawings are to be prepared for all areas.
 - 3. General Contractor is to assure that each trade has coordinated work with other trades, prior to submittal where submittal is required.
 - a. Include stamp on each submittal indicating that layout shop drawing has been coordinated.
 - 4. No layout shop drawing will be reviewed without stamped and signed coordinated assurance by General Contractor.
 - 5. All changes shall be clearly marked on each submitted layout drawing.
 - 6. Drawings shall show work of all trades including but not limited to'
 - a. Ductwork.
 - b. Piping: All Trades.
 - c. Mechanical Equipment.
 - d. Electrical Equipment.
 - e. Main Electrical conduits and bus ducts.
 - f. Equipment supports and suspension devices.
 - g. Structural and architectural constraints.
 - h. Show location of:
 - 1) Valves
 - 2) Piping specialties
 - 3) Dampers
 - 4) Access Doors
 - 5) Control and electrical panels
 - 6) Disconnect switches
 - 7. Drawings shall indicate coordination with work in other Divisions that must be incorporated in mechanical spaces, including, but not limited to:
 - a. Elevator equipment.
 - b. Cable trays not furnished under Division 16.
 - c. Computer equipment.
 - 8. Submission of drawings:
 - a. Prepare reproducible drawings.
 - b. Submit to other trades for review of space allocated to all trades.
 - c. Revise drawings to compensate for requirements of existing conditions and conditions created by other trades.
 - d. Review revisions and other trades.
 - e. Submit one reproducible and one blueline print to Engineer for review.
 - 9. Final prepared drawings shall show that other trades affected have made reviews and signed, by each trade, at completions of coordination.
 - a. General Contractor

- b. Include stamp on each submittal indicating that layout shop drawing has been coordinated.
- 10. No layout shop drawing will be reviewed without stamped and signed coordination assurance by General Contractor.
- B. Shop Drawings:
 - 1. Layout drawings of mechanical equipment rooms and penthouses showing all related equipment and equipment clearances required by other trades.
 - 2. Layout drawings of areas in which it may be necessary to deviate substantially from layout shown on the drawings. Minor transitions in ductwork, if required due to job conditions, need not be submitted as long as the duct area is maintained. Show major relocation of ductwork and major changes in size of ducts. Coordinate shop drawings with all trades prior to ductwork fabrication.
 - 3. Details of intermediate structural steel members required to span main structural steel for the support of ductwork.
 - 4. Method of attachment of duct hangers to building construction.
 - 5. Duct material, gage, type of joints and duct reinforcing for each size range, including sketches or SMACNA plate numbers for joints, method of fabrication and reinforcing.

1.22 GUARANTEE

- A. Furnish guarantee covering all work in accordance with general requirements of the contract for minimum period of one year. This guarantee shall exist for a period of one (1) year from the date of final acceptance of the work and shall apply to defects in materials and to defective workmanship of any kind.
- B. For factory-assembled equipment and devices on which the manufacturers furnish standard published guarantees as regular trade practice, obtain such guarantees and replace any such equipment that proves defective during the life of these guarantees.
- C. Guarantee all work for which materials are furnished, fabricated or field erected by the contractor, all factory-assembled equipment for which no specific manufacturer's guarantee is furnished, and all work in connection with installing manufacturer's guarantee is furnished, and all work in connection with installing manufacturer's guaranteed equipment.
- D. In the event of failure of any work, equipment or device during the life of the guarantee, repair or replace the equipment or defective work. Remove, replace or restore, at no cost to the Owner, any part of the structure or building which may be damaged either as the direct result of the defective work or in the course of the contractor's making replacement of the defective work or materials. Work shall be done at a time and in a manner as to cause no undue inconvenience to the Owner. Provide new materials, equipment, apparatus and labor to replace that determined by Engineer to be defective or faulty.
- E. This guarantee also applies to services including Instructions, Adjusting, Testing, Noise, Balancing, etc.
- F. Additional equipment and material guarantees and warrantees may be indicated in other sections. In all cases, the more stringent guarantee or warrantee shall be provided.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT QUALITY

- A. Material and equipment furnished under this Division of specification shall be new. Defective or inferior materials must be replaced by contractor at no cost to Owner regardless of the stage of construction. Inferior material shall be defined as material or equipment of a quality or performance less than that specified as determined by the Owner's Representative.
- B. Provide each item of equipment with manufacturer's identification tag which is readily accessible and clearly shows model and size.

2.02 ACCESS TO MECHANICAL WORK

A. Access Doors:

- 1. General: Where walls and ceilings must be penetrated for access to mechanical work, access doors shall be provided. Furnish adequate size for intended and necessary access. Furnish doors with UL Fire Rating to match wall or ceiling construction. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware.
- B. Access Door Construction: Refer to Section 083113 ACCESS DOORS AND FRAMES

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Tests:
 - 1. Perform as specified in individual sections, and as required by authorities having jurisdiction.
 - 2. Duration as noted.
- B. Provide required labor, material, equipment, and connections.
- C. Furnish written report and certification those tests have been satisfactorily completed.
- D. Repair or replace defective work, as directed.
- E. Pay for restoring or replacing damaged work due to tests as directed.
- F. Pay for restoring or replacing damaged work of others, due to tests, as directed.

3.02 ACCESS TO MECHANICAL WORK

- A. Coordinate installation and placement of access doors and panels with contractor for general construction.
- B. Remove or replace panels or frames that are warped, bowed, or otherwise damaged.

END OF SECTION

This page intentionally left blank

SECTION 230002 MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work Included in This Section: Materials, equipment, fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for the following:
 - 1. Motors.
 - 2. Factory-wired equipment (FWE).
 - 3. Factory-wired control panels (FWCP).
 - 4. Motor controllers where provided as part of mechanical equipment.
 - 5. Motor controllers where supplied under Division 23 Mechanical Work.
 - 6. Disconnects and safety switches for mechanical equipment.
 - 7. Fuses for equipment provided, and starters and disconnect switches.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 23 HVAC Instrumentation and Controls, Motors.
- B. Installation and Power Wiring of Motor Controllers.

1.03 REFERENCE STANDARDS

- A. Published specifications standards, tests, or recommended methods of trade, industry or governmental organization as apply to work in this section where cited below:
 - 1. ANSI American National Standards Institute.
 - 2. NEMA National Electrical Manufacturer's Association.
 - 3. IEEE Institute of Electrical and Electronic Engineers.

1.04 QUALITY ASSURANCE

- A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
- B. Supply all equipment and accessories new and free from defects.
- C. Supply all equipment and accessories in compliance with the applicable standards listed in Article 1.03 of this Section and with all applicable National, State and local codes.
- D. All items of a given-type shall be the products of the same manufacturer.

1.05 DIVISION OF WORK

A. This section delineates the work required to be performed by Contractors under Division 23 and Division 26.

1.06 WORK REQUIRED UNDER DIVISION 23

- A. Furnish motors, manual and combination starters, pushbutton devices, contactors, disconnect switches, electric thermostats, low voltage transformers, Emergency Break Glass Stations and other electrical devices required for equipment furnished.
- B. Install all items in piping and ductwork such as control valves, aquastats, ductstats, etc.
- C. All external wiring of equipment, all temperature control wiring, external wiring of control circuits of magnetic starters, interlocking wiring, boiler wiring, Emergency Break Glass Stations, and mounting of control devices, etc., shall be included under Division 23. All external wiring shall be in conduit. (Unless specifically shown to be provided by the Electrical Contractor)
- D. The Electrical Contractor, under Division 26, shall furnish and install all power wiring and conduit to junction box, to disconnect switch on unit, to motor starters and contactors, and between motor starters and contactors to motor or other load. Electrical Contractor shall be responsible for proper direction of rotation for all three phase equipment. The Electrical Contractor shall mount all starters, disconnects.

- E. Wiring required under Division 23 shall comply with the specifications as described in Division 26.
- F. The Plumbing Contractor, under Division 22, shall provide water and natural gas services to within two (2) feet of HVAC equipment requiring same and terminating with shut-off valves. The HVAC Contractor, under Division 23, shall make final connections to equipment.
- G. Provide disconnect switches or safety switches for equipment. (Unless specifically shown to be provided by the Electrical Contractor, starters and disconnects shown on the electrical drawings are for installation and do not require the Electrical Contractor to furnish units)
- H. Emergency Generator Exhaust muffler and flexible exhaust connection shall be furnished by the generator manufacturer under Division 26. Installation of the exhaust system including providing piping, insulation and accessories shall be included under Division 23.

1.07 SUBMITTALS

- A. Shop Drawings: Complete wiring diagrams of all power and control connections (standard diagrams will not be accepted). Deliver 2 copies of approved wiring diagrams to the Electric Contractor for installation of wiring and connections required under the Electric Contract.
- B. Product Data for Motor Controllers and Disconnect Switches: Manufacturer's catalog sheets, specifications and installation instructions. Submit enclosure type coordinated for service and location. Submit simultaneously with product data required for motors. Identify each controller for use with corresponding motor. Submit shop drawings and product data in accordance with project requirements.
- C. All warranties shall be delivered as part of the close-out submission.
- D. A receipt shall be delivered as part of the close-out submission that states all required spare parts have been delivered to the owner. This receipt must be signed and dated by the owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Motor Controllers and Disconnects
 - 1. Square D
 - 2. Allen-Bradley
 - 3. General Electric
 - 4. Cutler-Hammer

2.02 MOTOR CONTROLLERS

- A. General: All starters shall be correctly sized to motor connected thereto. Provide one (1) additional auxiliary contact over and above that normally furnished, at least two (2) required. Provide overload heaters for each phase. Coordinate starters and controllers with the temperature control Contractor and sequence of operations.
- B. Minimum Size: The minimum allowable size of single or three phase magnetic motor controller is NEMA size 0.
- C. Enclosures: Unless otherwise indicated furnish NEMA 1 enclosures, except where installed outdoors furnish NEMA 3R enclosures.
- D. Control Power: Furnish control power transformer (maximum control voltage 120 volts) mounted within each magnetic motor controller enclosure.
- E. Pilot Lights: Furnish pilot lights of the neon lamp type mounted in the controller enclosure, green for running, red for not running.

2.03 MOTOR CONTROLLER TYPES:

- A. Type A (Full Voltage, Manual, Non-Magnetic):
 - 1. Allen-Bradley Co. Bulletin 609 (or Bulletin 600 single phase, 1 HP or less only).

- 2. General Electric Co. CR-1062 (or CR-101 single phase, 1 HP or less only).
- 3. Cutler-Hammer. B100 (or MS single phase, 1 HP or less only).
- B. Type A2 (2 Speed, 2 Winding, Full Voltage, Manual, Non-Magnetic):
 - 1. Allen-Bradley Co. Bulletin 609TS (or Bulletin 600 single phase, 1 HP or less only).
 - 2. General Electric Co. CR-1062 (or CR-101 single phase, 1 HP or less only).
 - 3. Square D Co. Class 2512, Type M (or Class 2512, Type F single phase, 1 HP or less only).
- C. Type B (Full Voltage Magnetic):
 - 1. Allen-Bradley Co. Bulletin 709.
 - 2. General Electric Co. CR-206.
 - 3. Square D Co. Class 8536.
 - 4. Cutler-Hammer. ECN05.
- D. Type B-COM (Combination Full Voltage Magnetic/Safety Switch):
 - 1. Allen-Bradley Co. Bulletin 712.
 - 2. General Electric Co. CR-208.
 - 3. Square D Co. Class 8538.
 - 4. Cutler-Hammer. ECN16.
- E. Type B2 (2 Speed, 2 Winding, Full Voltage, Magnetic):
 - 1. Allen-Bradley Co. Bulletin 715.
 - 2. General Electric Co. CR209.
 - 3. Square D Co. Class 8810.
 - 4. Cutler-Hammer. ECN33.
- F. Type C (Automatic, Reduced Voltage, Magnetic):
 - 1. Allen-Bradley Co. Bulletin 746.
 - 2. General Electric Co. CR-231.
 - 3. Square D Co. Class 8606.
 - 4. Cutler-Hammer. ECA42.
- G. Type C-COM (Combination Automatic, Reduced Voltage, Magnetic/ Safety Switch):
 - 1. Allen-Bradley Co. Bulletin 746C.
 - 2. Square D Co. Class 8606.
 - 3. Cutler-Hammer. ECA43.
- H. Type D (Part Winding, Magnetic):
 - 1. Allen-Bradley Co. Bulletin 736.
 - 2. General Electric Co. CR-230.
 - 3. Square D Co. Class 8640.
 - 4. Cutler-Hammer. ECA45.

2.04 REMOTE PUSH BUTTON STATIONS

- A. Start-Stop with pilot light in NEMA 1 enclosure unless otherwise indicated.
 - 1. Allen-Bradley Co. Bulletin 800S.
 - 2. General Electric Co. CR-2943.
 - 3. Square D Co. Class 9001.
 - 4. Cutler-Hammer. Class 10250.

2.05 SAFETY SWITCHES

A. General Electric Co. Type TH; Square D Co. Heavy Duty Series; Cutler-Hammer HD Series; with the following:

- 1. Fused switches equipped with fuseholders to accept only the fuses specified in Section 16181 (U.L. Class RK-1, RK-5, L).
- 2. NEMA 1 enclosure unless otherwise indicated on drawing or required. 3R for devices installed outdoors.
- 3. Switch rated 240V for 120V, 208V, 240V, circuits; 600 V for 277V, 480V circuits.
- 4. Switch rated 600V for 277V, 480V circuits.
- 5. Solid neutral bus when neutral or grounding conductor is included with circuit.
- 6. Current rating and number of poles as indicated on drawings.

2.06 NAMEPLATES

- A. Phenolic Type: Standard phenolic nameplates with 3/8" minimum size lettering engraved thereon.
- B. Embossed Aluminum: Standard stamped or embossed aluminum tags: Tech Products, Inc., Seton Name Plate Corp.

PART 3 - EXECUTION

3.01 GENERAL

- A. Equipment shall be connected in a neat and skillful manner. Equipment deliver with terminal boxes that are inadequate shall be equipped with special boxes that suit the conditions by the Mechanical Contractor furnishing the equipment.
- B. In general, rigid conduit or tubing shall be used, but equipment that requires movement or that would transmit vibration to conduit shall be wired with flexible (liquid tight) steel conduit not over 18" long.
- C. All equipment shall be grounded with a green-covered ground wire run inside the conduit and connected to equipment frame on one end and to grounding system on the other end.
- D. All electrical work required in the Mechanical Contract shall conform to the applicable requirements of Division 26 of these Specifications.
- E. The Heating, Ventilating, and Air Conditioning Contractor shall assign all Electrical Work required under his contract to the approved Automatic Temperature Control Contractor, who shall perform this work with qualified electricians employed by that Contractor.
- F. The Mechanical Contractors shall cooperate with the Contractor for Electrical Work in making all necessary tests and in receiving, storing, and setting all motor-driven equipment, electrical devices, and controls furnished and/or installed under these contracts.
- G. Install heaters correlated with full load current of motors provided.
- H. Set overload devices to suit motors provided.

3.02 INSTALLATION

- A. Control Wiring:
 - 1. Provide control wiring and connections.
 - 2. Where control circuit interlocking is required between individually mounted motor controllers, provide a single pole on-off switch in a threaded type box mounted adjacent to motor safety switches which are remote from the control transformer (to enable interlock circuit to be opened when the motor safety switch is opened).
- B. Nameplates: Rivet or bolt the nameplate on the cover of NEMA 1 enclosures. Rivet or bolt and gasket the nameplate on cover of NEMA 3R or NEMA 12 enclosures. Provide phenolic or embossed aluminum nameplates as follows:
 - 1. On each remote control station, indicating motor controlled.
 - 2. On each interlock circuit switch, indicating purpose of switch.

3.03 TYPES OF MOTOR CONTROLLERS REQUIRED FOR SINGLE SPEED MOTORS (SYSTEMS UNDER 250 VOLTS)

- A. Single Phase Motors Less than 5 HP Manually Operated: Type A.
- B. Single Phase Motors Less than 1/2 HP Automatically Operated: Type A.
- C. Single Phase Motors 1/2 to 5 HP Automatically Operated: Type B.
- D. Three Phase Squirrel Cage Motors Less than 7-1/2 HP: Type B (B-COM when indicated on drawings).
- E. Three Phase Squirrel Cage Motors 7-1/2 HP and Larger: Type C (C-COM when indicated on drawings).
- F. Three Phase Hermetically Sealed Compressor Motors Less than 7-1/2 HP: Type B.
- G. Three Phase Hermetically Sealed Compressor Motors 7-1/2 HP and Larger: Type D.

3.04 TYPES OF MOTOR CONTROLLERS REQUIRED FOR SINGLE SPEED MOTORS (277/480 VOLT SYSTEM)

- A. Single Phase Motors Less than 5 HP Manually Operated: Type A.
- B. Single Phase Motors Less than 1 HP Automatically Operated: Type A.
- C. Single Phase Motors 1 to 5 HP Automatically Operated: Type B.
- D. Three Phase Squirrel Cage Motors Less than 15 HP: Type B (B-COM when indicated on drawings).
- E. Three Phase Squirrel Cage Motors 15 HP and Larger: Type C (C-COM when indicated on drawings).
- F. Three Phase Hermetically Sealed Compressor Motors Less than 15 HP: Type B.
- G. Three Phase Hermetically Sealed Compressor Motors 15 HP and Larger: Type D.

3.05 TYPES OF MOTOR CONTROLLERS REQUIRED FOR 2 SPEED MOTORS (SYSTEMS UNDER 250 VOLTS)

- A. Single Phase Motors Less than 5 HP Manually Operated: Type A2.
- B. Single Phase Motors Less than 1/2 HP Automatically Operated: Type A2.
- C. Single Phase Motors 1/2 to 5 HP Automatically Operated: Type B2.
- D. Three Phase Squirrel Cage Motors Less than 7-1/2 HP: Type B2.

3.06 TYPES OF MOTOR CONTROLLERS REQUIRED FOR 2 SPEED MOTORS (277/480 VOLT SYSTEM)

- A. Single Phase Motors Less than 5 HP Manually Operated: Type A2.
- B. Single Phase Motors Less than 1 HP Automatically Operated: Type A2.
- C. Single Phase Motors 1 to 5 HP Automatically Operated: Type B2.
- D. Three Phase Squirrel Cage Motors Less than 15 HP: Type B2.

3.07 DISCONNECTS

- A. Motor Controllers: Provide safety switch for all motor controllers. Provide combination type starter-disconnect unless otherwise noted on drawings.
- B. Motors: Provide a disconnect switch for all motors. Provide a separate safety switch for motors which are not within sight of the starter.
- C. Provide safety switches for all factory packaged equipment.
- D. Provide NEMA 3R safety switch for all rooftop and outdoor equipment.

E. Provide unit mounted disconnect switches for all equipment such as unit heaters, fans, unit ventilators, incremental units, etc

END OF SECTION

SECTION 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Single phase electric motors.
- D. Three phase electric motors.
- E. Electronically Commutated Motors (ECM).

1.02 RELATED REQUIREMENTS

A. Section 262913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 Load Ratings and Fatigue Life for Ball Bearings; 2015 (Reaffirmed 2020).
- B. IEEE 112 IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.
- C. NEMA MG 1 Motors and Generators; 2018.
- D. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- D. Operation Data: Include instructions for safe operating procedures.
- E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

- A. See Section 017800 Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Baldor Electric Company/ABB Group: www.baldor.com/#sle.
- B. Leeson Electric Corporation: www.leeson.com/#sle.
- C. Regal-Beloit Corporation (Century): www.centuryelectricmotor.com/#sle.
- D. Substitutions: See Section 016000 Product Requirements.

14457.20

EQUIPMENT-CPL

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- C. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

- A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.
- B. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.
- C. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, and dust collection systems: Totally enclosed type.

2.04 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 262913.
- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- J. Sound Power Levels: To NEMA MG 1.
- K. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
- L. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.
- M. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.06 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Applications:
 - 1. Commercial:
 - a. Roof Top Unit:
 - 1) Operating Mode: Constant speed.
 - 2) Input: Motor manufacturer to coordinate control requirements with the control board of the roof top unit and/or specified sequence of operation.
 - 3) Shaft Extension: Single.
 - b. DX Fan Coil Unit:
 - 1) Operating Mode: Constant cfm.
 - c. Hydronic Fan Coil Unit:
 - 1) Operating Mode: Constant cfm.
 - d. Power Roof Ventilator (PRV):
 - 1) Operating Mode: Constant cfm.
 - 2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.
 - 3) Shaft Extension: Single.
 - e. Energy Recovery Ventilator:
 - 1) Operating Mode: Constant cfm.
 - 2) Input: Motor manufacturer to coordinate control requirements with the control board of the energy recovery ventilator and/or specified sequence of operation.
 - 3) Shaft Extension: Single.
 - f. Hydronic Pump:
 - 1) Operating Mode: Constant speed.
 - 2) Input: Motor manufacturer to coordinate control requirements with the control board of the hydronic pump and/or specified sequence of operation.
 - 3) Flange Configuration: "C".

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

This page intentionally left blank

SECTION 230517 SLEEVES AND SLEEVE SEALS FOR HVAC PIPING-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe sleeves.
- B. Manufactured sleeve-seal systems.

1.02 RELATED REQUIREMENTS

- A. Section 078400 Firestopping.
- B. Section 230719 HVAC Piping Insulation-CPL.

1.03 REFERENCE STANDARDS

- A. ASTM C592 Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.
- B. ASTM E814 Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
 - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- B. Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- C. Pipe Passing Through Concrete Beam Flanges, except where Brass Pipe Sleeves are Specified:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Pipe Passing Through Mechanical Room Floors above Basement:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.

- E. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Modular/Mechanical Seal:
 - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
 - 2. Provide watertight seal between pipe and wall/casing opening.
 - 3. Elastomer element size and material in accordance with manufacturer's recommendations.
 - 4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- E. Structural Considerations:
 - 1. Do not penetrate building structural members unless indicated.
- F. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 - 1. Aboveground Piping:
 - a. Pack solid using mineral fiber in compliance with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
 - 2. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.
 - 3. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- G. Manufactured Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.

- 3. Locate piping in center of sleeve or penetration.
- 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
- 5. Tighten bolting for a water-tight seal.
- 6. Install in accordance with manufacturer's recommendations.
- H. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

This page intentionally left blank

SECTION 230519 METERS AND GAUGES FOR HVAC PIPING-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gauges and pressure gauge taps.
- B. Thermometers and thermometer wells.
- C. Filter gauges.

1.02 RELATED REQUIREMENTS

- A. Section 232113 Hydronic Piping.
- B. Section 232213 Steam and Condensate Heating Piping.

1.03 REFERENCE STANDARDS

- A. ASME B40.100 Pressure Gauges and Gauge Attachments; 2022.
- B. ASTM E1 Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2020).
- C. ASTM E77 Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- D. UL 393 Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

1.05 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
 - 3. Omega Engineering, Inc: www.omega.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi.

2.02 PRESSURE GAUGE TAPPINGS

- A. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
- B. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
- C. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Omega Engineering, Inc: www.omega.com/#sle.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Thermometers Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Stem: 3/4 inch NPT brass.
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F.

2.04 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.05 TEST PLUGS

A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.
- C. Install pressure gauges on the inlet and outlet piping of all hydronic zones, hydronic coils, and heat transfer equipment.
- D. Install pressure gauges upsteam and downstream of all pressure reducing valves.
- E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- F. Install thermometers in air duct systems on flanges.
- G. Install thermometers in the return duct, outside air duct, inlet duct, and supply duct of all air handling systems and terminal units.
- H. Install thermometers on the inlet and outlet piping of all hydronic zones, hydronic coils, and heat transfer equipment.
- I. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- J. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- K. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

- L. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- M. Locate test plugs adjacent to pressure gauges and pressure gauge taps.

END OF SECTION

This page intentionally left blank

SECTION 230523 GENERAL-DUTY VALVES FOR HVAC PIPING-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Applications.
- B. Globe valves.
- C. Ball valves.
- D. Butterfly valves.
- E. Check valves.
- F. Gate valves.

1.02 RELATED REQUIREMENTS

- A. Section 230553 Identification for HVAC Piping and Equipment-CPL.
- B. Section 230719 HVAC Piping Insulation-CPL.
- C. Section 232113 Hydronic Piping.

1.03 ABBREVIATIONS AND ACRONYMS

- 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. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. SWP: Steam working pressure.
- I. TFE: Tetrafluoroethylene.
- J. WOG: Water, oil, and gas.

1.04 REFERENCE STANDARDS

- A. ASME B1.20.1 Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- C. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- D. ASME B16.10 Face-to-Face and End-to-End Dimensions of Valves; 2022.
- E. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- F. ASME B16.34 Valves Flanged, Threaded, and Welding End; 2020.
- G. ASME B31.9 Building Services Piping; 2020.
- H. ASTM A126 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2019).
- I. ASTM A395/A395M Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
- J. ASTM A536 Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- K. ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- L. AWWA C606 Grooved and Shouldered Joints; 2022.

- M. MSS SP-45 Drain and Bypass Connections; 2020.
- N. MSS SP-67 Butterfly Valves; 2022.
- O. MSS SP-68 High Pressure Butterfly Valves with Offset Design; 2021.
- P. MSS SP-70 Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.
- Q. MSS SP-71 Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
- R. MSS SP-80 Bronze Gate, Globe, Angle, and Check Valves; 2019.
- S. MSS SP-110 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.06 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.
 - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 - 5. Secure check valves in either the closed position or open position.
 - 6. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
 - Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - Store valves in shipping containers and maintain in place until installation.
 a. Store valves indoors in dry environment.
- C. Exercise the following precautions for handling:
 - 1. Handle large valves with sling, modified to avoid damage to exposed parts.
 - 2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

1.

2.01 APPLICATIONS

- A. Provide the following valves for the applications if not indicated on drawings:
 - 1. Throttling (Hydronic): Ball and Globe.
 - 2. Throttling (Steam): Gate.
 - 3. Isolation (Shutoff): Gate and Ball.
- B. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:

- a. 2 NPS and Smaller: Threaded ends.
- b. 2-1/2 NPS and Larger: Grooved ends or flanged.
- 2. Copper Tube:
 - a. 2 NPS and Smaller: Threaded ends (Exception: Solder-joint valve-ends).
- C. Heating Hot Water Valves:
 - 1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - b. Ball: Full port, two piece, stainless steel trim.
 - c. Swing Check: Bronze disc, Class 125.
 - d. Globe: Bronze disc, Class 125.
 - 2. 2-1/2 NPS and Larger, Iron Valves:
 - a. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, aluminum-bronze disc, EPDM seat, 200 CWP.
 - b. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 175 CWP.
 - c. Swing Check: Metal seats, Class 125.
 - d. Grooved-End Swing Check: 3 NPS to 12 NPS, 300 CWP.
- D. Low Pressure Steam Valves (15 PSIG or Less):
 - 1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Gate: NRS, Class 125.
 - b. Globe: Bronze disc, Class 125.
 - 2. 2-1/2 NPS and Larger, Iron Valves:
 - a. Gate: NRS, Class 125.
- E. Steam-Condensate Valves:
 - 1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Gate: NRS, Class 125.
 - b. Ball: Full port, one piece, brass trim.
 - c. Swing Check: Metal seats, Class 125.
 - 2. 2-1/2 NPS and Larger, Iron Valves:
 - a. Swing Check: Metal seats, Class 125.
 - b. Gate: NRS, Class 125.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
- D. Valves in Insulated Piping: Provide 2 NPS stem extensions and the following features:
 - 1. Gate Valves: Rising stem.
 - 2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: Extended neck.
 - 4. Memory Stops: Fully adjustable after insulation is installed.
- E. Memory Stops: Fully adjustable after insulation is installed.
- F. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 - 3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.

- 4. Solder Joint Connections: ASME B16.18.
- 5. Grooved End Connections: AWWA C606.
- G. General ASME Compliance:
 - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 - 2. Building Services Piping Valves: ASME B31.9.
- H. Bronze Valves:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- I. Valve Bypass and Drain Connections: MSS SP-45.
- J. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE, GLOBE VALVES

- A. Class 125: CWP Rating: 200 psig:.
 - 1. Comply with MSS SP-80, Type 1.
 - 2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
 - 3. Ends: Threaded or solder joint.
 - 4. Stem and Disc: Bronze or PTFE.
 - 5. Packing: Asbestos free.
 - a. Handwheel: Malleable iron.

2.04 BRONZE, BALL VALVES

- A. General:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Two Piece, Full Port with Stainless Steel Trim:
 - 1. Comply with MSS SP-110.
 - 2. SWP Rating: 150 psig.
 - 3. CWP Rating: 600 psig.
 - 4. Body: Forged bronze or dezincified-brass alloy.
 - 5. Ends: Threaded.
 - 6. Seats: PTFE.
 - 7. Stem: Stainless steel.
 - 8. Ball: Stainless steel, vented.

2.05 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug Style: Bi-directional dead-end service without use of downstream flange.
 - 1. Comply with MSS SP-67, Type I.
 - 2. CWP Rating: 150 psig and 200 psig.
 - 3. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
 - 4. Stem: One or two-piece stainless steel.
 - 5. Seat: NBR.
 - 6. Disc: Coated ductile iron.

2.06 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 175 psig (1200 kPa), 300 psig (2070 kPa): 8 NPS (50 DN) or smaller, and 200 psig (1389 kPa): 10 NPS (250 DN) or larger.
 - 1. Comply with MSS SP-67, Type I.
 - 2. Body: Coated ductile iron.
 - 3. Stem: Stainless steel.
 - 4. Disc: Coated ductile iron.
 - 5. Disc Seal: EPDM.
2.07 HIGH-PERFORMANCE, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug type: Bi-directional dead end service without downstream flange.
 - 1. Comply with MSS SP-68.
 - 2. Class 150: CWP Rating: 285 psig and Class 300: CWP Rating: 720 psig at 100 degrees F.
 - 3. Body: Provide carbon steel, cast iron, ductile Iron, or stainless steel.
 - 4. Seat: Metal or reinforced PTFE.
 - 5. Offset stem: Stainless steel.
 - 6. Disc: Carbon steel.

2.08 BRONZE, SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa) and Class 150: CWP Rating: 300 psig (2070 kPa).
 - 1. Comply with MSS SP-80, Type 3.
 - 2. Body Design: Horizontal flow.
 - 3. Body Material: Bronze, ASTM B62.
 - 4. Ends: Threaded.
 - 5. Disc: Bronze.

2.09 IRON, FLANGED END SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa) with Metal Seats.
 - 1. Comply with MSS SP-71, Type I.
 - 2. Design: Clear or full waterway with flanged ends.
 - 3. Body: Gray iron with bolted bonnet in accordance with ASTM A126.
 - 4. Trim: Bronze.
 - 5. Disc Holder: Bronze.
 - 6. Gasket: Asbestos free.

2.10 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP:
 - 1. 2 NPS to 8 NPS.
 - 2. CWP Rating: 300 psig.
 - 3. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
 - 4. Seal: EPDM or Nitrile.
 - 5. Disc: Ductile iron.
 - 6. Coating: Black, non-lead paint.

2.11 BRONZE, GATE VALVES

- A. Non-Rising Stem (NRS) or Rising Stem (RS):
 - 1. Comply with MSS SP-80, Type I.
 - 2. Class 150: CWP Rating: 300 psig.
 - 3. Body Material: Bronze with integral seat and union-ring bonnet.
 - 4. Ends: Threaded.
 - 5. Stem: Bronze.
 - 6. Disc: Solid wedge; bronze.
 - 7. Packing: Asbestos free.
 - 8. Handwheel: Malleable iron, bronze, or aluminum.

2.12 IRON, GATE VALVES

- A. NRS or OS&Y:
 - 1. Comply with MSS SP-70, Type I.
 - 2. Body Material: Gray iron with bolted bonnet.
 - 3. Ends: Flanged.
 - 4. Trim: Bronze.

- 5. Disc: Solid wedge.
- 6. Packing and Gasket: Asbestos free.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- C. Install check valves where necessary to maintain direction of flow as follows:
 - 1. Swing Check: Install horizontal maintaining hinge pin level.

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.02 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 055000 Metal Fabrications: Materials and requirements for fabricated metal supports.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM A181/A181M Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2023.
- D. ASTM A36/A36M Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A47/A47M Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- F. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- G. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- H. ASTM E96/E96M Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- I. MFMA-4 Metal Framing Standards Publication; 2004.
- J. MSS SP-58 Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- K. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
 - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Installer Qualifications for Field-Welding: As specified in Section 055000.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with MSS SP-58.
 - 2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 4.0. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Materials for Metal Fabricated Supports: Comply with Section 055000.
- C. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.

14457.20

- d. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
- Provide factory-fabricated continuous-slot metal channel (strut) and associated fittings. 2 accessories, and hardware required for field-assembly of supports.
- 3. Comply with MFMA-4.
- 4. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - Outdoor and Damp or Wet Indoor Locations: Use galvanized steel. b
- 5. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
- Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height. 6.
- D. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - Minimum Size, Unless Otherwise Indicated or Required: 1
 - Equipment Supports: 1/2 inch diameter. a.
 - b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
 - Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter. С
 - Trapeze Support for Multiple Pipes: 3/8 inch diameter. d.
- E. Thermal Insulated Pipe Supports:
 - Manufacturers: 1
 - a. Buckaroos, Inc: www.buckaroos.com/#sle.
 - KB Enterprises: www.snappitz.com/#sle. b.
 - 2 General Construction and Requirements:
 - Insulated pipe supports to be provided at hanger, support, and guide locations on a. pipe requiring insulation or additional support.
 - Surface Burning Characteristics: Flame spread index/smoke developed index of b. 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch iron pipes. C.
 - Insulation inserts to consist of rigid phenolic foam insulation surrounded by a 360 d. degree, PVC jacketing.
 - 3. **PVC Jacket:**
 - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
 - Minimum Service Temperature: Minus 40 degrees F. b.
 - Maximum Service Temperature: 180 degrees F. C.
 - Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with d. ASTM E96/E96M.
 - Thickness: 60 mil. e.
 - Connections: Brush on welding adhesive. f.
 - Pipe insulation protection shields to be provided at the hanger points and guide locations 4. on pipes requiring insulation as indicated on drawings. Products:
 - Buckaroos, Inc; CoolDry: www.buckaroos.com/#sle. a.
- Pipe Supports: F.

5.

- Liquid Temperatures Up To 122 degrees F:
 - Overhead Support: MSS SP-58 Types 1, 3 through 12. a.
 - Support From Below: MSS SP-58 Types 35 through 38. b.
- Operating Temperatures from 122 to 446 degrees F: 2.
 - Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of a. MSS SP-58 Type 40 for insulated pipe.
 - Roller Support: MSS SP-58 Types 41 or 43 through 46, with appropriate saddle of b. MSS SP-58 Type 39 for insulated pipe.
 - Sliding Support: MSS SP-58 Types 35 through 38. C.

- 1. Manufacturers:
 - a. Anvil International; H-Block: www.anvilintl.com/#sle.
- 2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
- 3. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- H. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
 - 1. Manufacturers:
 - a. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - 2. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 - 3. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- I. Riser Clamps:
 - 1. Manufacturers:
 - a. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - 2. Provide copper plated clamps for copper tubing support.
 - 3. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- J. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- K. Strut Clamps: Two-piece pipe clamp.
- L. Insulation Clamps: Two bolt-type clamps designed for installation under insulation.
- M. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
 - 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- N. Intermediate Pipe Guides: Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.
 - 1. Pipe Diameter 6 inches and Smaller: Provide minimum clearance of 0.16 inch.
 - 2. Pipe Diameter 8 inches: Provide U-bolts with double nuts providing minimum clearance of 0.28 inch.
- O. Pipe Alignment Guides: Galvanized steel.
 - 1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.
 - 2. Pipe Diameter 10 inches and Larger: Roller type.
- P. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.
- Q. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
 - 1. Manufacturers:
 - a. Anvil International; H-Block: www.anvilintl.com/#sle.
 - b. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - c. Erico International Corporation, a brand of Pentair: www.erico.com/#sle.
 - d. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - e. PHP Systems/Design: www.phpsd.com/#sle.
 - f. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - 2. Provide steel pedestals with thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.

- 3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
- 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
- 5. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- R. Pipe Shields for Insulated Piping:
 - 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com/#sle.
 - 2. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Minimum Service Temperature: Minus 40 degrees F.
 - e. Maximum Service Temperature: 178 degrees F.
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- S. Anchors and Fasteners:

1

- Manufacturers Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - c. Powers Fasteners, Inc: www.powers.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
- 2. Manufacturers Powder-Actuated Fastening Systems:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - c. Powers Fasteners, Inc: www.powers.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
- 3. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
- 4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
- 5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
- 6. Hollow Masonry: Use toggle bolts.
- 7. Hollow Stud Walls: Use toggle bolts.
- 8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
- 9. Sheet Metal: Use sheet metal screws.
- 10. Wood: Use wood screws.
- 11. Plastic and lead anchors are not permitted.
- 12. Hammer-driven anchors and fasteners are not permitted.
- 13. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
 - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
- 14. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
- T. Pipe Installation Accessories:
 - 1. Copper Pipe Supports:
 - a. Manufacturers:

- 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
- 2. Thermal Insulated Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
- 3. Overhead Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
- 4. Plenum Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
- 5. Telescoping Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - Inserts and Clamps:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.

2.02 RETROFIT PIPING COVER SYSTEM

A. Manufacturers:

6.

SOUTH ORANGETOWN CSD

14457.20

- 1. DecoShield Systems, Inc: www.decoshield.com/#sle.
- B. General Requirements:
 - 1. Surface Burning Characteristics: Flame spread index/smoke developed index of 20/250, maximum, when tested in accordance with ASTM E84 or UL 723.
- C. Materials:
 - 1. Piping Cover System: Removal-resistant, modular, snap-fit cover units, clips, and anchors for use with CPVC, steel, and copper piping systems.
 - 2. Cover Units: L-shaped and U-shaped cross-section units of flame retardant resin material, paintable finish.
 - 3. Unit Length: 7.5 feet.
 - 4. Provide coupling fittings for joining units end to end and prefabricated inside and outside corner fittings and end caps as required.
 - 5. Provide mounting clips to secure covers to wall-ceiling per manufacturer requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

- G. Field-Welding (where approved by Architect): Comply with Section 055000.
- H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- I. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 033000.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- J. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- K. Secure fasteners according to manufacturer's recommended torque settings.
- L. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

This page intentionally left blank

SECTION 230550 WIND RESTRAINT FOR HVAC SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

A. Support and brace mechanical and electrical systems, as called for, to resist directional wind forces (lateral, longitudinal and vertical).

1.03 APPLICABLE CODES AND STANDARDS

- A. Provide work in compliance with the following codes and standards:
- B. 2020 International Building Code (Section 1609).
- C. 2020 International Mechanical Code (Section 301, Item 301.15).
- D. American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures with Supplement No. 1 Standard ASCE/SEI 7-10.

1.04 QUALITY ASSURANCE

- A. General:
 - 1. The contractor shall provide professional engineer stamped and signed calculations, and details of wind restraint systems to meet total design lateral force requirements for support and restraint of mechanical and electrical systems.
 - 2. The contractor shall provide all hardware/brackets/anchors required from the results of the calculations. MC to install all curbs and required hardware. Coordinate with the general contractor for installation.
 - 3. Systems requiring wind restraint including, but not limited to:
 - a. Exhaust fans.
 - b. Hooded intake or relief ventilators.
 - c. Ductwork.
 - d. Rooftop air handling equipment.
 - e. Condensing units.
 - f. Miscellaneous HVAC equipment.
 - g. Roof curbs and pipe/duct/equipment supports associated with any of the equipment listed above.

1.05 SUBMITTALS

- A. Submit wind force level (Fp) calculations from applicable building code. Submit pre- approved restraint selections, installation details, and plans indicating locations of restraints.
- B. Calculations, plans, restraint selection, and installation details shall be stamped and signed by a professionally licensed engineer experienced in wind restraint design.
- C. Submit manufacturer's product data.
- D. For each piece of equipment that requires wind restraint as outlined in this section, include the following:
 - 1. Dimensioned Outline Drawings of Equipment Unit: Identify the center of gravity and locate and describe mounting and anchoring provisions.
 - 2. Anchorage: Provide detailed description of equipment anchorage devices on which the calculations are based and their installation requirements. Identify anchor bolts, studs and other mounting devices. Provide information on the size, type and spacing of mounting brackets, holes and other provisions.

PART 1 PRODUCTS

2.01 CODE INFORMATION

- A. This project is subject to the wind bracing requirements of the 2015 International Building Code (Section 1609) and American Society of Civil Engineers ASCE/SEI 7-10. The following criteria are applicable to this project:
 - 1. Nominal Design Wind Speed (V) (Per ASCE 7-10): 120 mph.
 - 2. Risk Category (Per ASCE 7-10): III
 - 3. Exposure Category (Per ASCE 7-10): C
 - 4. Height and Exposure Adjustment Coefficient (Per ASCE 7-10): 1.21

2.02 WIND BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

- A. General:
 - 1. Design analysis shall include calculated dead loads, wind loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
 - 2. Analysis shall detail anchoring methods, bolt diameter, and embedment depth.
 - 3. All wind restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 2.1.
- B. Friction from gravity loads shall not be considered resistance to wind forces.

PART 1 EXECUTION

3.01 INSTALLATION

- A. Wind Restraint of Ductwork and Equipment:
 - 1. All restraint systems shall be installed in strict accordance with the manufacturer's restraint guidelines and all certified submittal data.
 - 2. The interaction between mechanical and electrical equipment and the supporting structures shall be designed into the restraint systems.
 - 3. Friction clips shall not be used for anchorage attachments.
 - 4. Expansion anchors shall not be used for non-vibration isolated equipment rated over 10 HP.
 - 5. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction and vertical restraints shall be provided to resist overturning.
 - 6. Installation of restraints shall not cause any change in position of equipment or ductwork, resulting in stresses or misalignment.
 - 7. Exhaust fans with hinge kits shall have wind restraint fasteners installed on the hinged side, same as the three (3) non-hinged sides.
 - 8. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.
 - 9. Do not install any equipment or duct that makes rigid connections with the building unless isolation is not specified.
 - 10. Prior to installation, bring to the Architect's/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
 - 11. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult Structural Engineer of record.
 - 12. Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The Contractor shall submit loads to the Structural Engineer of record for approval in this event.
 - 13. Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.
 - 14. Provide reinforced clevis bolts where required.

15. Do not brace a system to two independent structures such as a roof and wall.

This page intentionally left blank

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.

1.02 RELATED REQUIREMENTS

A. Section 099123 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Dampers: Ceiling tacks, where located above lay-in ceiling.
- F. Ductwork: Adhesive-backed duct markers or stencils.
- G. Heat Transfer Equipment: Nameplates.
- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Pipe markers.
- K. Pumps: Nameplates.
- L. Relays: Tags.
- M. Small-sized Equipment: Tags.
- N. Tanks: Nameplates.
- O. Thermostats: Nameplates.
- P. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- Q. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 5. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
- B. Letter Color: White.
- C. Letter Height: 1/4 inch.
- D. Background Color: Black.
- E. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 - 2. Brady Corporation: www.bradycorp.com/#sle.
 - 3. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 4. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 5. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 6. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 ADHESIVE-BACKED DUCT MARKERS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 3. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- C. Style: Individual Label.
- D. Color: Green/White Green/White.

2.05 STENCILS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 3. Insite Solutions, LLC: www.stop-painting.com/#sle.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 5. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.

- 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
- 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
- 6. Ductwork and Equipment: 2-1/2 inch high letters.
- C. Stencil Paint: As specified in Section 099123, semi-gloss enamel, colors complying with ASME A13.1.

2.06 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 5. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Color code as follows:
 - 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

2.07 CEILING TACKS

- A. Manufacturers:
 - 1. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
- B. Description: Steel with 3/4 inch diameter color coded head.
- C. Color code as follows:
 - 1. HVAC Equipment: Yellow.
 - 2. Fire Dampers and Smoke Dampers: Red.
 - 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 099123 for stencil painting.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 099123.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.

- 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Install ductwork with adhesive-backed duct markers. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- H. Locate ceiling tacks to locate dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

SECTION 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic, steam, and refrigerating systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Commissioning activities.

1.02 RELATED REQUIREMENTS

- A. Section 019113 General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- B. Section 230800 Commissioning of HVAC.

1.03 REFERENCE STANDARDS

- A. AABC (NSTSB) AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 111 Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008, with Errata (2019).
- C. NEBB (TAB) Procedural Standard for Testing Adjusting and Balancing of Environmental Systems; 2019.
- D. SMACNA (TAB) HVAC Systems Testing, Adjusting and Balancing; 2002.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Architect.
 - 2. Submit to the Commissioning Authority.
 - 3. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Identification and types of measurement instruments to be used and their most recent calibration date.
 - d. Final test report forms to be used.
 - e. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 5. Units of Measure: Report data in I-P (inch-pound) units only.

- 6. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 4. Duct systems are clean of debris.
 - 5. Fans are rotating correctly.
 - 6. Fire and volume dampers are in place and open.
 - 7. Air coil fins are cleaned and combed.
 - 8. Access doors are closed and duct end caps are in place.
 - 9. Air outlets are installed and connected.
 - 10. Duct system leakage is minimized.
 - 11. Hydronic systems are flushed, filled, and vented.
 - 12. Pumps are rotating correctly.

- 13. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations.
- B. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- F. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- E. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- F. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- G. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- H. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- I. Where modulating dampers are provided, take measurements and balance at extreme conditions.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 COMMISSIONING

- A. See Sections 019113 General Commissioning Requirements and 230800 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 25 percent of the air handlers plus a random sample equivalent to 10 percent of the final TAB report data as directed by Commissioning Authority.
 - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 - 2. Use the same test instruments as used in the original TAB work.
 - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
 - 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F.
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
 - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F. In the presence of the Commissioning Authority, verify that:
 - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.

- 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
- 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.09 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Boiler Feedwater Pumps.
 - 2. HVAC Pumps.
 - 3. Boilers.
 - 4. Air Cooled Refrigerant Condensers.
 - 5. Packaged Roof Top Heating/Cooling Units.
 - 6. Unit Air Conditioners.
 - 7. Air Coils.
 - 8. Air Handling Units.
 - 9. Fans.
 - 10. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.
 - 4. Phase, voltage, amperage; nameplate, actual, no load.
 - 5. RPM.
 - 6. Service factor.
 - 7. Starter size, rating, heater elements.
 - 8. Sheave Make/Size/Bore.
- B. V-Belt Drives:
 - 1. Identification/location.
 - 2. Required driven RPM.
 - 3. Driven sheave, diameter and RPM.
 - 4. Belt, size and quantity.
 - 5. Motor sheave diameter and RPM.
 - 6. Center to center distance, maximum, minimum, and actual.
- C. Pumps:
 - 1. Identification/number.
 - 2. Manufacturer.
 - 3. Size/model.
 - 4. Impeller.
 - 5. Service.
 - 6. Design flow rate, pressure drop, BHP.
 - 7. Actual flow rate, pressure drop, BHP.
 - 8. Discharge pressure.
 - 9. Suction pressure.
 - 10. Total operating head pressure.

- 11. Shut off, discharge and suction pressures.
- 12. Shut off, total head pressure.
- D. Combustion Equipment:
 - 1. Boiler manufacturer.
 - 2. Model number.
 - 3. Serial number.
 - 4. Firing rate.
 - 5. Overfire draft.
 - 6. Gas meter timing dial size.
 - 7. Gas meter time per revolution.
 - 8. Gas pressure at meter outlet.
 - 9. Gas flow rate.
 - 10. Heat input.
 - 11. Burner manifold gas pressure.
 - 12. Percent carbon monoxide (CO).
 - 13. Percent carbon dioxide (CO2).
 - 14. Percent oxygen (O2).
 - 15. Percent excess air.
 - 16. Flue gas temperature at outlet.
 - 17. Ambient temperature.
 - 18. Net stack temperature.
 - 19. Percent stack loss.
 - 20. Percent combustion efficiency.
 - 21. Heat output.
- E. Air Cooled Condensers:
 - 1. Identification/number.
 - 2. Location.
 - 3. Manufacturer.
 - 4. Model number.
 - 5. Number of compressors.
- F. Cooling Coils:
 - 1. Identification/number.
 - 2. Location.
 - 3. Service.
 - 4. Manufacturer.
 - 5. Air flow, design and actual.
 - 6. Entering air DB temperature, design and actual.
 - 7. Leaving air DB temperature, design and actual.
 - 8. Water flow, design and actual.
 - 9. Water pressure drop, design and actual.
 - 10. Entering water temperature, design and actual.
 - 11. Leaving water temperature, design and actual.
 - 12. Air pressure drop, design and actual.
- G. Heating Coils:
 - 1. Identification/number.
 - 2. Location.
 - 3. Service.
 - 4. Manufacturer.
 - 5. Air flow, design and actual.
 - 6. Water flow, design and actual.
 - 7. Water pressure drop, design and actual.

- 8. Entering water temperature, design and actual.
- 9. Leaving water temperature, design and actual.
- 10. Entering air temperature, design and actual.
- 11. Leaving air temperature, design and actual.
- 12. Air pressure drop, design and actual.
- H. Electric Duct Heaters:
 - 1. Manufacturer.
 - 2. Identification/number.
 - 3. Location.
 - 4. Model number.
 - 5. Design kW.
 - 6. Number of stages.
 - 7. Phase, voltage, amperage.
 - 8. Test voltage (each phase).
 - 9. Test amperage (each phase).
 - 10. Air flow, specified and actual.
 - 11. Temperature rise, specified and actual.
- I. Air Moving Equipment:
 - 1. Location.
 - 2. Manufacturer.
 - 3. Model number.
 - 4. Serial number.
 - 5. Arrangement/Class/Discharge.
 - 6. Air flow, specified and actual.
 - 7. Return air flow, specified and actual.
 - 8. Outside air flow, specified and actual.
 - 9. Total static pressure (total external), specified and actual.
 - 10. Inlet pressure.
 - 11. Discharge pressure.
 - 12. Sheave Make/Size/Bore.
 - 13. Number of Belts/Make/Size.
 - 14. Fan RPM.
- J. Return Air/Outside Air:
 - 1. Identification/location.
 - 2. Design air flow.
 - 3. Actual air flow.
 - 4. Design return air flow.
 - 5. Actual return air flow.
 - 6. Design outside air flow.
 - 7. Actual outside air flow.
 - 8. Return air temperature.
 - 9. Outside air temperature.
 - 10. Required mixed air temperature.
 - 11. Actual mixed air temperature.
 - 12. Design outside/return air ratio.
 - 13. Actual outside/return air ratio.
- K. Exhaust Fans:
 - 1. Location.
 - 2. Manufacturer.
 - 3. Model number.
 - 4. Serial number.

- 5. Air flow, specified and actual.
- 6. Total static pressure (total external), specified and actual.
- 7. Inlet pressure.
- 8. Discharge pressure.
- 9. Sheave Make/Size/Bore.
- 10. Number of Belts/Make/Size.
- 11. Fan RPM.
- L. Duct Traverses:
 - 1. System zone/branch.
 - 2. Duct size.
 - 3. Area.
 - 4. Design velocity.
 - 5. Design air flow.
 - 6. Test velocity.
 - 7. Test air flow.
 - 8. Duct static pressure.
- M. Flow Measuring Stations:
 - 1. Identification/number.
 - 2. Location.
 - 3. Size.
 - 4. Manufacturer.
 - 5. Model number.
 - 6. Serial number.
 - 7. Design Flow rate.
 - 8. Design pressure drop.
 - 9. Actual/final pressure drop.
 - 10. Actual/final flow rate.
 - 11. Station calibrated setting.
- N. Terminal Unit Data:
 - 1. Manufacturer.
 - 2. Type, constant, variable, single, dual duct.
 - 3. Identification/number.
 - 4. Location.
 - 5. Model number.
 - 6. Size.
 - 7. Minimum static pressure.
 - 8. Minimum design air flow.
 - 9. Maximum design air flow.
 - 10. Maximum actual air flow.
 - 11. Inlet static pressure.
- O. Air Distribution Tests:
 - 1. Air terminal number.
 - 2. Room number/location.
 - 3. Terminal type.
 - 4. Terminal size.
 - 5. Area factor.
 - 6. Design velocity.
 - 7. Design air flow.
 - 8. Test (final) velocity.
 - 9. Test (final) air flow.

10. Percent of design air flow.

This page intentionally left blank

SECTION 230713 DUCT INSULATION-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.
- C. Insulation jackets.

1.02 RELATED REQUIREMENTS

- A. Section 078400 Firestopping.
- B. Section 230553 Identification for HVAC Piping and Equipment-CPL.
- C. Section 233100 HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

- A. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- B. ASTM B209M Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- C. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- D. ASTM C534/C534M Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2020a.
- E. ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- F. ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- G. ASTM C916 Standard Specification for Adhesives for Duct Thermal Insulation; 2020.
- H. ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2019.
- I. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- J. ASTM E96/E96M Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- K. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- L. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible; 2021.
- M. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. JP Lamborn Co; Thermal Sleeve MT: www.jpflex.com/#sle.
 - 4. Knauf Insulation; Atmosphere Duct Wrap: www.knaufinsulation.com/#sle.
 - 5. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - 6. Substitutions: See Section 016000 Product Requirements.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 1200 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Indoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- F. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- G. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation; 700 Series FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.
 - 5. Substitutions: See Section 016000 Product Requirements.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.

- 1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
- 2. Maximum Service Temperature: 450 degrees F.
- 3. Maximum Water Vapor Absorption: 5.0 percent.
- 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.05 EXPANDED POLYSTYRENE INSULATION

- A. Manufacturers:
 - 1. Knauf Insulation.
- B. Insulation: Closed-cell, light-weight, resilient, foamed plastic composed of hydrogen and carbon.

2.06 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - 1. Lagging Adhesive:
 - a. Manufacturers:
 - 1) Design Polymerics; DP 3050 Water Based, Zero VOC, Premium Quality, Lagging Adhesive, and Vapor Retarder: www.designpoly.com/#sle.
 - 2) Substitutions: See Section 016000 Product Requirements
 - b. Compatible with insulation.
- B. Aluminum Jacket: ASTM B209 (ASTM B209M).
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.07 DUCT LINER

- A. Manufacturers:
 - 1. Armacell LLC; AP Coilflex: www.armacell.us/#sle.
 - 2. CertainTeed Corporation: www.certainteed.com/#sle.
 - 3. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 - 4. Johns Manville: www.jm.com/#sle.
 - 5. Knauf Insulation: www.knaufinsulation.com/#sle.

- 6. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- 7. Substitutions: See Section 016000 Product Requirements.
- B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Fungal Resistance: No growth when tested according to ASTM G21.
 - 4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
 - 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.40.
 - 6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm per ASTM C1071.
 - 7. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test ductwork for design pressure prior to applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated Ducts Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- D. Insulated Ducts Conveying Air Above Ambient Temperature:
 - 1. Provide with standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.
- G. Slope exterior ductwork to shed water.
- H. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 - 3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
- I. Duct and Plenum Liner Application:
 - 1. Adhere insulation with adhesive for 90 percent coverage.
 - 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
 - 3. Seal and smooth joints. Seal and coat transverse joints.

- 4. Seal liner surface penetrations with adhesive.
- 5. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

- A. Exhaust Ducts Within 10 ft of Exterior Openings:
 - 1. Flexible Glass Fiber Duct Insulation: 1-1/2 inches thick.
 - 2. Rigid Glass Fiber Duct Insulation: 1-1/2 inches thick.
- B. Outside Air Intake Ducts:
 - 1. Insulation:
 - a. Flexible Glass Fiber Duct Insulation:
 - 1) Thickness required to provide an R value not less than R-12.
 - b. Rigid Glass Fiber Duct Insulation:
 - 1) Thickness required to provide an R value not less than R-12.
- C. Plenums:
 - 1. Flexible Glass Fiber Duct Insulation: R-6.
 - 2. Rigid Glass Fiber Duct Insulation: R-6.
- D. Plenums (Cooling System):
 - 1. Flexible Glass Fiber Duct Insulation: R-6.
 - 2. Rigid Glass Fiber Duct Insulation: R-6.
- E. Supply Ducts:
 - 1. First 10 ft from unit supply/return connections
 - a. Duct Liner
 - 2. Other than first 10 ft from supply connection
 - a. Flexible Glass Fiber Duct Insulation:
 - 1) Thickness required to provide an R value not less than R-6.
 - b. Rigid Glass Fiber Duct Insulation:
 - 1) Thickness required to provide an R value not less than R-6.
 - 3. In Mechanical Rooms:
 - a. Rigid Glass Fiber Duct Insulation:
 - 1) Thickness required to provide an R value not less than R-6.
 - Return and Relief Ducts in Mechanical Rooms:
 - 1. Rigid Glass Fiber Duct Insulation:
 - a. Thickness required to provide an R value not less than R-6.
- G. Ducts Exposed to Outdoors:
 - 1. Insulation: Top of duct shall be slanted to shed water.
 - a. Expanded Polystyrene Insulation.
 - 1) Thickness required to provide an R value not less than R-12.
 - 2. Jacket:

F.

a. Alumaguard® flexible weather-proofing jacket, self-healing membrane on exterior duct-work. Install per manufactures recommendations.

This page intentionally left blank

SECTION 230716 HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Covering.
- B. Breeching insulation.

1.02 RELATED REQUIREMENTS

A. Section 230553 - Identification for HVAC Piping and Equipment-CPL.

1.03 REFERENCE STANDARDS

- A. ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- B. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- C. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible.

2.03 JACKETS

A. PVC Plastic:

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- C. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Flue Gas Breeching:
SECTION 230719 HVAC PIPING INSULATION-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 078400 Firestopping.
- B. Section 232113 Hydronic Piping: Placement of hangers and hanger inserts.
- C. Section 232213 Steam and Condensate Heating Piping: Placement of hangers and hanger inserts.
- D. Section 232300 Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

- A. ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.
- B. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- C. ASTM B209M Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- D. ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.
- E. ASTM C195 Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- F. ASTM C449 Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).
- G. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- H. ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017.
- I. ASTM C534/C534M Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2020a.
- J. ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation; 2019.
- K. ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2019.
- L. ASTM C585 Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010 (Reapproved 2016).
- M. ASTM C591 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2020.
- N. ASTM C795 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2018).
- O. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2021.
- P. ASTM D610 Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces; 2008 (Reapproved 2019).
- Q. ASTM D2842 Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2019.

- R. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- S. ASTM E96/E96M Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- T. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

- A. Manufacturers:
 - 1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation; _____: www.jm.com/#sle.
 - 3. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
 - 5. Owens Corning Corporation; VaporWick Pipe Insulation: www.ocbuildingspec.com/#sle.
 - 6. Substitutions: See Section 016000 Product Requirements.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
 - 1. K Value: ASTM C177, 0.23 at 75 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.

- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perminches.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Vapor Barrier Lap Adhesive: Compatible with insulation.
- G. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- H. Fibrous Glass Fabric:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
 - 2. Blanket: 1.0 lb/cu ft density.
 - 3. Weave: 5 by 5.
- I. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, black color.
- J. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- K. Insulating Cement: ASTM C449.

2.03 HYDROUS CALCIUM SILICATE

- A. Manufacturers:
 - 1. Johns Manville Corporation; _____: www.jm.com/#sle.
 - 2. Substitutions: See Section 016000 Product Requirements.
- B. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
 - 1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1200 degrees F.
 - 3. Density: 15 lb/cu ft.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- D. Insulating Cement: ASTM C449.

2.04 POLYISOCYANURATE CELLULAR PLASTIC

- A. Insulation Material: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
 - 1. Dimension: Comply with requirements of ASTM C585.
 - 2. K Value: 0.18 at 75 degrees F, when tested in accordance with ASTM C518.
 - 3. Minimum Service Temperature: Minus 70 degrees F.
 - 4. Maximum Service Temperature: 300 degrees F.
 - 5. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D2842.
 - 6. Moisture Vapor Transmission: 4.0 perm inch.
 - 7. Connection: Waterproof vapor barrier adhesive.

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Aeroflex USA, Inc; Aerocel Stay-Seal with Protape (SSPT): www.aeroflexusa.com/#sle.
 - 2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
 - 3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.06 EXTRUDED POLYSTYRENE (XPS) BOARD INSULATION

- A. Comply with ASTM E84.
- B. Insulation: ASTM C578; rigid closed cell.
 - 1. K Value: 0.23 at 75 degrees F.
 - 2. Maximum Service Temperature: 165 degrees F.
 - 3. Maximum Water Vapor Permeance: 5.0 perms.
- C. Billet Dimensions: 7 inches by 14 inches by 108 inches.
- D. Density: Type X, 1.30 pcf (21 kg/cu m), minimum.
- E. Water Absorption: Type X, 0.3 percent by volume, maximum, by total immersion.

2.07 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com/#sle.
 - b. Substitutions: See Section 016000 Product Requirements.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
 - 3. Covering Adhesive Mastic: Compatible with insulation.
- B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
- C. Vapor Barrier Membranes: ASTM C1136, Type IX.
 - 1. Multilayer Laminate Vapor Barrier:
 - a. Thickness: 2.4 mil.
 - b. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.
 - c. Manufacturers:
 - 1) Polyguard Products; ZERO-PERM: www.polyguardproducts.com/#sle.
 - 2) Substitutions: See Section 016000 Product Requirements.

2.08 ACCESSORIES

- A. General Requirements:
 - 1. Provide required accessories in accordance with and subject to the recommendations of the insulation manufacturer.
 - 2. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
 - 3. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
 - 4. Supply materials that are asbestos free.
- B. Corrosion Inhibitors:
 - 1. Corrosion Control Gel:
 - a. Manufacturers:

- 1) Polyguard Products; RG2400LT: www.polyguardproducts.com/#sle.
- 2) Substitutions: See Section 016000 Product Requirements.
- b. Corrosion Protection: Comply with ASTM B117 and ASTM D610.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- H. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- I. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 078400.
- K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- L. Concealed Piping: Finish with fitting covers on flanges, fittings, valves, and specialties.
- M. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Heating Water Supply and Return:
 - a. NPS 1-1/4 and Smaller: 1-1/2 inch thick Rigid Glass Fiber.
 - b. NPS 1-1/2 and Larger: 2 inch thick Rigid Glass Fiber.
 - 2. Low Pressure Steam Piping (250 deg. F and Below):
 - a. NPS 3-1/2 and Smaller: 2-1/2 inch thick Rigid Glass Fiber.
 b. NPS 4 and Larger: 3 inch thick Rigid Glass Fiber.
 - 3. Low Pressure, Gravity, and Pumped Steam Condensate:
 - a. NPS 3-1/2 and Smaller: 2-1/2 inch thick Rigid Glass Fiber.
 - b. NPS 4 and Larger: 3 inch thick Rigid Glass Fiber.
 - 4. Boiler Feed Water:
 - a. NPS 1-1/4 and Smaller: 1 inch thick Rigid Glass Fiber.
 - b. NPS 1-1/2 and Larger: 1-1/2 inch thick Rigid Glass Fiber.
- B. Cooling Systems:
 - 1. Cold Condensate Drains:
 - a. All Sizes: 1/2 inch thick Rigid Glass Fiber with Vapor Barrier.
 - b. All Sizes: 3/4 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
 - 2. Condensate Drains from Cooling Coils:
 - a. All Sizes: 1/2 inch thick Rigid Glass Fiber with Vapor Barrier.
 - b. All Sizes: 3/4 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
 - 3. Refrigerant Suction:
 - a. All Sizes: 1-1/2 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
 - b. Provide aluminum jacketing for exposed exterior piping.
 - 4. Refrigerant Hot Gas:
 - a. All Sizes: 1-1/2 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
 - b. Provide aluminum jacketing for exposed exterior piping.
 - 5. Refrigerant Liquid:
 - a. All Sizes: 1 inch thick Flexible Elastomeric Cellular.
 - b. Provide aluminum jacketing for exposed exterior piping.

END OF SECTION

SECTION 230800 COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. See Section 019113 General Commissioning Requirements for overall objectives; comply with the requirements of Section 019113.
- B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.
- D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
 - 1. Control system.
 - 2. Major and minor equipment items.
 - 3. Piping systems and equipment.
 - 4. Ductwork and accessories.
 - 5. Terminal units.
 - 6. Boilers.
 - 7. Pumps.
 - 8. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 RELATED REQUIREMENTS

- A. Section 017800 Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.
- B. Section 230593 Testing, Adjusting, and Balancing for HVAC-CPL.
- C. Section 230913 Instrumentation and Control Devices for HVAC.
- D. Section 250800 Commissioning of Integrated Automation.
- E. ASHRAE Guideline 1.1 HVAC&R Technical Requirements for the Commissioning Process; 2007, with Errata (2012).

1.03 SUBMITTALS

- A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B. Request integrated automation (controls) checklists and test procedures from Section 250800.
- C. Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
 - 1. System name.
 - 2. List of devices.
 - 3. Step-by-step procedures for testing each controller after installation, including:
 - a. Process of verifying proper hardware and wiring installation.
 - b. Process of downloading programs to local controllers and verifying that they are addressed correctly.

- c. Process of performing operational checks of each controlled component.
- d. Plan and process for calibrating valve and damper actuators and all sensors.
- e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
- 4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has "passed" and is operating within the contract parameters.
- 5. Description of the instrumentation required for testing.
- 6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.
- D. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- E. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
 - 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
 - 2. Full as-built set of control drawings.
 - 3. Full as-built sequence of operations for each piece of equipment.
 - 4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
 - a. Floor.
 - b. Room number.
 - c. Room name.
 - d. Air handler unit ID.
 - e. Reference drawing number.
 - f. Air terminal unit tag ID.
 - g. Heating and/or cooling valve tag ID.
 - h. Minimum air flow rate.
 - i. Maximum air flow rate.
 - 5. Full print out of all schedules and set points after testing and acceptance of the system.
 - 6. Full as-built print out of software program.
 - 7. Electronic copy on disk of the entire program for this facility.
 - 8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
 - 9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 - 10. Control equipment component submittals, parts lists, etc.
 - 11. Warranty requirements.
 - 12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
 - 13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
 - a. Sequences of operation.
 - b. Control drawings.
 - c. Points lists.
 - d. Controller and/or module data.
 - e. Thermostats and timers.
 - f. Sensors and DP switches.
 - g. Valves and valve actuators.

- h. Dampers and damper actuators.
- i. Program setups (software program printouts).
- F. Project Record Documents: See Section 017800 for additional requirements.
 - 1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
 - 2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- G. Draft Training Plan: In addition to requirements specified in Section 017900, include:
 - 1. Follow the recommendations of ASHRAE Guideline 1.1.
 - 2. Control system manufacturer's recommended training.
 - 3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- H. Training Manuals: See Section 017900 for additional requirements.
 - 1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 PREPARATION

- A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.
- B. Furnish additional information requested by the Commissioning Authority.
- C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.
- D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
- F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- G. Provide temperature and pressure taps in accordance with Contract Documents.

3.02 INSPECTING AND TESTING - GENERAL

- A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.

- C. Provide two-way radios for use during the testing.
- D. Valve/Damper Stroke Setup and Check:
 - 1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
 - 2. Set pump/fan to normal operating mode.
 - 3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
 - 4. Command valve/damper open; verify position is full open and adjust output signal as required.
 - 5. Command valve/damper to a few intermediate positions.
 - 6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
 - 7. Closure for Heating Coil Valves Normally Open:
 - a. Set heating setpoint 20 degrees F above room temperature.
 - b. Observe valve open.
 - c. Remove control air or power from the valve and verify that the valve stem and actuator position do not change.
 - d. Restore to normal.
 - e. Set heating setpoint to 20 degrees F below room temperature.
 - f. Observe the valve close.
 - g. Restore to normal.
- E. Isolation Valve or System Valve Leak Check: For valves not by coils.
 - 1. With full pressure in the system, command valve closed.
 - 2. Use an ultra-sonic flow meter to detect flow or leakage.
- F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

- A. TAB: Testing, adjusting, and balancing of HVAC.
- B. Coordinate commissioning schedule with TAB schedule.
- C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.
- D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
- E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.
- F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

- A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.

- D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
 - 1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
 - 2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
 - 1. Setpoint changing features and functions.
 - 2. Sensor calibrations.
- G. Demonstrate to the Commissioning Authority:
 - 1. That all specified functions and features are set up, debugged and fully operable.
 - 2. That scheduling features are fully functional and setup, including holidays.
 - 3. That all graphic screens and value readouts are completed.
 - 4. Correct date and time setting in central computer.
 - 5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
 - 6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
 - 7. Power failure and battery backup and power-up restart functions.
 - 8. Global commands features.
 - 9. Security and access codes.
 - 10. Occupant over-rides (manual, telephone, key, keypad, etc.).
 - 11. O&M schedules and alarms.
 - 12. Occupancy sensors and controls.
 - 13. All control strategies and sequences not tested during controlled equipment testing.
- H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

- A. See Section 017800 for additional requirements.
- B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

A. See Section 017900 for additional requirements.

- B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
 - 1. HVAC Control System: 8 hours.
 - 2. Boilers and System: 4 hours.
 - 3. Air Handling Units: 1 hours.
 - 4. Packaged Rooftop Units: 1 hours.
 - 5. Split System AC or Heat Pumps: 4 hours.
- E. TAB Review: Instruct Owner's personnel for minimum 2 hours, after completion of TAB, on the following:
 - 1. Review final TAB report, explaining the layout and meanings of each data type.
 - 2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
 - 3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
 - 4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 - 5. Other salient information that may be useful for facility operations, relative to TAB.
- F. HVAC Control System Training: Perform training in at least three phases:
 - 1. Phase 1 Basic Control System: Provide minimum of 4 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
 - a. This training may be held on-site or at the manufacturer's facility.
 - b. If held off-site, the training may occur prior to final completion of the system installation.
 - c. For off-site training, Contractor shall pay expenses of up to two attendees.
 - 2. Phase 2 Integrating with HVAC Systems: Provide minimum of 4 hours of on-site, handson training after completion of Functional Testing. Include instruction on:
 - a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
 - b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
 - c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
 - d. Every display screen, allowing time for questions.
 - e. Point database entry and modifications.

- 3. Phase 3 Post-Occupancy: Six months after occupancy conduct minimum of 2 hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.
- G. Provide the services of manufacturer representatives to assist instructors where necessary.
- H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION

This page intentionally left blank

SECTION 230913

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

- BASE BID - PROVIDE CONTROLS FOR THE NEW EQUIPEMENT THAT IS COMPATTIBLE WITH FUTURE BACNET UPGRADES AND THE CURRENT BMS.

VERIFY ALL EXISTING SEQUENCES BEFORE THE COMMENCEMENT OF ANY DEMOLITION WORK.

3.01 SECTION INCLUDES

- A. Control panels.
- B. Control Valves:
 - 1. Ball valves and actuators.
 - 2. Globe pattern.
 - 3. Electronic operators.
 - 4. Radiation valves.
- C. Dampers.
- D. Damper Operators:
 - 1. Electric operators.
- E. Humidistats:
 - 1. Limit duct humidistats.
- F. Input/Output Sensors:
 - 1. Temperature sensors.
 - 2. Humidity sensors.
 - 3. Static pressure (air pressure) sensors.
 - 4. Equipment operation (current) sensors.
 - 5. Damper position indicators.
 - 6. Carbon monoxide sensors.
 - 7. Carbon dioxide sensors.
- G. Thermostats:
 - 1. Electric room thermostats.
 - 2. Line voltage thermostats.
 - 3. Room thermostat accessories.
 - 4. Outdoor reset thermostats.
 - 5. Immersion thermostats.
 - 6. Electric low limit duct thermostats.
 - 7. Electric high limit duct thermostats.
- H. Time clocks.
- I. Transmitters:
 - 1. Temperature transmitters.
 - 2. Humidity transmitters.

3.02 RELATED REQUIREMENTS

- A. Section 230519 Meters and Gauges for HVAC Piping-CPL: Thermometer sockets and gauge taps.
- B. Section 230923 Direct-Digital Control System for HVAC.
- C. Section 230993 Sequence of Operations for HVAC Controls.

3.03 REFERENCE STANDARDS

- A. AMCA 500-D Laboratory Methods of Testing Dampers for Rating; 2018.
- B. ANSI/FCI 70-2 Control Valve Seat Leakage; 2021.

- C. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- D. NEMA DC 3 Residential Controls Electrical Wall-Mounted Room Thermostats; 2013.

3.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

3.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Manufacturer's Instructions: Provide for all manufactured components.
- E. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

3.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience approved by manufacturer.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

3.07 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Correct defective work within a five year period after Substantial Completion.

PART 2 PRODUCTS

4.01 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

4.02 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.

4.03 CONTROL VALVES

- A. Ball Valves and Actuators:
 - 1. Service: Use for chilled water, hot water, or steam at 15 to 25 psig (104.4 to 172.4).
 - 2. Flow Characteristic: Include 2-way, 3-way diverting, and 3-way mixing operation.
 - a. Heating Hot Water: Configure to fail normally open.
 - b. Chilled Water: Configure to fail normally closed.
 - 3. Provide pressure-independent type.

- 4. Rangeability: 500 to 1.
- 5. ANSI Rating: Class 150.
- 6. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
- 7. Body Size:
 - a. Under 2-1/2 inches:
 - 1) Connection: NPT.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - b. 2-1/2 inches and Above:
 - 1) Connection Type: Flanged.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - c. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
 - 2) Ambient Side: From minus 4 to 122 degrees F.
- 8. Actuator Requirements:
 - a. Assembly: Factory-mounted.
 - b. Input: 0 to 5 VDC configured for proportional control.
 - c. Accessories: Provide with valve position indicator and manual override.
- B. Globe Pattern:
 - 1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 - 2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
- C. Electronic Operators:
 - 1. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
 - 2. Select operator for full shut off at maximum pump differential pressure.
- D. Radiation Valves:
 - 1. Size for 3 psig maximum pressure drop at design flow rate.
 - 2. Operators (Modulating): Self-contained, linear motorized actuator with approximately 3/4 inch stroke, 60 second full travel with transformer and SPDT contacts: 24 v DC, 6 watt maximum input.

4.04 DAMPERS

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gauge, 0.1046 inch.
- C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gauge, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.

- D. Blade Seals: Synthetic elastomeric, inflatable, mechanically attached, field replaceable.
- E. Shaft Bearings: Oil impregnated sintered bronze.
- F. Linkage Bearings: Oil impregnated sintered bronze.
- G. Leakage: Less than one percent based on approach velocity of 2000 ft per min and 4 inches wg.
- H. Maximum Pressure Differential: 6 inches wg.
- I. Temperature Limits: Minus 40 to 200 degrees F.

4.05 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - 1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - 2. Provide one operator for maximum 36 sq ft damper section.
- B. Electric Operators:
 - 1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

4.06 HUMIDISTATS

- A. Limit Duct Humidistats:
 - 1. Insertion, two position type.
 - 2. Throttling Range: Adjustable 2 percent relative humidity.
 - 3. Operating Range: 20 to 80 percent.
 - 4. Maximum Temperature: 150 degrees F.

4.07 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
 - 1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
 - 2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
 - 3. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
 - 4. Temperature Sensing Device: Compatible with project DDC controllers.
 - 5. Performance Characteristics:
 - a. RTD:
 - 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
 - 4) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
 - 5) Range: Minus 40 degrees F through 220 degrees F minimum.
 - b. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
 - 2) Range: Minus 25 degrees F through 122 degrees F minimum.
 - 3) Heat Dissipation Constant: 2.7 mW per degree C.
 - c. Temperature Transmitter:
 - 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
 - 2) Output: 4 to 20 mA.
 - d. Room Sensors: Locking cover.
 - e. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - f. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.

- g. Room Temperature Sensors with Integral Digital Display:
 - 1) Construct for wall box.
- h. Temperature Averaging Elements:
 - 1) Use on duct sensors for ductwork 10 sq ft or larger.
 - 2) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
- i. Insertion Elements:
 - 1) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.
- B. Humidity Sensors:
 - 1. Duct Mounted Sensor: Voltage type encased in a die-cast metal, weather-proof housing.
 - a. Input Power, Voltage Type: Class 2; 12-30 VDC/24 VAC, 15mA max.
 - b. Input Power, mA Type: Class 2; Loop powered 12-30 VDC only, 30 mA max.
 - c. Output Voltage Type: 3-wire observed polarity.
 - d. Output mA Type: 2-wire, not polarity sensitive (clipped and capped).
 - e. Humidity:

3)

- 1) HS Element: Digitally profiled thin-film capacitive.
- 2) Accuracy 1 percent at 10 to 80 percent relative humidity at 77 degrees F, multipoint calibration, NIST traceable.
 - (a) Plus/minus 1 percent at 20 to 40 percent RH in mA output mode; (multipoint calibration, NIST traceable).
 - Scaling: 0 to 100 percent RH.
- f. Temperature Effect:
 - 1) Duct Mounted: Plus/minus 0.18 percent per degree F.
 - 2) Outdoor Mounted: 4 to 20mA version: (0.0013x%RHx(TdegreeC-25)).
- g. Hysteresis: 1.5 percent typical.
- h. Linearity: Included in accuracy specification.
- i. Reset Rate: 24 hours.
- j. Stability: Plus/minus 1 percent at 68 degrees F (20 degrees C) annually, for two years.
- k. Temperature Monitoring:
 - 1) Temperature Transmitter Output: Digital, 4 to 20mA (clipped and capped) or 0-5V/0-10V output.
 - (a) HO Transmitter Accuracy: Plus/minus 2.3 degrees F.
 - (b) HD Transmitter Accuracy: Plus/minus 1.0 degree F.
- I. Operating Environment:
 - 1) Operating Humidity Range: 0 to 100 percent RH noncondensing.
 - 2) Operating Temperature Range: Minus 40 degrees F to 122 degrees F.
- C. Static Pressure (Air Pressure) Sensors:
 - 1. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 - 2. Accuracy: One percent of full scale with repeatability 0.3 percent.
 - 3. Output: 0 to 5 vdc with power at 12 to 28 vdc.
- D. Equipment Operation (Current) Sensors:
 - 1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
 - 2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
 - 3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- E. Carbon Monoxide Sensors, for Single-Gang Electrical Box Mounting:
 - 1. General:

- a. Input Power: Class 2; 15 to 30 VDC/24 VAC plus/minus 20 percent, 50/60 Hz.
- b. Relay Ratings: 1A/30VAC/DC, normally open.
- c. Operating Temperature Range: Minus 4 degrees F to 122 degrees F.
- d. Operating Humidity Range: 0 to 90 percent RH non-condensing.
- e. Terminal Block Wire Size: 30 AWG (0.255 mm) by 12 AWG (2.05 mm).
- f. Terminal Block Torque: 0.37 to 0.44 inch-lbf.
- g. Protection Class: IP20 in accordance with IEC 60529.
- 2. Sensor:
- F. Carbon Dioxide Sensors, Duct and Wall:
 - 1. Calibration Characteristics:
 - a. Automatically compensating algorithm for sensor drift due to sensor degradation.
 - b. Maximum Drift: 2 percent.
 - c. User calibratable with a minimum calibration interval of 5 years.
 - 2. Construction:
 - a. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
 - b. Housing: High impact plastic.

4.08 THERMOSTATS

- A. Electric Room Thermostats:
 - 1. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
- B. Room Thermostat Accessories:
- C. Outdoor Reset Thermostats:
 - 1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
- D. Immersion Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- E. Electric Low Limit Duct Thermostats:
- F. Electric High Limit Duct Thermostats:
 - 1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above setpoint,

4.09 TIME CLOCKS

A. Seven day programming switch timer with synchronous timing motor and seven day dial, continuously charged Ni-cad battery driven power failure 8 hour carry over and multiple switch trippers to control systems for minimum of two and maximum of eight signals per day with two normally open and two normally closed output switches.

PART 3 EXECUTION

5.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.

5.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of exposed control sensors with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches. Refer to Section 262726.
- C. Mount freeze protection thermostats using flanges and element holders.
- D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- E. Provide separable sockets for liquids and flanges for air bulb elements.
- F. Provide guards on thermostats in entrances.
- G. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- H. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors.
- I. Provide isolation (two position) dampers of parallel blade construction.
- J. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- K. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- L. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- M. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

5.03 MAINTENANCE

- A. See Section 017000 Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- C. Provide complete service of controls systems, including call backs, and submit written report of each service call.
- D. In addition to normal service calls, make minimum of 4 complete normal inspections of approximately 4 hours duration to inspect, calibrate, and adjust controls.

END OF SECTION

This page intentionally left blank

SECTION 230923 DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. DDC system for monitoring and controlling of HVAC systems.
 - 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.
- B. Related Requirements:
 - 1. Section 230913 "Instrumentation and Control Devices for HVAC".
 - 2. Section 260583 "Wiring Connections".
 - 3. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical components.

1.03 DESCRIPTION OF WORK

A. BASE BID - PROVIDE CONTROLS FOR THE NEW EQUIPEMENT THAT IS COMPATIBLE WITH FUTURE BACNET UPGRADES AND THE CURRENT TBS BMS.

- B. Furnish all labor, materials, equipment, and service necessary to extend the existing building operation Digital Control System and provide a complete and operating temperature control system. System shall use Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein. Control sequences are specified on plans.
 - 1. All actuation of valves and dampers shall be electric unless specifically called out elsewhere in the specifications or drawings.
- C. In accordance to the scope of work, the system shall provide a scalable vector-based graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability and allowing future expansion of both input/output points and processing/control functions.
- D. For this project, the system shall consist of the following components:
 - Administration and Programming Workstation(s): The BAS Contractor shall furnish (qty 1) Administration and Programming Workstation Computers as described "Administrative/Programming Workstation & Enterprise Server Requirements" section of this specification. These workstation(s) must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third-party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.
 - 2. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control set points and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the workstation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer-based hardware to support the web-based user interface.

- 3. Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish Ethernet-based Network Server Controllers. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted.
- 4. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Network Server Controllers (B-BC).
- 5. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC.
- 6. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).
- E. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135-2008, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2008, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.
- F. The software tools required for network management of the ANSI / ASHRAE[™] Standard 135-2008, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner.
- G. The system shall support Modbus TCP and RTU protocols natively, and not require the use of gateways.
- H. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.
 - 1. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs.
 - 2. Data shall reside on a supplier-installed server for all database access.
 - 3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.

1.04 ACTION SUBMITTALS

- A. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical schematics will be allowed where appropriate.
 - 1. Each drawing containing an equipment schematic shall contain a table indicating what equipment is covered by this drawing (i.e. equipment "tag #") and which drawing in the Construction Document set this piece of equipment is shown on.

- B. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.
- C. Submittal data shall contain descriptions of sequences of operation.
- D. Submit a digital copy of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. Prior to submitting, the Contractor shall check all documents for accuracy.
- E. The Engineer will make corrections, if required, and return to the Contractor. The Contractor shall then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
- F. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS shall be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report shall be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
- G. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. See Section 3.6 for detail required in Commissioning the system.
- H. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

1.05 CLOSEOUT SUBMITTALS

- A. OPERATING AND MAINTENANCE MANUALS
 - 1. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the lead-time and expected frequency of use of each part clearly identified.
 - 2. Following project completion and testing, the BAS contractor shall submit as-built drawings reflecting the exact installation of the system.

1.06 QUALITY ASSURANCE

- A. All labor, material, equipment and software necessary to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be provided by Day Automation Systems. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner. This contractor also is responsible for all costs of changes in the work required by substitute equipment.
- B. The Building Management System (BMS) Contractor must have been in business for not less than 10 years and providing BMS systems must be the Contractors primary business. BMS Contractor must be an authorized distributor or branch office of the manufacturers specified. BMS Contractor must have a trained staff of application engineers, project managers, software engineers, commissioning staff, and service staff experienced in the configuration, programming and service of the automation system.
- C. The BMS Contractor shall have a training facility with regularly scheduled training to provide ongoing regularly scheduled application training.

- D. Manufacturer: A firm regularly engaged in manufacture of microprocessor temperature control equipment, of types and sizes which are similar to required equipment, and which have been in satisfactory use for not less than 10 years, in similar service.
- E. Electrical standards: Provide electrical products that comply with the following agency approvals:
 - 1. UL-916; Energy Management Systems for BAS components and ancillary equipment
 - 2. UL-873; Temperature Indication and Regulating Equipment
 - 3. FCC, Part 15, Subpart J, Class A Computing Devices
- F. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

1.07 WARRANTY AND ACCEPTANCE

- A. The microprocessor temperature control contractor shall warrant the control system installed in this contract to be free from defects in material and workmanship, except for damages from other causes, for a period of one year after final acceptance from the owner. The microprocessor temperature control contractor shall be responsible for all necessary revisions to the software required for a workable system performance through the first year of operation. Any changes in the software shall be transmitted immediately to the owner. The software responsibility is for a complete and workable system as described in the control cycle description of the specification. The software shall become the property of the owner.
- B. Updates to the manufacturer's software shall be provided at no charge during the warranty period.
- C. All equipment required to maintain operation of the temperature control system for the project shall be stocked in the microprocessor temperature control contractor's local facility. It shall be immediately available in the event of component failure. A spare or loaner piece of equipment shall be installed immediately when a failure occurs, and the equipment shall be returned to the factory for repair.
- D. Submit a proposal to provide all services, materials and the equipment necessary for preventative maintenance on the entire system for a period of one year. The work covered in this proposal shall include maintenance of the control equipment including all computer equipment, CPU, peripherals, transmission equipment, and related HVAC control devices.

PART 2 PRODUCTS

2.01 DDC SYSTEM MANUFACTURERS

- A. Manufacturer
 - 1. Day Automation.
 - 2. Starktech.
 - 3. Johnson Controls.
 - 4. Honeywell.
 - 5. Trane.
 - 6. Siemens.
 - 7. Or approved equal.

2.02 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
- 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.

2.03 SCOPE OF WORK

- A. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators and other accessory equipment, along with a complete system of electrical interlocking wiring as required to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
- B. Provide building operation Front End Software Workstation for this project. All building systems graphics, scheduling and centralized alarms must be developed on this software to provide the district one portal for the complete system from any existing District EcoStruxure for building operation workstation.
- C. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
- D. All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor shall review and check out the system. At that time, the BAS contractor shall demonstrate the operation of the system to the Owner and prove that it complies with the intent of the drawings and specifications.
 - 1. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification.
- E. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative. Commissioning reports showing the testing of each DDC point on the system shall be submitted to the Engineer for review and approval upon completion of the commissioning process.

2.04 SYSTEM ARCHITECTURE

- A. General
 - The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
 - 2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
 - 3. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
 - 4. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP and/or Modbus TCP protocol. All protocols shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow both protocols to be natively supported. A sub-network of SDCUs using the BACnet MS/TP and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.
- B. TCP/IP Level

- 1. The TCP/IP layer connects all the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.
- C. Fieldbus Level with Standalone Digital Control Units (SDCUs)
 - 1. The fieldbus layer shall be supporting all the following types of SDCUs:
 - a. BACnet SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 50 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2007
 - b. Modbus SDCU requirements: The system shall consist of one or more Modbus RTU (RS-485 or RS-232) field buses managed by the Network Server Controller. The field bus layer shall consist of up to 62 SDCUs for operation of HVAC, power metering, and lighting equipment. If utilizing Modbus TCP, the field bus layer shall consist of up to 100 SDCUs for operation of HVAC, power metering, and lighting equipment.
- D. Standard Network Support
 - 1. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.
- E. Support For Open Systems Protocols
 - 1. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.05 OPERATOR WORKSTATION REQUIREMENTS

- A. General
 - 1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 10 concurrent operator users and/or 1 engineering users within the enterprise server.
 - 2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
 - 3. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system (specified below). The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
 - 4. A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC.
- B. Administration/Programming Workstation & Enterprise Server Requirements
 - I. The Enterprise Server shall consist of the following:
 - a. Processor
 - 1) GHz or higher
 - b. Memory
 - 1) 4GB or higher
 - c. Operating systems:
 - 1) Microsoft Windows XP Pro 32-bit SP3

- 2) Microsoft Windows 7 Pro 32-bit
- 3) Microsoft Windows 7 Pro 64-bit
- 4) Microsoft Windows 2008 R2 64-bit
- 5) 10/100MBPS Ethernet NIC
- 6) 250 GB hard disk
- 7) License agreement for all applicable software
- 2. The workstation shall consist of the following:
 - a. Processor
 - GHz or higher
 - b. Memory
 - 1) 4GB or higher
 - c. Operating systems:
 - 1) Microsoft Windows XP Pro 32-bit SP3
 - 2) Microsoft Windows 7 Pro 32-bit
 - 3) Microsoft Windows 7 Pro 64-bit
 - 4) Microsoft Windows 2008 R2 64-bit
 - 5) Serial port, parallel port, USB port
 - 6) 10/100MBPS Ethernet NIC
 - 7) 20 GB hard disk
 - 8) DVD drive
 - 9) High resolution (minimum 1280 x 1024), 17" flat panel display
 - 10) Optical mouse and full function keyboard
 - 11) Audio sound card and speakers
 - 12) License agreement for all applicable software.
- C. Web-Based Operator PC Requirements
 - 1. Any user on the network can access the system, using the following software:
 - a. Windows 2000/XP and above
 - b. Internet Explorer 8 (32-bit)
 - c. Internet Explorer 9 (32-bit)
 - d. Firefox 4.0 (32-bit) and above
 - e. Java-enabled
- D. User Interface:
 - 1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software.
- E. The building operation user interface will be used as the graphical user interface to represent all live system data, schedule adjustment and alarm annunciation from devices installed by an energy management contractor.
- F. The user interface will include the following graphical screens and features as a minimum:
 - 1. A main screen for the building which will include global commands to adjust the occupied and unoccupied building set points for the entire building. Hyperlinks to open space temperature reports and fan run indication status reports will also be included.
 - 2. AutoCAD files will be imported into the user interface to create floor plan graphics. Each piece of mechanical equipment will be represented on the floor plan with a color coded tag denoting its type (i.e. AHU, UV, FCU, VAV, Boiler, Heat Pump, Exhaust Fan, Radiation or CUH). Live space temperature data will be displayed in the associated room containing the space temperature sensor. Clicking on the live space temperature value will open a schematic of the mechanical equipment.

- 3. Each piece of controlled mechanical equipment will have a dedicated user interface screen. An engineering style ductwork diagram will be provided for all air systems. An engineering style piping diagram will be provided for all hot water and chilled water systems. The ductwork and piping diagrams will be accurate representations to the piping or ductwork installed.
- 4. The mechanical equipment graphic will display the current operating mode (occupied, unoccupied, warm-up or cool-down), a summary of associated alarms, the scheduled time of operation, set point adjustment information, and operator override timer information.
- 5. Every system input, output and control point will accumulate historical trend date for a minimum of 24 hours. An option to collect data for extended period of time (i.e. 1 year) will also be available on every point. A report of the historical trend data will be available as a link from the mechanical equipment graphic.
- 6. Alarm alerts will be configured for the following conditions as a minimum
 - a. Fan/Pump run indication failure
 - b. Fan/Pump stop failure
 - c. Space temperature high
 - d. Space temperature low
 - e. Low hot water supply temperature
 - f. Boiler alarm
 - g. Pump/Fan VSD alarm
 - h. Each associated alarm will contain a detailed message describing the alarm condition.
- 7. A reporting engine will be included at no additional charge to create ad hock reports on alarms, system activity, and live system values. The reporting engine will offer an option for the operator to adjust the search criteria.
- 8. Ten equipment schedules will be created for each building. Each piece of mechanical equipment will be assigned to one of the ten equipment schedules. The operator will be able to change the equipment schedule assignment from the graphical user interface. Each of the ten equipment schedules will have an option to either subscribe or not subscribe to the holiday schedule.
- G. User Security
 - 1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.
- H. Automatic monitoring
 - 1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user configurable.
- I. Alarm Management
 - 1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
 - 2. Alarm management features shall include:
 - a. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)

- b. Playing an audible sound on alarm initiation or return to normal.
- c. Sending an e-mail anyone listed in a workstation's e-mail account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required, and no email client software must be running in order for email to be distributed.
- d. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
- e. An operator shall have the capability to assign an alarm to another user of the system. Such assignments shall be tracked to insure alarm response.
- J. Report Generation
 - 1. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
 - 2. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future use.
 - 3. All reports shall be able to be set up to automatically run or be generated on demand.
 - 4. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
 - 5. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
 - 6. Minimum supplied reports shall include:
 - a. Activities Per Server Report
 - b. Activities Per User Report
 - c. Alarm Amount by Category Report
 - d. Alarm Amount by Type Report
 - e. Alarms Per Sever Report
 - f. Current Alarm Report
 - g. Most Active Alarm Report
 - h. System Errors Per Server Report
 - i. Top Activities Report
 - j. Top Alarms Report
 - k. Top System Errors Report
 - I. Trend Log Comparison Report
 - m. User Logins Report
 - n. Users and Groups Reports
- K. Scheduling
 - 1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
 - 2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
 - 3. Schedules shall be programmable for a minimum of one year in advance.
- L. Programmer's Environment
 - 1. Programming in the NSC shall be line-programming format.
 - 2. It shall be possible to save custom programs as libraries for reuse throughout the system.
 - 3. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple drag and drop actions without the need of complicated programming.
- M. Audit Trail

- 1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
- 2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
- N. Web-based Operator Software
 - 1. General:
 - a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
 - b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
 - 2. Graphic Displays
 - a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
 - b. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
 - 3. Alarm Management
 - a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
 - b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser.
- O. Groups and Schedules
 - 1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
 - 2. Through the browser interface, operators must be able to change schedules change start and stop times, add new times to a schedule, and modify calendars.
- P. User Accounts and Audit Trail
 - 1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
 - 2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

2.06 NETWORK SERVER CONTROLLERS (NSCS)

- A. The BACnet NSC shall be classified as a "native" BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).
- B. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

- C. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.
- D. It shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization by means of an Internet site including automatic synchronization
 - 6. Native integration of Modbus controller data or BACnet controller data and Modbus controller data
- E. Hardware Specifications
 - 1. Memory:
 - a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
 - 2. Each NRC shall provide the following on-board hardware for communication:
 - a. One 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet
 - b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
 - c. One Device USB port
 - d. Two host USB Ports
- F. Automatic Restart After Power Failure:
 - 1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.
- G. Battery backup:
 - 1. The NSC shall include an on-board battery to back up the controller's RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.
- H. User Programming Language:
 - 1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be a script-based structured text and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of the script programs.
 - 2. Network Server Controllers that use a "canned" program method will not be accepted.
- I. NSCs shall have the ability to perform any or all the following energy management routines:
 - 1. Time of Day Scheduling
 - 2. Calendar Based Scheduling
 - 3. Holiday Scheduling
 - 4. Temporary Schedule Overrides
 - 5. Optimal Start
 - 6. Night Setback Control

- 7. Enthalpy Switchover (Economizer)
- 8. Peak Demand Limiting
- 9. CFM Tracking
- 10. Heating/Cooling Interlock
- 11. Hot/Cold Deck Reset
- 12. Hot Water Reset
- J. History Logging:
 - Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
 - 2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
 - 3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
 - 4. The presentation of logged data shall be built into the server capabilities of the NSC Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
- K. Alarm Management:
 - 1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
 - 2. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
 - 3. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
 - 4. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.
- L. Embedded Web Server
 - 1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

2.07 BACNET FIELDBUS AND BACNET SDCUS

- A. Networking
 - 1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
 - 2. IP To Field Bus Routing Devices
 - a. A Network Server Controller shall be used to provide this functionality.
 - b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
 - c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.
- B. Field Bus Wiring and Termination
 - 1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.

2. Each field bus shall have a termination resistor at both ends of each segment.

C. Repeaters

- 1. Repeaters are required to connect two segments.
- 2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space
- D. Field Bus Devices
 - 1. General Requirements
 - a. Devices shall have a light indicating that they are powered.
 - b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
 - c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.
- E. Network Server Controllers (NSCs)
 - 1. Shall be BTL certified.
- F. Advance Application Controllers (B-AAC)
 - 1. Shall be BTL certified.

2.08 ELECTRICAL POWER DEVICES

- A. Transformers:
 - 1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.

2.09 IDENTIFICATION

- A. Valve Tags:
 - 1. Brass tags and brass chains attached to valve.
 - 2. Tags shall be at least 1.5 inches (38 mm) in diameter.
 - 3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
 - 4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

2.10 DDC SENSORS AND POINT HARDWARE

- A. General: Where indicated on the drawings, schedules or sequence of operations, provide equipment that conforms to the following specifications:
- B. Temperature Sensors:
 - 1. All temperature devices shall use precision thermistors accurate to +/- 0.36°F over a range of –30 to 230°F.
 - 2. Standard space sensors shall be provided in an off-white enclosure for mounting on a standard electrical box.
 - 3. Where manual override of unoccupied mode of control is indicated on the drawings or sequence of operation, provide a push button for selecting after hours operation.
 - 4. Where manual adjustment to the setpoint is indicated on the drawings or sequence of operation, provide slider with +/- programmable scale
 - 5. Where a local display is indicated on the drawings or sequence of operation, the sensor shall incorporate LCD display for viewing the space temperature.
 - 6. Where digital setpoint adjustment and/or other operator selectable parameters are indicated on the drawings or sequence of operation, provide a sensor with built in buttons and digital display. The sensor shall be programmable to provide custom function as specified.

- 7. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless-steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified.
- 8. Averaging sensors shall be employed in all mixing plenum applications and in any other application where the temperature might otherwise be stratified. The averaging sensor tube shall contain at least four thermistor sensors.
- Immersion sensors shall be employed for measurement of temperature in all chilled water, hot water and glycol applications. Thermal wells shall be brass or stainless steel for noncorrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
- C. Humidity Sensors:
 - 1. Humidity sensors shall be polymer resistance type.
 - Space humidity sensors shall have a sensing range of 05 to 95% with accuracy of +/- 2% RH.
 - Duct sensors and Outdoor air humidity sensors shall have a sensing range of 05 to 95% RH with accuracy of +/- 3% RH. Sensors shall be suitable for ambient temperature conditions of -40 to 212°F.
 - 4. Equipment shall be able to demonstrate that accuracy is NIST traceable calibration.
- D. Pressure Sensors:
 - 1. Air pressure or differential air pressure measurements in the range of 0 to 10" water column shall be accurate to +/- 1% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Acceptable manufacturer shall be Setra model C-264.
 - 2. Liquid pressure or differential liquid pressure measurements shall be accurate to +/-0.25% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-230.
 - 3. Steam pressure measurements shall be accurate to +/- 0.13% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-207.
- E. Airflow Probes:
 - 1. Provide an array of airflow traverse probes where indicated, capable of continuously monitoring the fan or duct capacities (CFM) they serve. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s) and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30°. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket and signal fittings suitable for HVAC duct installation.
 - 2. The airflow traverse probe shall not induce a pressure drop in excess of 0.03" w.c. at 2000 FPM, nor measurably contribute to sound levels within the duct. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular duct) or at equal concentric area centers (for circular ducts) along the probe length. The airflow traverse probe shall be capable of producing steady, non-pulsating signals of total and static pressure without need for flow corrections or factors, with an accuracy of 2-3% of actual flow, over a velocity range of 400 to 4000 FPM.
- Provide the minimum number of probes indicated: Duct height 8 12", 1 probe; 13 30", 2 probes; 31 54", 3 probes; 55 84", 4 probes; 85 120", 5 probes; 121 180", 6 probes.
- 4. The airflow traverse probe shall be the VOLU-probe as manufactured by Air Monitor Corporation, or equivalent.
- F. Liquid Flow Measurement:
 - Hi Liquid flow measurement devices shall be accurate to +/- 0.75% over a turn down ratio of 10:1. Insertion probe sensing element shall be made of 316l stainless steel. The sensing element shall have an elliptical shape that eliminates the separation point at a fixed or variable location ahead of the static pressure pick up point. Device shall only require one welded insert mounted to piping system. Acceptable manufacturer shall be Preso, model BAR.
- G. High Limit Thermostats:
 - 1. High limit thermostats shall be located as directed and shall be manual reset type set at 120°F in the return and 180°F in the discharge. Thermostats shall be double pole so as to provide input capability for alarm at the BAS.
- H. Low Limit Thermostats:
 - 1. Safety low limit thermostats shall be vapor pressure type with a 20-foot minimum element. Element shall respond to the lowest temperature sensed by any one-foot section. Provide one thermostat for each 25 square foot of coil area.
 - 2. Low limit thermostat shall be manual reset and shall be double pole so as to provide input capability for alarm at the BAS.
- I. Current Sensing Status Switches
 - 1. Current status switches shall be used to monitor the run status of fans, pumps, motors and electrical loads. Acceptable manufacturer is Veris or approved equal.
- J. Current Measurement Devices
 - 1. Measurement of three-phase power shall be accomplished with a kW/kWh transducer. The instrument shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWh). Provide Veris Model 6000 Power Transducer or approved equal.
- K. Carbon Monoxide and Carbon Dioxide Sensing Devices
 - 1. Space or duct mounted carbon dioxide (CO2) sensor shall be a dual element thermally compensated Lithium Tantalate IR detector and shall contain an on board relay with field adjustable trip point and adjustable time delay. The sensor shall monitor CO2 over a range of 0 3000 PPM, have an accuracy of +/-3% and operate within the range of 32-104°F and 0-95% RH. The sensor shall have a calibration accuracy of 0.5%, a repeatability of no more than +/-20 PPM and a drift of no more than +/-2%. The sensor shall have a green LED for normal operation, and a red LED for relay, and a reset button. Where required by the drawings or specifications, provide an LCD display for displaying PPM level and field adjustable settings. Greystone Product # CDD or equivalent.
 - 2. Wall mounted carbon monoxide (CO) sensor shall be microprocessor based (12-bit accuracy) and shall monitor CO over a range of 0-300 PPM (optional 200-500 PPM). The device shall have an accuracy of +/-3% (electrochemical type) or +/-5% (solid state type) and operate within the range of 32-122°F and 0-95% RH. The sensor shall have a calibration accuracy of 0.5%. Where required by the drawings or specifications, provide an LCD display for displaying PPM level and system configuration information and/or audible alarm with programmable trip point and disable jumper. Greystone Product # CMD or equivalent.
- L. Refrigerant Loss Monitor

- 1. Provide infrared refrigerant loss monitor to allow compliance with ASHRAE 15. Monitor shall detect all halogen-based refrigerants, and refrigerant types shall be field changeable without recalibration. Monitor shall provide continuous digital display of system status and shall provide analog output for remote monitoring. Provide system malfunction detection and indication, and visual alarm indication. SenTech Series IR-SNIF or equivalent.
- M. Control Valves
 - 1. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Provide valves that mate and match the material of the connected piping.
 - 2. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Valves shall be selected to provide an initial pressure drop of not more than 4 psig for water applications. For low pressure steam application, the pressure drop shall be equal to the supply pressure minus the heating element design inlet pressure.
 - 3. Trim material shall be stainless steel.
 - 4. Normal position of both heating and cooling valves shall be open. Three Way valves shall be piped to fail open to both heating and cooling.
 - 5. Electric Bi-Directional actuators are acceptable on VAV Terminal Units and Reheat coil valve control if so noted.
 - 6. All electric actuators for applications other than VAV terminal units and Reheat Coil valve Control shall be Proportional analog 4-20Ma or 0-10Vdc input and shall be positioned to reflect the output value of the computer control system and shall be spring return to normal position.
- N. Dampers
 - Automatic dampers furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers shall be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
 - 2. Damper frames shall be hat shaped channel, 4" deep constructed of 16-gauge galvanized steel. Stainless steel side seals, and sintered bronze, oil-impregnated bearings shall also be provided.
 - 3. Damper blades shall be 16-gauge galvanized steel and shall be 6" on center. Provide vinyl-grip seals on blades.
 - 4. Provide damper linkage that consists of 0.50" diameter steel, cadmium plated and chromate treated pivots. Provide a ¼-20 set-screw with a locking-patch to lock the pivots to a 0.31 diameter aluminum rod. Pivots shall rotate in a Celcon bearing. Blade brackets shall be 12-gauge cadmium plated steel. Blades shall be individually factory adjusted for maximum shut off.
 - 5. Provide axles that are steel, 0.350" diameter cadmium plated and driveshafts that are ½" diameter cadmium plated steel, extendable 6".
 - 6. For high performance applications, control dampers shall meet or exceed the UL Class I leakage rating.
 - 7. Control dampers shall be Ruskin, Arrow or approved equal.
 - 8. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control.
- O. Electric Thermostats: Provide a low voltage thermostat for control of single zone heating and air conditioning unit as specified in the sequence of operation. Electric thermostats shall include a display of the current space temperature as well as a mechanism for adjusting the setpoint locally. Aquastats on unit heaters shall stop the fan when the water temperature is below 100°F. The control contractor may provide full DDC control of the unit heaters in lieu of electric thermostats and use the global water temperature for low temperature interlock if it is offered at no change in price.

PART 3 EXECUTION

3.01 CONTRACTOR RESPONSIBILITIES

- A. General: Installation of the building automation system shall be performed by the Temperature Controls Contractor or a Subcontractor. However, all installation shall be under the personal supervision of the Temperature Controls Contractor. The Temperature Controls Contractor shall certify all work is proper and complete. The design, scheduling, coordination, programming, training, and warranty requirements for the project be performed by the Temperature Contractor.
- B. Demolition: Remove controls which do not remain as part of the building automation system, including all associated abandoned wiring, conduit, and pneumatic tubing. The Owner will inform the Contractor of any equipment that is to be removed that will remain the property of the Owner. This equipment shall be handled with care so as not to damage it. All other equipment that is removed shall be disposed of by the Contractor.
- C. Cleanup: At the completion of the work, all equipment pertinent to this section shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this section. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.

3.02 WORK BY OTHERS

- A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- B. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment specified in this section for installation by the Mechanical Contractor.
- C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
 - 1. Automatic Control Dampers
 - 2. Automatic Control Valves.
 - 3. Temperature Sensing Thermal Wells
 - 4. Pressure Control Sensing Taps

3.03 WIRING, CONDUIT AND CABLE

- A. ALL wiring (high voltage, 50 volts and greater) and conduit is to be installed in accordance with local and national electrical codes and Division 16 (Electrical division) specification.
 - 1. All temperature control cable less than 50 volts is to be considered low voltage.
 - 2. All low voltage cable is to be run in conduit in any non-accessible concealed space and up to 10 ft. above floor level within mechanical rooms. Wiring above 10 ft or within accessible areas (ceilings, crawl spaces) may be run exposed with proper support with bridle rings. Wiring is to be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.
 - 3. Conduit sleeves shall be run through any concrete or block walls for low voltage cable to be run through such walls.
 - 4. All low voltage cable shall be run separate from high voltage cable. All microprocessor communications cable shall be run separate from any low or high voltage cable.
 - 5. Any cable running in plenum rated areas shall be plenum rated cable.
 - 6. Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum rated coaxial cable when running in return air plenums.
 - 7. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
 - 8. Only glass fiber is acceptable, no plastic will be allowed.
 - 9. Fiber optic cable shall only be installed and terminated by an experienced contractor.
 - 10. Wires and tubing shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.

- 11. A true earth ground shall be available in the building. Ground shall be run from the source electrical panel ground to each temperature control panel or controller.
- 12. Metallic surface raceway may be used in finished areas on non accessible masonry walls AS APPROVED BY OWNER AND/OR ARCHITECT/ENGINEER. All surface raceway in finished areas shall be color matched to the existing finish within the limitations of standard manufacturer's colors.

3.04 HARDWARE INSTALLATION

- A. Installation Practices for Field Devices
 - 1. Actuators shall be firmly mounted to give positive movement, and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the actuator stroke.
 - Actuators shall be stroked ~5%, tightened and returned to normal position to give a positive seal.
 - 3. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
 - 4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
 - 5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
 - 6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. The low pressure port shall be piped to the outside of the building.
- B. Enclosures:
 - 1. For all I/O requiring field interface devices, these devices where practical shall be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure that protects the device(s) from dust and moisture and conceals integral wiring and moving parts.
 - 2. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
 - 3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. All locks shall be keyed identically.
 - 4. All outside mounted enclosures shall meet the NEMA-4 rating.

3.05 SOFTWARE INSTALLATION

- A. General: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.
- B. Database Configuration: The Contractor shall provide all labor to configure those portions of the database that are required by the point list and sequence of operation.
- C. Graphic user interface: Unless otherwise directed by the owner, the Contractor shall provide color graphic displays as depicted in the schematic drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

3.06 EXISTING CONTROL DEVICES

- A. The bid for the control work shall be based on the premise that existing control devices (i.e. valves & damper operators) are operational and are not in need of repair or replacement, unless otherwise noted.
 - This contractor shall notify the Owner's Representative of existing control devices that need to be replaced or repaired that may be noticed in the process of installation of new work.

3.07 COMMISSIONING AND SYSTEM STARTUP

- A. Point to Point Checkout: Each I/O device (both field mounted and those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
- B. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.
- C. System Acceptance Testing:
 - 1. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
 - 2. Perform an operational test of each third-party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

3.08 TRAINING

- A. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel.
- B. The BAS Contractor shall have a dedicated training center with a minimum of 8 permanent workstations connected to a simulated system.
- C. Trainees must have the ability to access their system remotely during the classroom training session as required.
- D. The BAS Contractor's trainer must have a minimum of 10 years of experience with the manufacturer's software and products per the following description:
 - 1. On-site training shall consist of a minimum of (8) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include:
 - a. System Overview
 - b. System Software and Operation
 - 1) System access
 - 2) Software features overview
 - 3) Changing setpoints and other attributes
 - 4) Scheduling
 - 5) Editing programmed variables
 - 6) Displaying color graphics
 - 7) Running reports
 - 8) Workstation maintenance
 - 9) Application programming
 - c. Operational sequences including start-up, shutdown, adjusting and balancing.
 - d. Equipment maintenance.
- E. Classroom training shall include a minimum of (4) training slots for two days of course material covering workstation operation and controller programming. The cost for travel and lodging shall be included in this contract if Training Center is more than 150 miles from the Project Site.
- F. The training facility shall have the capability to record the session and provide a DVD record of the training if required.

G. The training facility shall have the capability to train on the owner's system through off site connection.

SECTION 230934 VARIABLE-FREQUENCY MOTOR CONTROLLERS-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.
- B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

- A. Section 230529 Hangers and Supports for HVAC Piping and Equipment-CPL.
- B. Section 230553 Identification for HVAC Piping and Equipment-CPL: Identification products and requirements.
- C. Section 260526 Grounding and Bonding for Electrical Systems.
- D. Section 260573 Power System Studies: Additional criteria for selection and adjustment of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS

- A. IEC 60529 Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).
- B. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- C. NEMA ICS 2 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- D. NEMA ICS 5 Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.
- E. NEMA ICS 6 Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).
- F. NEMA ICS 7 Industrial Control and Systems: Adjustable-Speed Drives; 2020.
- G. NEMA ICS 7.1 Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems; 2022.
- H. NEMA ICS 7.2 Application Guide for AC Adjustable Speed Drive Systems; 2021.
- I. NEMA ICS 61800-2 Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.
- J. NEMA MG 1 Motors and Generators; 2018.
- K. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- L. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. UL 508A Industrial Control Panels; Current Edition, Including All Revisions.
- N. UL 61800-5-1 Standard for Adjustable Speed Electrical Power Drive Systems Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
 - 2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
 - 3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.

- 4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
- 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include wiring diagrams showing factory and field connections.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - 1. Include contact information for entity providing contract maintenance and trouble call-back service.
- F. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- G. Maintenance Materials: Furnish following for Owner's use in maintenance of project.
 1. See Section 016000 Product Requirements, for additional provisions.
 - 2. Air Filters: Two of each different type.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
 - 1. Authorized service facilities located within 200 miles of project site.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Provide minimum 18 month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB: www.abb.com/#sle.
- B. Square D.
- C. Yaskawa Electric Corp.

- D. Substitutions: See Section 016000 Product Requirements.
- E. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. Variable-Frequency Motor Controller:
 - 1. Configuration: Packaged controller with across-the-line bypass.
 - 2. Rectifier/Converter: Diode-based, 6-pulse type.
 - 3. Control Method: Vector; closed-loop, with feedback.
 - 4. Filtering: Provide input/line reactor and output/load reactor.
- D. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.
- E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
 - 1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
 - 2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
 - 3. Motor nameplate data.
 - 4. Requirements for speed control range, speed regulation, and braking.
 - 5. Motor suitability for bypass starting method, where applicable.
- F. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.
- G. Operating Requirements:
 - 1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
 - 2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
 - 3. Efficiency: Minimum of 96 percent at full speed and load.
 - 4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
 - 5. Overload Rating:
 - a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
 - b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
- H. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
 - 1. Rectifier/Converter: Diode-based, 6-pulse type unless otherwise indicated.
- I. Control System:
 - 1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
 - 2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
 - 3. Control Functions:
 - a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.

- 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved lowspeed torque.
- 2) Vector Control: Provide selectable autotuning function.
- b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
- c. Selectable braking control; DC injection or flux braking.
- d. Adjustable minimum/maximum speed limits.
- e. Adjustable pulse width modulation switching carrier frequency.
- f. Adjustable motor slip compensation.
- g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
- 4. Status Indications:
 - a. Motor run/stop status.
 - b. Motor forward/reverse status.
 - c. Local/remote control status.
 - d. Output voltage.
 - e. Output current.
 - f. Output frequency.
 - g. DC bus voltage.
 - h. Motor speed.
 - i. Elapsed run time.
 - j. Discrete input/output status.
 - k. Analog input/output values.
- 5. Protective Functions/Alarm Indications:
 - a. Overcurrent.
 - b. Motor overload.
 - c. Undervoltage.
 - d. Overvoltage.
 - e. Controller overtemperature.
 - f. Input/output phase loss.
 - g. Output short circuit protection.
 - h. Output ground fault protection.
- 6. Inputs:
 - a. Digital Input(s): Three.
 - b. Analog Input(s): Two.
- 7. Outputs:
 - a. Analog Output(s): One.
 - b. Relay Output(s): Two.
- 8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
 - a. Serial Communications: RS-485; support for Modbus RTU protocol.
 - b. Ethernet Communications: Support for Modbus TCP protocol.
- 9. Features:
 - a. Password-protected security access.
 - b. Event log.
- J. Power Conditioning/Filtering:
 - 1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
 - 2. Reactor Impedance: 3 percent, unless otherwise indicated or required.
- K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
 - 1. Disconnects: Circuit breaker or disconnect switch type.

- a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
- b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
- c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
- 2. Provide door-mounted remote operator interface.
- 3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
 - a. Bypass Method: Manual, unless otherwise indicated.
 - b. Bypass Configuration: 3-contactor type, with contactors for bypass, drive output, and drive input.
 - c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated or required.
 - d. Overload Relays: Solid state or bimetallic thermal type.
- 4. Pilot Devices Required:
 - a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
 - b. Packaged Controllers with Bypass:
 - 1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
 - 2) Motor Control Selector Switch: HAND/OFF/AUTO.
 - 3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.
- L. Service Conditions:
 - 1. Provide controllers and associated components suitable for operation under following service conditions without derating:
 - a. Altitude: Less than 3,300 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
 - 2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.
- M. Short Circuit Current Rating:
 - 1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as determined by short circuit study performed in accordance with Section 260573.
 - 2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.
- N. Conductor Terminations: Suitable for use with conductors to be installed.
- O. Enclosures:
 - 1. Comply with NEMA ICS 6.
 - 2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
 - a. Outdoor Locations: Type 3R or Type 4.
 - 3. Finish: Manufacturer's standard unless otherwise indicated.
 - 4. Cooling: Forced air or natural convection as determined by manufacturer.
 - 5. Enclosure Space Heaters:
 - a. Provide in each controller enclosure installed outdoors and in unconditioned indoor spaces.
 - b. Size according to manufacturer's recommendations for worst case ambient temperature to prevent condensation.
 - c. Heater Control: Thermostat.

d. Heater Power Source: Provide connection to transformer factory-installed in enclosure or suitable external branch circuit as indicated or as required.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Overload Relays:
 - 1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
 - 2. Comply with NEMA ICS 2.
 - 3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
 - 4. Trip-free operation.
 - 5. Visible trip indication.
 - 6. Resettable:
 - a. Employ manual reset unless otherwise indicated.
 - b. Do not employ automatic reset with two-wire control.
 - 7. Bimetallic Thermal Overload Relays:
 - a. Interchangeable current elements/heaters.
 - b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
 - c. Trip test function.
 - Solid State Overload Relays:
 - a. Adjustable full load current.
 - b. Phase loss protection.
 - c. Phase imbalance protection.
 - d. Ambient temperature insensitive.
 - e. Thermal memory.
 - f. Trip test function.
 - g. Provide isolated alarm contact.

2.04 ACCESSORIES

8.

- A. Auxiliary Contacts:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each bypass motor starter, minimum.
- B. Pilot Devices:
 - 1. Comply with NEMA ICS 5; heavy-duty type.
 - 2. Pushbuttons: Unless otherwise indicated, provide momentary, nonilluminated type with flush button operator; normally open or normally closed as indicated or as required.
 - 3. Selector Switches: Unless otherwise indicated, provide maintained, nonilluminated type with knob operator; number of switch positions as indicated or as required.
 - 4. Indicating Lights: Push-to-test type unless otherwise indicated.
 - 5. Provide LED lamp source for indicating lights and illuminated devices.
- C. Control and Timing Relays:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of relays indicated or required to perform necessary functions.
- D. Control Power Transformers:
 - 1. Size to accommodate burden of contactor coil(s) and connected auxiliary devices.
 - 2. Include primary and secondary fuses.

2.05 SOURCE QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Factory test controllers in accordance with NEMA ICS 61800-2.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings of controllers are consistent with indicated requirements.
- C. Verify that mounting surfaces are ready to accept controllers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.
- C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 230529.
- F. Install controllers plumb and level.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Install field-installed devices, components, and accessories.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.
- D. Packaged Controllers with Bypass: Test for proper operation in both drive and bypass modes.
- E. Test for proper interface with other systems.
- F. Correct deficiencies and replace damaged or defective controllers or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 017800 Closeout Submittals, for closeout submittals.
- B. See Section 017900 Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Location: At project site.

3.07 PROTECTION

A. Protect installed controllers from subsequent construction operations.

3.08 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

SECTION 231113 FACILITY FUEL-OIL PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping and fittings.
- B. Flanges and piping components.
- C. Pipe hangers and supports.
- D. Valves.
- E. Strainers.
- F. Flexible connectors.

1.02 RELATED REQUIREMENTS

A. Section 230553 - Identification for HVAC Piping and Equipment-CPL.

1.03 REFERENCE STANDARDS

- A. API Spec 5L Line Pipe; 2018, with Errata.
- B. API RP 1615 Installation of Underground Petroleum Storage Systems; 2011 (Reaffirmed 2020).
- C. ASME B1.1 Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms); 2019.
- D. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- E. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- F. ASME B16.9 Factory-Made Wrought Buttwelding Fittings; 2018.
- G. ASME B16.11 Forged Fittings, Socket-Welding and Threaded; 2016, with Errata (2017).
- H. ASME B16.12 Cast Iron Threaded Drainage Fittings; 2019.
- I. ASME B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- J. ASME B18.2.2 Nuts for General Applications: Machine Screw Nuts; and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series); 2022.
- K. ASME B31.3 Process Piping; 2022.
- L. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2020.
- M. ASTM A105/A105M Standard Specification for Carbon Steel Forgings for Piping Applications; 2023.
- N. ASTM A182/A182M Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service; 2023.
- O. ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.
- P. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- Q. ASTM A563/A563M Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric); 2021a.
- R. ASTM D229 Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation; 2019, with Editorial Revision.
- S. ASTM F844 Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use; 2019.

- T. MSS SP-58 Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- U. MSS SP-80 Bronze Gate, Globe, Angle, and Check Valves; 2019.
- V. MSS SP-110 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 PIPING AND FITTINGS

- A. Regulatory Requirements:
 - 1. Comply with the material, fabrication, and operating requirements of ASME B31.3, except as modified herein.
 - 2. Comply with ASME B31.1 for installation of fuel oil piping.
 - 3. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation of fuel oil system.
 - 4. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- B. Comply with the material, fabrication, and operating requirements of ASME B31.3, except as modified herein.
- C. Carbon Steel Pipe:
 - 1. Comply with One of the Following:
 - a. ASTM A53/A53M, Type E or S, Grade B, seamless or electric welded, Schedule 80 for pipe less than 2-1/2 inches in diameter or Schedule 40 for pipe 2-1/2 inches in diameter and larger.
 - b. API Spec 5L, Product Specification Level (PSL) 1, Grade B, submerged-arc welded or gas metal-arc welded.
 - 2. End Connections:
 - a. Forged, socket weld type, complying with ASTM A182/A182M and ASME B16.11 for pipe or fittings less than 2-1/2 inches.
 - Buttweld type complying with ASTM A234/A234M, Grade WPB and ASME B16.9 for pipe or fittings 2-1/2 inches and larger of the same wall thickness as the adjoining pipe.
 - c. Threaded type complying with ASME B16.3, Class 150 or ASME B16.11.

2.02 FLANGES, COUPLINGS, AND PIPING COMPONENTS

- A. Flanges:
 - 1. Provide flanged end connections on equipment, fittings, piping, piping components, adapters, couplings, and valves complying with ASME B16.5, Class 150.
 - 2. Carbon Steel: Comply with ASTM A105/A105M.

- 3. Gaskets, Non-Isolating:
 - a. 1/8 inch thick.

4.

- b. Comply with ASME B16.12, raised-faced type.
- c. Material: Buna-N.
- Gaskets, Electrically Isolating:
 - a. Comply with ASTM D229.
 - b. Electrical Insulating Material: 1000 ohms resistance.
 - c. Chemically compatible with fuel handled.
 - d. Full face type.
 - e. Provide full surface, spiral-wound, mylar, insulating sleeves between bolts and holes of flanges.
 - f. Furnish bolt shank diameter not less than diameter at root of threads.
 - g. Provide high-strength 1/8 inch thick, phenolic, insulating washers next to flanges with flat, circular, stainless steel washers over the insulating and under bolt heads and nuts.
 - h. Supply adequate bolt length to accommodate insulating gaskets and stainless steel washers.
- 5. Bolts, Nuts, and Washers:
 - a. Comply with ASME B18.2.1 and ASME B18.2.2.
 - b. Bolts:
 - 1) Regular hexagonal type.
 - 2) Threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes 1 inch and smaller and Eight-Pitch Thread Series for sizes larger than 1 inch.
 - 3) Provide sufficient length to obtain full bearing on nuts, projecting no more than two full threads beyond nuts with bolts tightened to required torque.
 - c. Nuts:
 - 1) Hexagonal, heavy series type.
 - Threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes 1 inch and smaller and Eight-Pitch Thread Series for sizes larger than 1 inch.
 - d. Carbon Steel Material:
 - 1) Bolts: Comply with ASTM A307, Grade B, hot-dipped galvanized.
 - 2) Nuts: Comply with ASTM A563/A563M, Grade A, hex-style, hot-dipped galvanized.
 - 3) Washers: Comply with ASTM F844, hot-dipped galvanized.
- B. Piping Components:
 - 1. Provide components that meet the material, fabrication, and operating requirements of ASME B31.3, except as modified herein.
 - 2. Pressure Design Class: Class 150, as defined in ASME B16.5.

2.03 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
- C. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

2.04 GATE VALVES

A. MSS SP-80, Class 125, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends.

2.05 GLOBE VALVES

A. MSS SP-80, Class 125, bronze body, bronze trim, handwheel, bronze disc, solder ends.

2.06 BALL VALVES

A. MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder.

2.07 SWING CHECK VALVES

A. MSS SP-80, Class 125, bronze body and cap, bronze swing disc, solder ends.

2.08 FLEXIBLE CONNECTORS

A. Bronze inner hose and braided exterior sleeve, suitable for minimum 200 psi CWP and 250 degrees F.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, are dry, and have not been over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Excavate In Accordance With:
- E. Backfill in Accordance With:

3.03 PIPING INSTALLATION

- A. Install in accordance with manufacturer's instructions and API RP 1615.
- B. Route piping in orderly manner and maintain gradient.
- C. Group piping whenever practical at common elevations.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. Provide clearance for installation of insulation and access to valves and fittings.

SECTION 231123 FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for natural gas piping systems.

1.02 RELATED REQUIREMENTS

- A. Section 230516 Expansion Fittings and Loops for HVAC Piping.
- B. Section 230553 Identification for HVAC Piping and Equipment-CPL.

1.03 REFERENCE STANDARDS

- A. ANSI LC 1/CSA 6.26 Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing; 2019.
- B. ANSI Z223.1 National Fuel Gas Code; 2024.
- C. ASME BPVC-IX Boiler and Pressure Vessel Code, Section IX Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- D. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- E. ASME B31.1 Power Piping; 2022.
- F. ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.
- G. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- H. MSS SP-78 Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
 - 1. Manufacturers:
 - a. Wheatland Tube Company: www.wheatland.com/#sle.
 - 2. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 3. Joints: Threaded or welded to ASME B31.1.
 - 4. Mechanical Press Sealed Fittings: Double pressed type and approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.

- B. Flexible Gas Piping:
 - 1. Corrugated Stainless Steel Tubing: Comply with ANSI LC 1/CSA 6.26.
 - 2. Comply with ASTM E84.
 - 3. Fittings: Provided by piping system manufacturer.

2.02 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.
- B. Flanges for Pipe Size Over 1 Inch:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

2.03 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.

2.04 BALL VALVES

- A. Manufacturers:
 - 1. Apollo Valves: www.apollovalves.com/#sle.
 - 2. Grinnell Products: www.grinnell.com/#sle.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com/#sle.
 - 4. Nibco, Inc: www.nibco.com/#sle.
 - 5. Viega LLC: www.viega.us/#sle.
- B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder, threaded, or grooved ends with union.

2.05 PLUG VALVES

A. Construction 2-1/2 Inches and Larger: MSS SP-78, 175 psi CWP, cast iron body and plug, pressure lubricated, Teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 230516.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Install vent piping penetrating roofed areas to maintain integrity of roof assembly..
- I. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Paint piping yellow.

3.04 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Provide plug valves in natural gas systems for shut-off service.

3.05 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe Size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inches to 2 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.
 - c. Pipe Size: 2-1/2 inches to 3 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 1/2 inch.
 - d. Pipe Size: 4 inches to 6 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 5/8 inch.

This page intentionally left blank

SECTION 232113 HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Heating water and glycol piping, above grade.
- D. Equipment drains and overflows.
- E. Pipe hangers and supports.
- F. Unions, flanges, mechanical couplings, and dielectric connections.

1.02 RELATED REQUIREMENTS

- A. Section 230516 Expansion Fittings and Loops for HVAC Piping.
- B. Section 230719 HVAC Piping Insulation-CPL.
- C. Section 232500 HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-IX Boiler and Pressure Vessel Code, Section IX Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- B. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- C. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- D. ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- E. ASME B31.9 Building Services Piping; 2020.
- F. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2020.
- G. ASTM A106/A106M Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2019a.
- H. ASTM A183 Standard Specification for Carbon Steel Track Bolts and Nuts; 2014 (Reapproved 2020).
- I. ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.
- J. ASTM A536 Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- K. ASTM B32 Standard Specification for Solder Metal; 2020.
- L. ASTM B88 Standard Specification for Seamless Copper Water Tube; 2022.
- M. ASTM B88M Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- N. ASTM D2000 Standard Classification System for Rubber Products in Automotive Applications; 2018.
- O. ASTM F708 Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
- P. ASTM F1476 Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2019).
- Q. AWS D1.1/D1.1M Structural Welding Code Steel; 2020.
- R. AWWA C606 Grooved and Shouldered Joints; 2022.

S. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.

1.05 QUALITY ASSURANCE

A. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
 - b. Grooved mechanical connections and joints comply with AWWA C606.
 - 1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
 - 2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
 - c. Use rigid joints unless otherwise indicated.
 - d. Use gaskets of molded synthetic rubber with central cavity, pressure-responsive configuration, and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
 - e. Provide steel coupling nuts and bolts complying with ASTM A183.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
 - 1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.
- D. Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated, provide at least at main shutoff, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
 - 2. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
 - 3. For throttling service, use plug cocks. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 HEATING WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - 2. Threaded Joints: ASME B16.3, malleable iron fittings.
 - 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
 1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.04 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
 - 5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
 - 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
 - 8. Vertical Support: Steel riser clamp.
 - 9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 10. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 11. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 12. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 - 13. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Less:
 - 1. Ferrous Piping: 150 psig malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.

- B. Flanges for Pipe 2 Inches and Greater:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Gaskets: 1/16 inch thick, preformed neoprene.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Mechanical Couplings: Comply with ASTM F1476.
 - 3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
 - 4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
 - 5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 - 7. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. Grinnell Products: www.grinnell.com/#sle.
 - c. Victaulic Company: www.victaulic.com/#sle.
- D. Dielectric Connections:
 - 1. Waterways:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600-volt breakdown test.
 - c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.
 - 2. Flanges:
 - a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.
 - 3. Unions:
 - a. 1/2 to 1 Inches: Brass solder to galvanized FPT.
 - b. 1/2 to 2 Inches: Brass solder to galvanized FPT.
 - c. 1/2 to 1 Inches: Brass to galvanized FPT or FIP (Female Iron Pipe).
 - d. 3/4 to 1/2 Inch Reducer: Brass solder to galvanized FPT.
 - e. Service: 250 psi, minus 20 to 180 deg F.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. See Section 232500 for additional requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and to avoid interference with use of space.
- D. Group piping whenever practical at common elevations.
- E. Sleeve pipe passing through partitions, walls, and floors.
- F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- G. Slope piping and arrange to drain at low points.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 230516.
- I. Grooved Joints:
 - 1. Install in accordance with the manufacturer's latest published installation instructions.
 - 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- J. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 230719.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- M. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- B. Hanger Spacing for Steel Piping.
 - 1. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 2. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 3. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 - 4. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 - 5. 8 Inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.

This page intentionally left blank

SECTION 232114 HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Strainers.
- E. Suction diffusers.
- F. Pump connectors.
- G. Pressure-temperature test plugs.
- H. Balancing valves.
- I. Relief valves.

1.02 RELATED REQUIREMENTS

A. Section 232113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com/#sle.
 - 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psi.

D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
- B. Manual Type: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- D. Washer Type:
 - 1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring-loaded ball check valve.

2.03 AIR SEPARATORS

- A. Centrifugal Air Separators/Strainers:
 - 1. Manufacturers:
 - a. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - b. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - c. Taco, Inc: www.taco-hvac.com/#sle.
 - 2. Steel, tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi operating pressure, with integral bronze strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.04 STRAINERS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 2. Flexicraft Industries: www.flexicraft.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.
- B. Size 2 inch and Under:
 - 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
 - 1. Provide flanged or grooved iron body for 175 psi working pressure, Y pattern with 1/16 inch or 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
 - 1. Provide flanged or grooved iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.05 SUCTION DIFFUSERS

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Grinnell Products: www.grinnell.com/#sle.
 - 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 4. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
 - 5. Victaulic Company of America: www.victaulic.com/#sle.

- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.06 PUMP CONNECTORS

- A. Manufacturers:
 - 1. Anvil International; AnviFlex: www.anvilintl.com/#sle.
 - 2. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - 3. The Metraflex Company; Vane Flex: www.metraflex.com/#sle.
- B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 - 1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
 - 2. End Connections: Same as specified for pipe jointing.
 - 3. Provide pump connector with integral vanes to reduce turbulent flow.
 - 4. Provide necessary accessories including, but not limited to, swivel joints.

2.07 PRESSURE-TEMPERATURE TEST PLUGS

- A. Manufacturers:
 - 1. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - 2. Peterson Equipment Company Inc: www.petesplug.com/#sle.
 - 3. Sisco Manufacturing Company Inc: www.siscomfg.com/#sle.
- B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- C. Application: Use extended length plugs to clear insulated piping.

2.08 BALANCING VALVES

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 2. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - 3. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 - 4. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 5. Taco, Inc: www.taco-hvac.com/#sle.
- B. Size 2 inch and Smaller:
 - 1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
 - 2. Metal construction materials consist of bronze or brass.
 - 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- C. Size 2.5 inch and Larger:
 - 1. Provide ball, globe, or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
 - 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 - 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

2.09 RELIEF VALVES

- A. Manufacturers:
 - 1. Apollo Valves: www.apollovalves.com/#sle.
 - 2. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 3. ITT Bell & Gossett: www.bellgossett.com/#sle.

B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points and as indicated.
- C. Provide manual air vents in ceiling spaces and other concealed location
- D. Provide automatic air vents in exposed locations and in mechanical rooms.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- F. Provide valved drain and hose connection on strainer blowdown connection.
- G. Support pump fittings with floor-mounted pipe and flange supports.
- H. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- I. Pipe relief valve outlet to nearest floor drain.

SECTION 232123 HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line circulators.
- B. Vertical in-line pumps.

1.02 RELATED REQUIREMENTS

- A. Section 230513 Common Motor Requirements for HVAC Equipment-CPL.
- B. Section 230716 HVAC Equipment Insulation.
- C. Section 230719 HVAC Piping Insulation-CPL.
- D. Section 232113 Hydronic Piping.
- E. Section 232114 Hydronic Specialties.

1.03 REFERENCE STANDARDS

A. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Armstrong Fluid Technology, Inc: www.armstrongfluidtechnology.com/#sle.
- B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com/#sle.
- C. SIHI Group: www.sterlingsihi.com/#sle.

2.02 HVAC PUMPS - GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Base Mounted Pumps: Aligned by qualified millwright.
- C. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

2.03 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi maximum working pressure.
- B. Casing: Cast iron, with flanged pump connections.
- C. Impeller: Non-ferrous keyed to shaft.
- D. Bearings: Oil-lubricated bronze sleeve.
- E. Shaft: Alloy steel with bronze sleeve, integral thrust collar.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.

2.04 VERTICAL IN-LINE PUMPS

A. Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 175 psi working pressure.

- B. Casing: Cast iron, with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- E. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 250 degrees F maximum continuous operating temperature.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- E. Provide drains for bases and seals, piped to and discharging into floor drains.
- F. Check, align, and certify alignment of base-mounted pumps prior to start-up.
- G. Lubricate pumps before start-up.

SECTION 232213 STEAM AND CONDENSATE HEATING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe and pipe fittings.
- B. Pipe hangers and supports.
- C. Steam piping system.
- D. Steam condensate piping system.

1.02 RELATED REQUIREMENTS

- A. Section 083100 Access Doors and Panels.
- B. Section 230523 General-Duty Valves for HVAC Piping-CPL.
- C. Section 230553 Identification for HVAC Piping and Equipment-CPL.
- D. Section 230719 HVAC Piping Insulation-CPL.
- E. Section 232214 Steam and Condensate Heating Specialties.

1.03 REFERENCE STANDARDS

- A. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- B. ASME B31.1 Power Piping; 2022.
- C. ASME B31.9 Building Services Piping; 2020.
- D. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2020.
- E. ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.
- F. AWS D1.1/D1.1M Structural Welding Code Steel; 2020.
- G. MSS SP-58 Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Comply with ASME B31.9 and ASME B31.1 code for installation of piping system.

2.02 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
 - 1. Fittings: ASME B16.3 malleable iron Class 150, or ASTM A234/A234M wrought steel.
 - 2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.03 LOW PRESSURE STEAM CONDENSATE PIPING

- A. Steel Pipe: ASTM A53/A53M, Schedule 80, black.
 - 1. Fittings: ASME B16.3 malleable iron Class 150, or ASTM A234/A234M wrought steel.
 - 2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.04 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Hangers for Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
- C. Hangers for Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
- D. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches: Steel channels with welded spacers and hanger rods.
- E. Multiple or Trapeze Hangers for Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.
- F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- G. Wall Support for Pipe Sizes 4 to 5 Inches: Welded steel bracket and wrought steel clamp.
- H. Wall Support for Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
- I. Vertical Support: Steel riser clamp.
- J. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- K. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.05 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 Inches and Under:
 - 1. Ferrous Piping: 150 psig galvanized malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe Over 2 Inches:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick preformed non-asbestos graphite fiber.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as indicated.
 - 3. Place hangers within 12 inches of each horizontal elbow.
- 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- 5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
- 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- F. Provide clearance for installation of insulation and access to valves and fittings.
- G. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083100.
- H. Slope steam piping one inch in 40 feet in direction of flow. Use eccentric reducers to maintain bottom of pipe level.
- I. Slope steam condensate piping one inch in 40 feet. Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.

3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 6. 4 inch: Maximum span, 12 feet; minimum rod size, 1/2 inch.
 - 7. 6 inch: Maximum span, 14 feet; minimum rod size, 1/2 inch.
- B. Hanger Spacing for Steel Steam Piping.
 - 1. 1/2 inch: Maximum span, 8 feet; minimum rod size, 1/4 inch.
 - 2. 3/4 inch and 1 inch: Maximum span, 9 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/4 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 4. 1-1/2 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 5. 2 inches: Maximum span, 13 feet; minimum rod size, 3/8 inch.
 - 6. 2-1/2 inches: Maximum span, 14 feet; minimum rod size, 3/8 inch.
 - 7. 3 inches: Maximum span, 15 feet; minimum rod size, 3/8 inch.
 - 8. 4 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 - 9. 6 inches: Maximum span, 21 feet; minimum rod size, 1/2 inch.
- C. Hanger Spacing for Steel Steam Condensate Piping.
 - 1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.

This page intentionally left blank

SECTION 232214 STEAM AND CONDENSATE HEATING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Steam traps.
- B. Steam air vents.
- C. Safety relief valves.
- D. Steam control valves.

1.02 RELATED REQUIREMENTS

- A. Section 230513 Common Motor Requirements for HVAC Equipment-CPL: Pump motors.
- B. Section 232213 Steam and Condensate Heating Piping.
- C. Section 260583 Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- B. ASME BPVC-VIII-1 Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.
- C. ASME B31.9 Building Services Piping; 2020.
- D. ASTM A126 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2019).
- E. ASTM A276/A276M Standard Specification for Stainless Steel Bars and Shapes; 2017.
- F. ASTM A743/A743M Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application; 2021.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide for manufactured products and assemblies required for this project.
 - 2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
 - 4. Include electrical characteristics and connection requirements.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 STEAM TRAPS

A. Manufacturers:

- 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
- 2. Marshall Engineered Products Company: www.mepcollc.com/#sle.
- 3. Spirax-Sarco: www.spiraxsarco.com/us/#sle.
- B. Steam Trap Applications:
 - 1. Use Float and Thermostatic Traps for:
 - a. Unit heaters.
 - b. Heating coils.
 - c. Main headers.
 - d. Branch lines.
- C. Float and Thermostatic Steam Traps:
 - 1. Metal body with bolted cover, stainless steel or bronze bellows type thermostatic air vent, stainless steel or copper float, stainless steel lever valve assembly, bottom drain plug, and accessible to internal parts without disturbing piping.

2.02 STEAM AIR VENTS

A. 225 psi WSP: Balanced pressure type; ASTM A126 cast iron body and cover; access to internal parts without disturbing piping; phosphor bronze bellows, stainless steel valve and seat.

2.03 SAFETY RELIEF VALVES

- A. Valve: Bronze body, stainless steel valve spring, stem, and trim, direct pressure actuated, capacities ASME certified and labelled.
- B. Accessories: Drip pan elbow.

2.04 STEAM CONTROL VALVES

- A. Valve Configuration:
 - 1. Electrical Actuator: 2-position, 4 to 20 mA with 6 to 8 second travel.
- B. Materials:
 - 1. Valve Body: Carbon steel A216 Grade WCB.
 - 2. Bonnet: Carbon steel A216 Grade WCB.
 - 3. Valve/Valve Seat: 17-4 PH h900.
 - 4. Valve Spindle: Stainless steel, comply with ASTM A276/A276M, Type 431.
 - 5. Gland Packing:
 - a. Carbon filled V-Teflon, 450 degrees F.
 - b. Grafoil, 800 degrees F.
 - 6. Yoke: Ductile iron.
 - 7. Actuator Spring: Silicon chromium spring steel.
 - 8. Actuator Diaphragm: Nitrite reinforced with nylon fiber.
 - 9. Cage Material: Stainless steel CB30, comply with ASTM A743/A743M.
 - 10. Sealing Ring Material: Carbon filled V-Teflon.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install steam and steam condensate piping and specialties in accordance with ASME B31.9.
- B. Install specialties in accordance with manufacturer's instructions.
- C. Steam Traps:
 - 1. Provide minimum 3/4 inch size on steam mains and branches.
 - 2. Install with union or flanged connections at both ends.
 - 3. Provide gate valve and strainer at inlet, and gate valve and check valve at discharge.
 - 4. Provide minimum 10 inch long, line size dirt pocket between apparatus and trap.

SECTION 232300 REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Filter-driers.
- G. Solenoid valves.

1.02 RELATED REQUIREMENTS

- A. Section 078400 Firestopping.
- B. Section 230716 HVAC Equipment Insulation.
- C. Section 230719 HVAC Piping Insulation-CPL.

1.03 REFERENCE STANDARDS

- A. AHRI 710 Performance Rating of Liquid-Line Driers; 2009.
- B. AHRI 760 Performance Rating of Solenoid Valves for Use With Volatile Refrigerants; 2007.
- C. ASHRAE Std 15 Safety Standard for Refrigeration Systems; 2022, with Errata (2023).
- D. ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- E. ASME B31.5 Refrigeration Piping and Heat Transfer Components; 2022.
- F. ASTM B280 Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2020.
- G. AWS A5.8M/A5.8 Specification for Filler Metals for Brazing and Braze Welding; 2019.
- H. MSS SP-58 Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- I. UL 429 Electrically Operated Valves; Current Edition, Including All Revisions.

1.04 SYSTEM DESCRIPTION

- A. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
- B. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
 - 2. Use line size on leaving side of liquid solenoid valves.
- C. Valves:
 - 1. Use service valves on suction and discharge of compressors.
 - 2. Use gauge taps at compressor inlet and outlet.
- D. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

2.02 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
- B. Pipe Supports and Anchors:
 - 1. Provide hangers and supports that comply with MSS SP-58.
 - a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 6. Vertical Support: Steel riser clamp.
 - 7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 - 9. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.03 REFRIGERANT

A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.04 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.05 VALVES

- A. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.06 FILTER-DRIERS

- A. Performance:
 - 1. Flow Capacity Liquid Line: _____ ton, minimum, rated in accordance with AHRI 710.
 - 2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
 - 3. Design Working Pressure: 350 psi, minimum.
- B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

- C. Construction: UL listed.
 - 1. Connections: As specified for applicable pipe type.

2.07 SOLENOID VALVES

- A. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.
- B. Coil Assembly: UL 429 UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- G. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.5.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 6. Provide copper plated hangers and supports for copper piping.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Flood piping system with nitrogen when brazing.
- J. Insulate piping and equipment.
- K. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

L. Fully charge completed system with refrigerant after testing.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.04 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.

SECTION 232500 HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Materials.
 - 1. System cleaner.
 - 2. Closed system treatment (water).
- B. By-pass (pot) feeder.

1.02 RELATED REQUIREMENTS

- A. Section 232113 Hydronic Piping.
- B. Section 232114 Hydronic Specialties.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. AmSolv-Amrep, Inc: www.amsolv.com/#sle.
- B. GE Water & Process Technologies: www.gewater.com/#sle.
- C. Nalco, an Ecolab Company: www.nalco.com/#sle.
- D. Substitutions: See Section 016000 Product Requirements.

2.02 MATERIALS

- A. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
- B. Closed System Treatment (Water):
 - 1. Manufacturers:
 - a. AmSolv-Amrep, Inc: www.amsolv.com/#sle.
 - b. GE Water & Process Technologies: www.gewater.com/#sle.
 - c. Nalco, an Ecolab Company: www.nalco.com/#sle.
 - 2. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 - 3. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.

2.03 BY-PASS (POT) FEEDER

- A. Manufacturers:
 - 1. Griswold Controls: www.griswoldcontrols.com/#sle.
 - 2. J. L. Wingert Company: www.jlwingert.com/#sle.
 - 3. Neptune, a brand of the Dover Company: www.neptune1.com/#sle.
- B. 2 quart quick opening cap for working pressure of 175 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

- A. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

SECTION 233100 HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ductwork.
- B. Nonmetal ductwork.
- C. Casings and plenums.
- D. Duct cleaning.

1.02 RELATED REQUIREMENTS

- A. Section 230593 Testing, Adjusting, and Balancing for HVAC-CPL.
- B. Section 230713 Duct Insulation-CPL: External insulation and duct liner.
- C. Section 233300 Air Duct Accessories.
- D. Section 233600 Air Terminal Units.
- E. Section 233700 Air Outlets and Inlets.

1.03 REFERENCE STANDARDS

- A. ASHRAE (FUND) ASHRAE Handbook Fundamentals; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASTM A36/A36M Standard Specification for Carbon Structural Steel; 2019.
- C. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- D. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- E. ICC-ES AC01 Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).
- F. ICC-ES AC106 Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry; 2018, with Editorial Revision (2020).
- G. ICC-ES AC193 Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
- H. ICC-ES AC308 Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.
- I. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- J. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible; 2021.
- K. SMACNA (LEAK) HVAC Air Duct Leakage Test Manual; 2012.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration prior to start of work for B pressure class and higher systems.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).

1.05 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply (Heating Systems): 2 inch wg pressure class, galvanized steel.
- D. Low Pressure Supply (System with Cooling Coils): 2 inch wg pressure class, galvanized steel.
- E. Return and Relief: 2 inch wg pressure class, galvanized steel.
- F. General Exhaust: 1 inch wg pressure class, galvanized steel.
- G. Transfer Air and Sound Boots: 1/2 inch wg pressure class, galvanized steel.

2.02 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. VOC Content: Not more than 250 g/L, excluding water.
 - 3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - 4. Manufacturers:
 - a. Carlisle HVAC Products; Hardcast Versa-Grip 181 Water Based Fiber Reinforced Duct Sealant: www.carlislehvac.com/#sle.
 - b. Design Polymerics; DP 1010 Water Based Smooth Duct Sealant, Zero VOC, Premium Quality: www.designpoly.com/#sle.
 - c. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
- C. Gasket Tape: Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle rings connections.
- D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 - 6. Other Types: As required.

2.03 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook Fundamentals.
- C. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- D. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.

- E. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
- F. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- G. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

2.04 MANUFACTURED DUCTWORK AND FITTINGS

- A. Flat Oval Ducts: Machine made from round spiral lockseam duct.
 - 1. Manufacture in accordance with SMACNA (DCS).
 - 2. Fittings: Manufacture at least two gauges heavier metal than duct.
 - 3. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
- C. Round Ducts: Round lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
- D. Flexible Ducts: Two ply vinyl film supported by helically wound spring steel wire.
 - 1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 - 2. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 - 3. Maximum Velocity: 4000 fpm.
 - 4. Temperature Range: Minus 10 degrees F to 160 degrees F.
- E. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
- F. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).

2.05 CASINGS AND PLENUMS

- A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gauge, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Flexible Ducts: Connect to metal ducts with adhesive.
- E. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- F. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

- G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- H. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- I. Use double nuts and lock washers on threaded rod supports.
- J. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- K. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

3.02 CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

SECTION 233300 AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Combination fire and smoke dampers.
- C. Combination fire and smoke dampers corridor dampers.
- D. Duct access doors.
- E. Duct test holes.
- F. Fire dampers.
- G. Flexible duct connectors.
- H. Volume control dampers.

1.02 RELATED REQUIREMENTS

- A. Section 078400 Firestopping.
- B. Section 233100 HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

- A. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- B. NFPA 92 Standard for Smoke Control Systems; 2021, with Amendment.
- C. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible; 2021.
- D. UL 33 Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- E. UL 555 Standard for Fire Dampers; Current Edition, Including All Revisions.
- F. UL 555S Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 Product Requirements, for additional provisions.
 - 2. Extra Fusible Links: One of each type and size.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A. Manufacturers:
 - 1. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane): www.carlislehvac.com/#sle.

- 2. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
- 3. Krueger-HVAC, Division of Air System Components: www.krueger-hvac.com/#sle.
- 4. Ruskin Company: www.ruskin.com/#sle.
- 5. Titus HVAC, a brand of Johnson Controls: www.titus-hvac.com/#sle.
- 6. Ward Industries, a brand of Hart and Cooley, Inc: www.wardind.com/#sle.
- 7. Substitutions: See Section 016000 Product Requirements.
- B. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Nailor Industries, Inc: www.nailor.com/#sle.
 - 2. NCA, a brand of Metal Industries Inc: www.ncamfg.com/#sle.
 - 3. Pottorff: www.pottorff.com/#sle.
 - 4. Ruskin Company: www.ruskin.com/#sle.
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- E. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
- G. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.03 COMBINATION FIRE AND SMOKE DAMPERS - CORRIDOR DAMPERS

- A. Manufacturers:
 - 1. Ruskin Company: www.ruskin.com/#sle.
 - 2. United Enertech: www.unitedenertech.com/#sle.
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- E. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
- G. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.04 DUCT ACCESS DOORS

A. Manufacturers:

- 1. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
- 2. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
- 3. Nailor Industries, Inc: www.nailor.com/#sle.
- 4. Ruskin Company: www.ruskin.com/#sle.
- 5. Substitutions: See Section 016000 Product Requirements.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Access doors with sheet metal screw fasteners are not acceptable.

2.05 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.06 FIRE DAMPERS

- A. Manufacturers:
 - 1. Lloyd Industries, Inc: www.firedamper.com/#sle.
 - 2. Nailor Industries, Inc: www.nailor.com/#sle.
 - 3. Ruskin Company: www.ruskin.com/#sle.
 - 4. United Enertech: www.unitedenertech.com/#sle.
 - 5. Ward Industries, a brand of Hart and Cooley, Inc: www.wardind.com/#sle.
 - 6. Substitutions: See Section 016000 Product Requirements.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Horizontal Dampers: Galvanized steel, 22 gauge, 0.0299 inch frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- D. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.07 FLEXIBLE DUCT CONNECTORS

- A. Manufacturers:
 - 1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
 - 2. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 - 3. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Flexible Duct Connections: Fabric crimped into metal edging strip.
- D. Maximum Installed Length: 14 inch.

2.08 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 - 2. Nailor Industries, Inc: www.nailor.com/#sle.
 - 3. Ruskin Company: www.ruskin.com/#sle.
 - 4. United Enertech: www.unitedenertech.com/#sle.
 - 5. Substitutions: See Section 016000 Product Requirements.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Splitter Dampers:
- D. Single Blade Dampers:
 - 1. Fabricate for duct sizes up to 6 by 30 inch.
 - 2. Blade: 24 gauge, 0.0239 inch, minimum.
- E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

- 1. Blade: 18 gauge, 0.0478 inch, minimum.
- F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 233100 for duct construction and pressure class.
- B. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
- C. Provide duct test holes where indicated and required for testing and balancing purposes.
- D. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- F. Demonstrate re-setting of fire dampers to Owner's representative.
- G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- I. Use splitter dampers only where indicated.
- J. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

SECTION 233700 AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diffusers:
- B. Rectangular ceiling diffusers.
- C. Registers/grilles:
 - 1. Ceiling-mounted, exhaust and return register/grilles.
- D. Duct-mounted supply and return registers/louvers.
- E. Gravity ventilators.

1.02 REFERENCE STANDARDS

- A. AMCA 511 Certified Ratings Program Product Rating Manual for Air Control Devices; 2021, with Editorial Revision (2022).
- B. AMCA 550 Test Method for High Velocity Wind Driven Rain Resistant Louvers; 2022.
- C. ASHRAE Std 70 Method of Testing the Performance of Air Outlets and Air Inlets; 2023.
- D. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- E. ASTM B221M Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2013.

1.03 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.04 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carnes, a division of Carnes Company Inc: www.carnes.com/#sle.
- B. Krueger-HVAC: www.krueger-hvac.com/#sle.
- C. Price Industries: www.price-hvac.com/#sle.
- D. Titus, a brand of Air Distribution Technologies: www.titus-hvac.com/#sle.

2.02 RECTANGULAR CEILING DIFFUSERS

- A. Type: Provide rectangular and square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.
- B. Connections: Round.
- C. Color: As indicated.

2.03 DUCT-MOUNTED SUPPLY AND RETURN REGISTERS/LOUVERS

A. Type: Duct-mounted, rectangular register for round-spiral duct with adjustable pivot-ended blades, end caps, built-in volume damper, and dual cover flanges to lay flush on duct surface regardless of diameter. Performance to match manufacturer's catalog data.

B. Color: As indicated on drawings.

2.04 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 1/2 inch maximum spacing, with blades set at 45 degrees, vertical face.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting.
- C. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Color: As indicated.
- E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.05 GRAVITY VENTILATORS

- A. Hood Intake and Relief Gravity Ventilator:
 - 1. Manufacturers:
 - a. American Coolair Corporation: www.coolair.com/#sle.
 - b. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - c. Loren Cook Company: www.lorencook.com/#sle.
 - 2. General:
 - a. Low silhouette for intake applications with natural gravity or negative pressure system(s).
 - b. Performance ratings and factory testing to be in accordance with AMCA 511 and AMCA 550.
 - c. Suitable for non-ducted applications.
 - d. Equipment to bear permanently affixed manufacturer's nameplate listing model and serial number.
 - 3. Hood and Base:
 - a. Material: Aluminum.
 - b. Hood Construction: Precision formed, arched panels with interlocking seams.
 - c. Vertical End Panels: Fully locked into hood end panels.
 - d. Curb Cap: Pre-punched mounting holes for installation.
 - 4. Birdscreen:
 - a. Fabricate in accordance with ASTM B221 (ASTM B221M).
 - b. Construction: 1/2 inch Galvanized mesh.
 - c. Horizontally mounted across hood intake area.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- C. Install diffusers to ductwork with air tight connection.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- E. Paint ductwork visible behind air outlets and inlets matte black, see Section 099123.

SECTION 235100 BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Field fabricated breechings.
- B. Manufactured breechings.
- C. Double wall metal stacks (B-2&3).

1.02 RELATED REQUIREMENTS

- A. Section 078400 Firestopping.
- B. Section 230513 Common Motor Requirements for HVAC Equipment-CPL: Induced draft fan motor.
- C. Section 230716 HVAC Equipment Insulation.
- D. Section 260583 Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ANSI Z223.1 National Fuel Gas Code; 2024.
- B. ASTM A193/A193M Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications; 2023.
- C. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- D. ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2018a.
- E. NFPA 31 Standard for the Installation of Oil-Burning Equipment; 2020, with Amendment (2023).
- F. NFPA 54 National Fuel Gas Code; 2021.
- G. NFPA 211 Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; 2019.
- H. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible; 2021.
- I. UL 103 Factory-Built Chimneys for Residential Type and Building Heating Appliances; Current Edition, Including All Revisions.

1.04 DEFINITIONS

- A. Breeching: Vent connector.
- B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
- C. Smoke Pipe: Round, single wall vent connector.
- D. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- E. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.06 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

- B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.

1.07 QUALITY ASSURANCE

- A. Designer Qualifications: Design stacks under direct supervision of a Professional Structural Engineer experienced in design of the type of work specified and licensed in the state of New York.
- B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum three years documented experience, and approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Breechings, Chimneys, and Stacks:
 - 1. AMPCO by Hart & Cooley, Inc; Model VSI: www.ampcostacks.com/#sle.
 - 2. DuraVent; DuraStack Pro (DIS2): www.duravent.com/#sle.
 - 3. Metal-Fab, Inc: www.mtlfab.com/#sle.
 - 4. Security Chimneys International; Secure Stack Pro (CIX2): www.securitychimneys.com/#sle.
 - 5. Selkirk Corporation; Model PS: www.selkirkcommercial.com/#sle.
 - 6. Z-Flex U.S. Inc: www.z-flex.com/#sle.

2.02 BREECHINGS, CHIMNEYS, AND STACKS - GENERAL REQUIREMENTS

- A. Regulatory Requirements:
 - 1. Comply with applicable codes for installation of natural gas burning appliances and equipment.
 - 2. Comply with NFPA 31 for installation of oil burning appliances and equipment.

2.03 FIELD FABRICATED BREECHINGS

- A. Breechings 24 inches or More in Diameter: Fabricate from ASTM A1011/A1011M Type B carbon steel; weld longitudinal seams and make end joints by welding, lapping and bolting, or with companion flanges.
- B. Breechings Less Than 24 inches in Diameter: Fabricate from hot-dipped galvanized steel sheet, ASTM A653/A653M FS, with G90/Z275 coating; make longitudinal seams using pipe lock or flat lock groove seam and make end joints beaded and crimped.
- C. Minimum Metal Thicknesses based on SMACNA (DCS):
 - 1. Sizes up to 12 inches: 18 gauge, 0.0478 inch.
 - 2. Sizes 13 to 24 inches: 16 gauge, 0.0598 inch.
 - 3. Sizes 25 to 36 inches: 14 gauge, 0.0747 inch.
- D. Provide adjustable self-actuating barometric draft dampers, where indicated on drawings, full size of breeching.
- E. Provide cleanout doors of same gauge as breeching where indicated on drawings.
- F. Reinforcing: Provide angle frames for rectangular breeching and flanged girth joints or angle frames for round breeching in accordance with SMACNA (DCS), at following intervals:
- G. Fabricate breeching fittings to match adjoining breechings. Fabricate elbows with center-line radius equal to breeching width. Limit angular tapers to 20 degrees maximum.

2.04 MANUFACTURED BREECHINGS

- A. Provide factory-built, modular connector and manifold system, tested to UL 103 with positive pressure rating.
- B. Assembly to be UL listed for use with building equipment in compliance with NFPA 211.
- C. Fabricate with 1 inch minimum air space between walls and construct inner liner of 304 stainless steel and outer jacket of 304 stainless steel.
 - 1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.
- D. Design, fabricate, and install gas-tight preventing products of combustion leaking into the building.

2.05 DOUBLE WALL METAL STACKS (B-2&3)

- A. Provide double wall metal stacks, tested to UL 103 and UL listed with positive pressure rating, for use with building heating equipment, in compliance with NFPA 211.
- B. Fabricate with 1 inch minimum air space between walls and construct inner liner of 304 stainless steel and outer jacket of AL29-4C stainless steel.
 - 1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.
- C. Accessories, UL Labeled:

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54
- C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA (DCS) for equivalent duct support configuration and size.
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- G. Insulate breechings in accordance with Section 230716.
- H. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.
- I. Level and plumb chimney and stacks.
- J. Clean breechings, chimneys, and stacks during installation, removing dust and debris.
- K. Provide maximum 2 feet of breeching to connect appliance to chimney. Provide Type B chimney continuously from appliances.

3.02 SCHEDULES

- A. Breechings, Chimneys and Stacks.
 - 1. Boiler 2&3 Double wall metal stacks.

This page intentionally left blank

SECTION 235100 - FLUES - CONDENSING BOILERS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 WORK INCLUDED, BUT NOT LIMITED TO

A. Manufactured chimneys and vent systems for condensing boiler (B-4).

1.03 REFERENCE STANDARDS

- A. ANSI /NFPA. 211, Section 2-3.1 and Appendix A.
- B. N.Y.S. Industrial Code Rule #4.
- C. ASHRAE Handbook, Equipment Chapter 31.
- D. Labeling by ANSI/ UL 103
- E. Labeling by UL 959
- F. Labeling by UL-1738, ULC-S636
- G. NFPA 54 / ANSI Z223.1
- H. Uniform Mechanical Code Chapter 9
- I. Local Codes

1.04 QUALITY ASSURANCE

- A. The entire exhaust vent system from each boiler or appliance to the termination, including accessories, except as noted, shall be from one manufacturer.
- B. Technical Services Support: The factory-built modular exhaust vent system shall be furnished by a vendor organization which assures design, installation, and services coordination; and provides in-warranty and post-warranty unified responsibility for owner, architect, consulting engineer, and contractor.
- C. Underwriter's Laboratories, Inc.: Exhaust vent/chimney components shall be tested and listed by the Underwriters' Laboratories, Inc. (ULI) for use as Building Heating Appliance Chimney for Class II venting with natural or propane gas which produce continuous flue temperatures not above 230□F.

1.05 WARRANTY

A. Manufacturer shall warranty the exhaust vent system and all components against functional failure due to defects in material and workmanship for a period of ten years from date of commissioning. Functional failure shall be defined as any failure of the system or a component to perform its intended function of exhausting, without leakage, combustion by-products from engine operation or boiler heating equipment.

1.06 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 01300. Drawings showing the actual layout and drawn to scale shall be provided by the manufacturer. The system shall be installed as designed by the manufacturer and in accordance with the terms of the manufacturer's 10-year warranty and in conjunction with sound engineering practice.
- B. Shop drawings shall include material list, product data, dampers, expansion joint, gas duct and gasket, scaled drawings showing plan and elevation of all systems and components, and details of method of support.

- C. Exhaust vent manufacturer shall provide computer generated inner diameter sizing information for the exhaust vent system, taking into account each individual appliance firing rate and pressure/ temperature requirements, and considering seasonal firing rates of each piece of equipment and possible combinations of firing rates. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the inner pipe.
- D. The Contractor (s) shall furnish the specific requirements of equipment actually used on the project. Operating characteristics shall include flue gas flow rate, BTU input, outlet temperature, local altitude, stack layout, and available external pressure at boiler outlet, etc., necessary to determine system operation at maximum and minimum levels of burner turndown range.
- E. Sizing information and shop drawings shall be reviewed and endorsed by the individual equipment manufacturer's representative before submittal to the Engineer.
- F. Submit Manufacturer's extended Ten-Year Warranty.
- G. Submit manufacturer's installation instructions.
- H. Submit manufacturer's descriptive literature, operating instructions, and maintenance and repair data.
- I. Furnish Construction Contractor with two sets of approved drawings showing exact location and dimensions of roof opening required for chimney pipe.
- J. All warranties shall be delivered as part of the close-out submission.
- K. Unless otherwise stated above, provide a written warranty (Manufacturer's standard form) in which the Manufacturer agrees to repair or replace components that fail in material and workmanship within one year from date of Substantial Completion / Start-Up. Warranty shall include labor.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

2.02 MANUFACTURERS:

- A. Centrotherm InnoFlue Vent System (basis of design) or approved equal.
- B. Heatfab Saf-T-CI or approved equal.

2.03 GENERAL

- A. Manufactured exhaust vent for gas fired equipment, boiler stack and breeching components, supports and terminations shall be factory prefabricated and shall be laboratory tested and listed by the Underwriters Laboratory, Inc., for use with building heating equipment burning gas, oil for condensing appliances, as described in NFPA 211
- B. The vent shall be of the single wall, factory-built type, designed for use in conjunction with Category II, or IV condensing gas fired appliances, condensing oil fired appliances or as specified by the heating equipment manufacturer.
- C. Maximum continuous flue gas temperature shall not exceed 230 degrees F (110 degrees C).
- D. Vent shall be listed for a maximum positive pressure rating of 20" w.c.
- E. The vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. All systems components shall be UL/cUL listed and supplied by the same manufacturer.
- F. The vent shall be constructed from Flame Resistant Polypropylene, with a min. wall thickness of:

Diameter		Wall Thickness of Extruded Pipes			
mm	inches	min (mm)	max (mm)	min (inch)	max (inch)
DN 60	2"	1.7	2.2	0.0669	0.0866
DN 80	3"	1.8	2.4	0.0709	0.0945
DN 110	4"	2.4	3.2	0.0945	0.1260
DN 125	5"	2.7	3.7	0.1063	0.1457
DN 160	6"	2.9	4.5	0.1142	0.1772
DN 200	8"	3.5	4.5	0.1378	0.1772
DN 250	10"	3.3	4.7	0.1299	0.1850
DN 315	12"	4.2	5.8	0.1654	0.2283

- G. All systems components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings required to install the vent system shall be UL/cUL listed and provided by the vent manufacturer.
- H. All systems components shall include a factory- installed gasket in their female-end to render the vent air and watertight when the male/female ends are pushed together as per manufacturer's instructions. Vent systems requiring field installed sealants or compounds shall not be acceptable.
- I. Vent layout shall be designed and installed in compliance with manufacturer's installation instructions and all applicable local codes.
- J. This flue system shall be designed and installed to be gas tight and thus prevent leakage of combustion products into a building. The system shall be designed to compensate for all flue gas induced thermal expansions.

2.04 MATERIALS

- A. Silicone Sealant: Storm Collar to Chimney, Ventilated Thimble or Roof support outer and other area requiring weatherizing caulking.
- B. Note: Silicone sealant is prohibited for use on internal venting system. Internal venting system shall only receive sealants approved by the manufacturer to ensure no erosion occurs.
- C. Inner Core: Polypropylene or AL-29-4C stainless steel.
- D. Jackets:
 - 1. Not required for system designed for single wall polypropylene rated for zero clearance.
 - 2. 430 stainless steel sheet where applicable.
- E. Air Space: Outer jacket and inner liner shall be separated by a 5/32" air space where applicable.
- F. Chimney: For natural gas or propane fired equipment.

2.05 FABRICATION

A. Fabricate boiler flues with baseplate, anchors, cleanout, provision for support, expansion and contraction, tee-sections, flashing and counter-flashing, drainage, insulated exit cone.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install and support breeching in accordance with manufacturer's printed instructions. Provide hinged inspection doors with gasket and locking device.
- B. When installed according to the manufacturer's installation instructions, the piping and its supporting system shall resist side loads (whether system is horizontal or vertical) at least 1.5 times the weight per foot of the piping. Wall supports shall support (as verified by manufacturer testing)200 feet of pipe in 6" through 20-inch ID sizes and 100 feet of pipe in 24 inch ID and larger sizes with a factor of safety of at least four.

- C. Install flue with positive slope back to appliance.
- D. Unless otherwise indicated on the plans, install one expansion joint in vertical run and one in horizontal run.
- E. This Contractor shall furnish and install structural steel framing required for roof penetration supports.
- F. Complete system shall be provided to comply with National safety standards and building codes for positive internal pressure systems up to 3", negative or neutral pressure.
- G. Correct leakage (if any) observed during boiler operational tests.
- H. Inner joints are to be field assembled with factory supplied sealant to maintain system rating and listing.
- I. The vent system and breechings shall be inspected and cleaned before the final connection to the appliances.
- J. Penetrations through top of chimney shall be suitable for a non-combustible roof and shall be according to the manufacturer's detail drawings and installation instructions. At chimney top penetrations use a factory fabricated ventilated thimble or ventilated roof support.
- K. Boiler flue extensions above roof shall terminate as required by Local and State Codes and as required by Appendix D of NFPA 211.
- L. Exposed flue along wall or above roofs shall be provided with guying or supporting every 12 feet, with a maximum of six feet extending above the last guying point.

SECTION 235216 CONDENSING BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured units.
- B. Boiler construction.
- C. Boiler trim.
- D. Fuel burning system.
- E. Factory installed controls.
- F. SED requirements.
- G. Magnetic filters.

1.02 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete.
- B. Section 230913 Instrumentation and Control Devices for HVAC.
- C. Section 232114 Hydronic Specialties.
- D. Section 232123 Hydronic Pumps.
- E. Section 232500 HVAC Water Treatment.
- F. Section 235100 Breechings, Chimneys, and Stacks.
- G. Section 260583 Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.
- B. ANSI Z21.13 American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2022.
- C. ASHRAE Std 90.1 I-P Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- E. ASME BPVC-IV Boiler and Pressure Vessel Code, Section IV Rules for Construction of Heating Boilers; 2023.
- F. ASME BPVC-VIII-1 Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.
- G. NBBI Manufacturer and Repair Directory The National Board of Boiler and Pressure Vessel Inspectors (NBBI); Current Edition.
- H. NFPA 31 Standard for the Installation of Oil-Burning Equipment; 2020, with Amendment (2023).
- I. NFPA 54 National Fuel Gas Code; 2021.
- J. SCAQMD 1146.1 Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters; 1990, with Amendment (2018).

1.04 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

B. All boiler/burner controls and accessories, that are necessary to ensure safe operation, shall be listed and bear the seal of approval of a Nationally Recognized Testing Laboratory (NRTL).

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittals procedures.
- B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
- C. Manufacturer's Field Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.08 WARRANTY

- A. See Section 017800 Closeout Submittals for additional warranty requirements.
- B. Provide a five year warranty to include coverage for heat exchanger.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Combination Natural Gas/No. 2 Fuel Oil for Indoor or Outdoor Applications:
1. Substitutions: See Section 016000 - Product Requirements.

2.02 MANUFACTURED UNITS

- A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.
- B. Unit: Metal membrane wall, water or fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.

2.03 BOILER CONSTRUCTION

- A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.
- B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.
- C. Required Directory Listings:
 - 1. AHRI Directory of Certified Product Performance Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
 - 2. NBBI Manufacturer and Repair Directory The National Board of Boiler and Pressure Vessel Inspectors (NBBI); current edition at www.nationalboard.org.
- D. Heat Exchanger: Construct with materials that are impervious to corrosion where subject to contact with corrosive condensables.
- E. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.
- F. Insulate casing with insulation material, protected and covered by heavy-gauge metal jacket.

G. Factory apply boiler base and other components, that are subject to corrosion, with durable, acrylic, powder coated, painted, or weather-proofed finish.

2.04 BOILER TRIM

- A. ASME rated pressure relief valve.
- B. Flow switch.
- C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.
- D. Temperature and pressure gauge.
- E. Pressure Switches:
 - 1. High gas pressure.
 - 2. Low gas pressure.
 - 3. Air pressure.
- F. Manual reset high limit.
- G. Boiler Pump (where required by boiler design):
 - 1. Primary pump, factory supplied and sized for field installation to ensure minimum, continuous circulation through boiler.
 - 2. Where pump is not provided by boiler manufacturer, provide pump in accordance with boiler manufacturer's recommendations.
 - 3. Pump time delay.

2.05 FUEL BURNING SYSTEM

- A. Provide forced draft automatic burner or pulse combustion, integral to boiler, designed to burn natural gas, propane, and No. 2 fuel oil, and maintain fuel-air ratios automatically.
 - 1. Blower Design: Statically and dynamically balanced to supply combustion air; direct connected to motor.
 - 2. Forced Draft Design: Mixes combustion air and gas to achieve 90 percent combustion efficiency.
 - 3. Pulse Combustion Design: Self-aspirating, not requiring blower for combustion.
 - 4. Combustion Air Filter: Protects fuel burning system from debris.
- B. Gas Train: Plug valve, safety gas valve, gas-air ratio control valve, and pressure regulator controls air and gas mixture.
- C. Emission of Oxides of Nitrogen Requirements: Comply with SCAQMD 1146.1 for natural gas fired system, as applicable.
- D. Intakes: Combustion air intake capable of accepting free mechanical room air or direct outside air through a sealed intake pipe.

2.06 FACTORY INSTALLED CONTROLS

- A. Option for internal or external (0-10) VDC control.
- B. Temperature Controls:
 - 1. Automatic reset type to control fuel burning system on-off and firing rate to maintain temperature.
 - 2. Manual reset type to control fuel burning system to prevent boiler water temperature from exceeding safe system water temperature.
 - 3. Low-fire start time delay relay.
- C. Electronic PI setpoint/modulation control system.
- D. Microprocessor-based, fuel/air mixing controls.

2.07 MAGNETIC FILTERS

- A. Manufacturers:
 - 1. ADEY Innovation LLC: www.adey.com/#sle.

- 2. Substitutions: See Section 016000 Product Requirements.
- B. Description: ASME BPVC-VIII-1 compliant, packaged oxide filtration assembly configured to remove dissolved ferrous metals from hydronic systems.
- C. In-line Filter Assembly:
 - 1. Magnetic belt surrounded by stainless steel vessel and nonferrous casing.
 - 2. Provide filter assembly with automatic air vent and EPDM flange gaskets.
 - 3. Flange Connections: 2 inches, ASME B16.5 Class 150.
 - 4. Maximum Fluid Service Pressure: 145 psi.
 - 5. Maximum Temperature: 212 degrees F.

2.08 SED REQUIREMENTS

- A. The burner and boiler shall be installed with adequate controls to provide the following functions and interlocks:
 - 1. Automatic flame safeguard controls.
 - 2. Trial for ignition periods on the pilot and main burner.
 - 3. Combustion airflow supervision to the combustion chamber.
 - 4. Pre-ignition purging of the combustion chamber (four air changes of combustion chamber.)
 - 5. Proven start and supervision of induced draft and forced draft fan operation.
 - 6. Proven low-fire start on inputs over 1,000,000 BTU per hour.
 - 7. Shut-down on low oil temperature and low oil pressure.
 - 8. Non-recycling safety shut-down on upper limit gas pressure or low limit gas pressure.
 - 9. Proving fuel valve in closed position for burners on boilers over 250 BHP.
 - 10. All flame supervisory and programming control units shall include a self-checking circuit. This self-checking must be performed at least once on each ignition cycle. For 5 million BTU or larger systems, it is required that the flame detector and programmer check itself continuously and periodically during operation to assure safe equipment conditions during prolonged firing periods.
 - 11. High limit manual reset operating control of heating medium. This additional limit control shall not be installed on a common sampling tube with the operative limit control.
 - 12. High-pressure limit control for steam; high temperature limit control for warm air and hot water.
 - 13. Low water cut-off (LWCO) control.
 - 14. An alarm system to signal burner failure and shut-down.
 - 15. Observation ports shall be provided for visually observing the pilot and main flame.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.
- C. Install boiler and provide connection of No. fuel oil service in accordance with requirements of NFPA 31 and applicable codes.
- D. Install boiler on concrete housekeeping base, sized minimum of 6 inches larger than boiler base in accordance with Section 033000.
- E. Coordinate factory installed controls with Section 230913.
- F. Coordinate provisions for water treatment in accordance with Section 232500.
- G. Pipe relief valves to nearest floor drain.
- H. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

- I. Provide piping connection and accessories in accordance with Section 232114.
- J. Connect vent combustion generated fumes to breeching, chimney or exhaust stack; see Section 235100.
- K. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front end.

3.02 CLOSEOUT ACTIVITIES

- A. See Section 017900 Demonstration and Training for additional requirements.
- B. Demonstrate proper operation of equipment to Owner's designated representative.
- C. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.

This page intentionally left blank

SECTION 235223 CAST-IRON BOILERS

PART 1 GENERAL - OWNER PROVIDED BOILERS

1.01 SECTION IS FOR REFERENCE ONLY - BOILERS AND TRIM ARE OWNER PROVIDED.

- A. Boilers.
- B. Controls and boiler trim.
- C. Steam and condensate connections.
- D. Fuel connection.
- E. Collector, draft hood, and chimney connection.
- F. SED Requirements.

1.02 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete.
- B. Section 232114 Hydronic Specialties.
- C. Section 232214 Steam and Condensate Heating Specialties.
- D. Section 235100 Breechings, Chimneys, and Stacks.
- E. Section 260583 Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AHRI 1500 Performance Rating of Commercial Space Heating Boilers; 2015.
- B. ANSI Z21.13 American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2022.
- C. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- D. ASME BPVC-IV Boiler and Pressure Vessel Code, Section IV Rules for Construction of Heating Boilers; 2023.
- E. ASME BPVC-VIII-1 Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.
- F. NFPA 31 Standard for the Installation of Oil-Burning Equipment; 2020, with Amendment (2023).
- G. NFPA 54 National Fuel Gas Code; 2021.
- H. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL (DIR) Online Certifications Directory; Current Edition.
- J. UL 726 Oil-Fired Boiler Assemblies; Current Edition, Including All Revisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Weil-McLain/SPX Corporation: www.weil-mclain.com/#sle. Owner Provided
- B. Substitutions: See Section 016000 Product Requirements.

2.02 REGULATORY REQUIREMENTS

- A. Comply with ASME BPVC-IV and ASME BPVC-VIII-1 for boiler construction.
- B. Comply with NFPA 70.
- C. Comply with applicable codes for internal wiring of factory wired equipment.
- D. Units: UL (DIR) listed and labeled.

- E. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.
- F. All boiler/burner controls and accessories, that are necessary to ensure safe operation, shall be listed and bear the seal of approval of a Nationally Recognized Testing Laboratory (NRTL).

2.03 MANUFACTURED UNITS

- A. Hot Water Boilers: Suitable for forced draft with insulated jacket, sectional cast iron heat exchanger, natural gas burning system, refractory, controls, tankless water heater, and boiler trim including circulator and fill system consisting of diaphragm type expansion tank, fill and check valve, and automatic air vent.
- B. Provide water wall design consisting of water backed combustion area with water circulating around firebox. Refractory chamber or separate base not required.

2.04 STEAM BOILER TRIM

- A. ASME rated pressure relief valve, 15 psig.
- B. Steam pressure gauge, 0 to 30 psig.
- C. Water column gauge glass set with cocks.
- D. (2) Two Low water cut-off to prevent burner operation when boiler water drops below safe level and boiler condensate return pump control to maintain water level by controlling pump operation.
- E. Operating pressure controller for burner to maintain steam pressure setting.
- F. High limit pressure control with manual reset for burner to prevent steam pressure from exceeding system pressure.

2.05 FUEL BURNING SYSTEM

- A. Burner Operation: On-off with low fire position for ignition.
- B. Oil Burner Safety Controls: Energize burner motor and electric ignition, limit time for establishment of main flame, monitor flame continuously during burner operation and stop burner on flame failure with manual reset necessary, solenoid oil delay valve opens after burner motor energized and closes when de-energized.
- C. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after air flow proven and slight delay, allow gas valve to open.
- D. Combination Gas-Oil Burner: Burner for natural gas and No. 2 fuel oil built as unit, equipped with gas pressure regulator and oil gas selector switch.
- E. Collector and Draft Hood: Non-metallic vent pipe and air intake.
- F. Controls: Pre-wired, factory assembled electronic controls in control cabinet with flame scanner or detector, programming control, relays, and switches. Provide pre-purge and post-purge ignition and shut-down of burner in event of ignition pilot and main flame failure with manual reset.

2.06 SED REQUIREMENTS

- A. The burner and boiler shall be installed with adequate controls to provide the following functions and interlocks:
 - 1. Automatic flame safeguard controls.
 - 2. Trial for ignition periods on the pilot and main burner.
 - 3. Combustion airflow supervision to the combustion chamber.
 - 4. Pre-ignition purging of the combustion chamber (four air changes of combustion chamber.)
 - 5. Proven start and supervision of induced draft and forced draft fan operation.
 - 6. Proven low-fire start on inputs over 1,000,000 BTU per hour.
- 7. Shut-down on low oil temperature and low oil pressure.
- 8. Non-recycling safety shut-down on upper limit gas pressure or low limit gas pressure.
- 9. Proving fuel valve in closed position for burners on boilers over 250 BHP.
- 10. All flame supervisory and programming control units shall include a self-checking circuit. This self-checking must be performed at least once on each ignition cycle. For 5 million BTU or larger systems, it is required that the flame detector and programmer check itself continuously and periodically during operation to assure safe equipment conditions during prolonged firing periods.
- 11. High limit manual reset operating control of heating medium. This additional limit control shall not be installed on a common sampling tube with the operative limit control.
- 12. High-pressure limit control for steam; high temperature limit control for warm air and hot water.
- 13. Low water cut-off (LWCO) control.
- 14. An alarm system to signal burner failure and shut-down.
- 15. Observation ports shall be provided for visually observing the pilot and main flame.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install boiler on concrete housekeeping base, sized minimum 6 inches larger than boiler base; see Section 033000.
- C. Provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.
- D. Provide connection to fuel oil supply in accordance with requirements of NFPA 31.
- E. Provide piping connections and accessories as indicated; see Section 232114.

3.02 SYSTEM STARTUP

A. Provide the services of manufacturer's field representative for starting and testing unit.

This page intentionally left blank

SECTION 236313 AIR COOLED REFRIGERANT CONDENSERS

<<<< UPDATE NOTES

PART 1 GENERAL

2.01 SECTION INCLUDES

- A. Manufactured units.
- B. Casing.
- C. Condenser coils.
- D. Fans and motors.
- E. Controls.

2.02 RELATED REQUIREMENTS

- A. Section 230513 Common Motor Requirements for HVAC Equipment-CPL.
- B. Section 232300 Refrigerant Piping.
- C. Section 260583 Wiring Connections: Electrical characteristics and wiring connections.

2.03 REFERENCE STANDARDS

- A. AHRI 210/240 Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.
- B. ASHRAE Std 20 Methods of Laboratory Testing Remote Mechanical-Draft Air-Cooled Refrigerant Condensers; 2019.
- C. ASHRAE Std 90.1 I-P Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- E. UL 207 Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

2.04 SUBMITTALS

A. Product Data: Provide rated capacities, weights, accessories, electrical requirements, and wiring diagrams.

2.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

3.01 MANUFACTURERS

- A. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
- B. HITACHI.
- C. FUJITSU USA Basis of Design
- D. Substitutions: See Section 016000 Product Requirements.

3.02 PERFORMANCE REQUIREMENTS

3.03 MANUFACTURED UNITS

- A. Provide packaged, factory assembled, pre-wired unit, suitable for outdoor use consisting of casing, condensing coil and fans, integral sub-cooling coil liquid accumulator.
- B. Construction and Ratings: In accordance with AHRI 210/240 and UL 207. Testing shall be in accordance with ASHRAE Std 20.

C. Performance Ratings: Energy Efficient Rating (EER)/Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1 I-P, in combination with compressor units.

3.04 CASING

- A. House components in welded steel frame with steel panels with weather resistant, baked enamel finish.
- B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.
- C. Provide removable access doors or panels with quick fasteners.

3.05 CONDENSER COILS

A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig, and vacuum dehydrate. Seal with holding charge of nitrogen.

3.06 FANS AND MOTORS

- A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge, equipped with roller or ball bearings with grease fittings extended to outside of casing.
- B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built-in current and thermal overload protection; refer to Section 230513.

3.07 CONTROLS

- A. Provide factory wired and mounted control panel, NEMA 250, containing fan motor starters, fan cycling thermostats, compressor interlock, and control transformer.
- B. Provide controls to permit operation down to 0 degrees F ambient temperature.
- C. Provide thermostat to cycle fan motors in response to outdoor ambient temperature.

PART 3 EXECUTION

4.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide for connection to electrical service. Refer to Section 260583.
- C. Provide cooling season start-up, winter season shut-down service, for first year of operation.
- D. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

SECTION 236414 CONDENSERS/CONDENSING UNITS

PART 1 – GENERAL

1.01 REFERENCE STANDARDS

A. ASTM - Ameican Society for Testing and Materials; Current.

1.02 RELATED DOCUMENTS

1.03 GENERAL DESCRIPTION

A. This section includes the design, controls and installation requirements for air-cooled condensers / condensing units.

1.04 QUALITY ASSURANCE

- A. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- B. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- C. System Seasonal Energy Efficiency Ratio (SEER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- D. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL label.

1.05 SUBMITTALS

- A. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
- B. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, clearances, and connection details. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Unit shall be shipped with doors bolted shut to prevent damage during transport and thereafter while in storage awaiting installation.
- B. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

1.07 WARRANTY

- A. Manufacturer shall provide a limited "parts only" warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance and refrigerant.
- B. Compressors shall carry a 5 year warranty from date of original equipment shipment from the factory.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Products shall be provided by the following manufacturers:

- 1. AAON
- 2. Substitute equipment may be considered for approval that includes at a minimum:
 - a. R-410A refrigerant
 - b. Hinged access doors with lockable handles
 - c. Two-stage compressors with capacities of 100% and 67%
 - d. 2,500 hour salt spray tested exterior corrosion protection
 - e. Designed, engineered, and manufactured in the United States of America
 - f. All other provisions of the specifications must be satisfactorily addressed

2.02 CONDENSING UNITS

- A. General Description
 - 1. Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the control compartment.
 - 2. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - 3. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
 - 4. Installation, Operation and Maintenance manual shall be supplied within the unit.
 - 5. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
 - 6. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.
- B. Construction
 - 1. Unit shall be completely factory assembled, piped, and wired and shipped in one section.
 - 2. All cabinet walls, access doors, and roof shall be fabricated of G90 galvanized steel panels.
 - 3. Unit shall be specifically designed for outdoor application.
 - 4. Access to compressors and control components shall be through hinged access doors with quarter turn, lockable handles.
 - 5. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
 - 6. Unit shall include forklift slots.
- C. Electrical
 - 1. Unit shall be provided with standard power block for connecting power to the unit.
 - 2. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.
 - 3. Unit shall have a 5kAIC SCCR.
 - 4. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
 - 5. Unit shall be provided with factory installed and factory wired 115V, 12 amp GFI outlet in the unit control panel.
 - 6. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage, or on phase reversal.
- D. Refrigeration System
 - 1. Unit shall be provided with one independently circuited R-410A two-stage scroll compressor with thermal overload protection. Two-stage compressor shall include 2 stages of capacity control, 67% and 100%.
 - 2. Each compressor shall be furnished with a crankcase heater.

- 3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.
- 4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
- 5. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided and installed. Field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line and insulated suction line.
- 6. Unit shall include a factory holding charge of R-410A refrigerant and oil. Adjusting the charge of the system will be required during installation.
- 7. Unit shall include 2 stages of capacity control.
- 8. Shall be equipped with a 5 minute off delay timer to prevent compressor short cycling.
- 9. Each refrigeration circuit shall be equipped with a liquid line sight glass.
- 10. Lead refrigeration circuit shall be equipped with flooded condenser low ambient head pressure control to allow operation down to 0°F. Option includes adjustable compressor lockout, low ambient control valve, check valve, and liquid line receiver.
- 11. Units shall be provided with a suction pressure transducer on the refrigeration circuit.
- E. Fans
 - 1. Condenser fan shall be horizontal discharge, axial flow, direct drive fans.
 - Condensing unit shall be provided with an electrically commutated motor (ECM) condenser fan, condenser head pressure controller, and discharge pressure transducers for modulating head pressure control to allow cooling operation down to 35°F. Fan motor shall be weather protected, single phase, direct drive, and totally enclosed air over (TEAO) with electronic protection.
- F. Coils
 - 1. Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
 - 2. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
 - 3. Coils shall be hydrogen leak tested.
- G. Controls
 - 1. Unit shall be provided with a terminal block for field installation of controls. Option shall include factory installed isolation relays.

PART 3 - EXECUTION

3.01 INSTALLATION, OPERATION, AND MAINTENANCE

- A. Installation, Operation and Maintenance manual shall be supplied with the unit.
- B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.
- C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

This page intentionally left blank

SECTION 237223 PACKAGED AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Energy recovery units.
- B. Casing.
- C. Fans.
- D. Filters.
- E. Dampers.
- F. Roof curbs.
- G. Power and controls.
- H. Service accessories.

1.02 RELATED REQUIREMENTS

A. Section 077200 - Roof Accessories: Roof curb.

1.03 REFERENCE STANDARDS

- A. AMCA 500-D Laboratory Methods of Testing Dampers for Rating; 2018.
- B. AMCA 500-L Laboratory Methods of Testing Louvers for Rating; 2015.
- C. AHRI 1060 (I-P) Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment; 2018.
- D. ASHRAE Std 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2017, with Addendum (2022).
- E. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- F. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's installation instruction, product data, and engineering calculations.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store in manufacturer's unopened packaging.

1.06 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Warranty ventilator to be free from defects in material and workmanship and of all parts for period of 1-1/2 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Energy Recovery Ventilators:
 - 1. RenewAire: www.renewaire.com/#sle.
 - 2. Ruskin Company: www.ruskin.com/#sle.
 - 3. Semco Inc.: www.semcohvac.com/#sle.

- 4. Substitutions: See Section 016000 Product Requirements.
- B. Basis of Design: RenewAire: www.renewaire.com/#sle.

2.02 ENERGY RECOVERY UNITS

- A. Energy Recovery Units: Provide stationary core air-to-air exchanger; prefabricated packaged system designed by manufacturer.
 - 1. Provide unit with a AHRI 1060 (I-P) compliant air-to-air exchanger.
 - 2. Access: Hinged and/or screwed access panels on front.
 - 3. Lifting holes at the unit base.
 - 4. Framing: Welded extruded aluminum tubular frame capable of supporting components and casings.
 - 5. Permanent name plate listing manufacturer mounted inside door near electrical panel.

2.03 CASING

- A. Wall, Floor, and Roof Panels:
 - 1. Panels: Removable.
 - 2. Construction: 1 inch thick, double wall box construction, with formed edges of exterior wall overlapping formed edges of interior wall.
 - 3. Aluminum is standard. Factory-painted aluminized steel is an economic alternative when the higher corrosion resistance of aluminum is not required.
 - 4. Exterior Wall: Galvanized steel sheet.
 - a. 0.040 inches thick aluminum.
 - 5. Interior Wall: Galvanized sheet metal.
 - a. 22 gauge, 0.0299 inch galvanized sheet metal.
 - 6. Insulation:
 - a. 1/2 inch insulated fiberglass.
 - b. Panel Cores: Mineral wool board.
 - c. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.
 - d. Smoke Developed Index (SDI): 50, maximum, when tested in accordance with ASTM E84 or UL 723.
 - 7. Roof Panel: Weatherproof.
 - 8. Coating: Polyurethane enamel.
- B. Access Panels: Provide access to components through a large, tightly sealed and easily removable panel.
- C. Doors:
 - 1. Construct doors of same construction and thickness as wall panels.

2.04 FANS

- A. Provide separate fans for exhaust and supply blowers.
- B. Fans:
 - 1. Individually driven with a dedicated motor.
- C. Housings: 12 gauge, 0.1046 inch aluminized steel with plenums integral to general housing and constructed to Class 1 fan standards.

D. Motors:

- 1. Motors: Open drip proof.
- 2. Efficiency: High.
- 3. Speed: Single.
- 4. Control: Constant Speed.
- 5. Fan Motor: UL listed and labeled.
- E. Drives:
 - 1. Fans: Belt driven.

- 2. Horsepower: 7.5 HP.
- 3. Service Factor: 1.2.

2.05 FILTERS

A. Exhaust and Fresh Air Streams: MERV 13 filters constructed to meet ASHRAE Std 52.2.

2.06 DAMPERS

- A. Exhaust Back-Draft Damper: Factory installed, galvanized steel.
 - 1. High performance, backdraft dampers suitable for application in HVAC systems with velocities to 3000 feet per minute.
 - 2. Louvers, Dampers, and Shutters: AMCA 500-D and AMCA 500-L.
 - 3. Damper Capacity: Demonstrate damper capacity to withstand HVAC system operating conditions.
 - 4. Fabrication:
 - a. Frame: 20 gauge, 0.0359 inch, 3 inch roll formed galvanized steel channel with rear flange, prepunched mounting holes, and welded corner clips for maximum rigidity.
 - b. Blades:
 - 1) Style: Single-piece, overlap frame.
 - 2) Material: Roll formed 28 gauge, 0.0149 inch galvanized steel.
 - 3) Width: Maximum 6 inches.
- B. Return Air Damper:
 - 1. Factory installed, adjustable volume control, opposed blade damper for regulating airflow, based on external static pressure.
 - 2. Return Air Damper: Structural hat channels, reinforced at corners.
 - 3. Roll-formed Frames: Structurally superior to 13 gauge, 0.0897 inch U-channel frames.
 - 4. Blades: Single skin, 16 gauge, 0.0598 inch.
- C. Motorized Dampers: Provide motorized dampers at outside air inlet, exhaust air outlet, and supply air outlet.
 - 1. Type: Motorized two position parallel blade damper with blade seals.
 - 2. Motorized Damper: Roll-formed structural hat channels, reinforced at the corners,
 - 3. Blades: Single skin, 16 gauge, 0.0598 inch.
- D. Motorized Louvers:
 - 1. Type: Motorized two position parallel blade louver with drainable blades, blade seals, and jamb seals
 - 2. Adjustable louver:
 - a. Fabrication: Mullion style.
 - 1) Frame:
 - (a) Material: Extruded aluminum, Alloy 6063-T5.
 - 2) Blades:
 - (a) Style: Horizontal, adjustable, drainable.
 - (b) Material: Formed aluminum, Alloy 6063-T5.

2.07 ROOF CURBS

- A. Curbs: Provide full perimeter 14" roof curb fabricated from 10 gauge, 0.1345 inch aluminized steel.
 - 1. Curbs: Knock-down type.

2.08 POWER AND CONTROLS

- A. Motor Control Panels: UL listed.
- B. Include necessary motor starters, fuses, transformers and overload protection according to NFPA 70.
- C. Provide single-point field connection to power supply.
- D. Install wiring in accordance with NFPA 70.

2.09 SERVICE ACCESSORIES

- A. Internal Service Lights: Provide vapor tight light with protective cage and minimum 40 watt bulb.
- B. Electrical Receptacle:
 - 1. Provide duplex, ground fault interrupter type receptacle.
 - 2. Provide re-settable circuit breaker in control panel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that structure is ready for installation of unit, that openings in deck for ductwork, if required, are correctly sized and located, and that mechanical and electrical utilities supplying unit are of correct capacities and are accessible.

3.02 INSTALLATION

- A. Provide openings for suitable ductwork connection.
- B. Outdoor Installations:
 - 1. Roof Panels:
 - a. Fasteners: Use concealed means of attachment.
 - b. Minimize penetrations through roof.
 - 2. Provide drip edge around roof perimeter.
 - 3. Do not locate roof panel joints above doors.

3.03 SYSTEM STARTUP

A. Provide services of manufacturer's authorized representative to provide start up of unit.

3.04 CLEANING

A. Clean filters, air plenums, interior and exposed-to-view surfaces prior to Substantial Completion.

SECTION 237416

PACKAGED ROOFTOP UNITS / OUTDOOR AIR HANDLING UNITS

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. ANSI American National Standards Institute; 2020.
- B. ASTM Ameican Society for Testing and Materials; Current.
- C. ASTM D1929 Standard Test Method for Determining Ignition Temperature of Plastics; 2020.

1.02 RELATED DOCUMENTS

1.03 GENERAL DESCRIPTION

This section includes the design, controls and installation requirements for packaged rooftop Α units / outdoor air handling units.

1.04 QUALITY ASSURANCE

- Packaged air-cooled condenser units shall be certified in accordance with ANSI/AHRI Standard Α 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.
- B. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical C. Refrigeration.
- D. Unit Seasonal Energy Efficiency Ratio (SEER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- E. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- F. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.05 SUBMITTALS

- Product Data: Literature shall be provided that indicates dimensions, operating and shipping Α. weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation, and Maintenance manual with startup requirements shall be provided.
- Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, B. construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.06 DELIVERY, STORAGE, AND HANDLING

- Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage A. during transport and thereafter while in storage awaiting installation.
- Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and B. unloading the unit at its final location.
- C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation, and Maintenance manual.

237416

1.07 WARRANTY

A. Manufacturer shall provide a limited "parts only" warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for Installation, Operation, and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Products shall be provided by the following manufacturers:
 - 1. AAON
 - 2. Substitute equipment may be considered for approval that includes at a minimum:
 - a. R-454B refrigerant
 - b. Variable capacity compressor with 10-100% capacity control
 - c. Direct drive supply fans
 - d. Double wall cabinet construction
 - e. Insulation with a minimum R-value of 13
 - f. Stainless steel drain pans

2.02 ROOFTOP UNITS

- A. General Description
 - 1. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil, electric heaters, exhaust fans, energy recovery wheels, and unit controls.
 - 2. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
 - 3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - 4. Unit components shall be labeled, including refrigeration system components, and electrical and controls components.
 - 5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
 - 6. Installation, Operation, and Maintenance manual shall be supplied within the unit.
 - 7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
 - 8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.
- B. Construction
 - 1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
 - 2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
 - 3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, reduces heat transfer through the panel, and prevents exterior condensation on the panel.

- 4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
- 5. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 210/240. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
- 6. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
- 7. Access to filters, dampers, cooling coils, reheat coil, heaters, energy recovery wheels, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
- 8. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- 9. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
- 10. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
- 11. Unit shall include lifting lugs on the top of the unit.
- 12. Unit base pan shall be provided with 1/2 inch thick foam insulation.
- C. Electrical
 - 1. Unit shall have a 5kAIC SCCR.
 - 2. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
 - 3. Air-source heat pump shall include a defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation. Defrost cycle shall begin when outdoor coil temperature is below a fixed setpoint and have a fixed 10 minute run time, or end when the outdoor coil temperature is above a fixed setpoint. Defrost timer, with 30/60/90 minute selectable defrost cycle interval time, shall be factory installed in the controls compartment. During defrost cycle all compressors shall energize, reversing valve shall de-energize, and auxiliary heat shall energize.
 - 4. Unit shall be provided with a factory installed and factory wired 115V, 12 amp GFI outlet disconnect switch in the unit control panel.
 - 5. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.
- D. Supply Fans
 - 1. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
 - 2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
 - 3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

237416

UNITS

- 4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
- E. Exhaust Fans
 - 1. Exhaust dampers shall be sized for 100% relief.
 - 2. Fans and motors shall be dynamically balanced.
 - 3. Unit shall include factory provided motorized relief dampers. The dampers shall be field installed.
 - 4. Unit shall include barometric relief dampers.
 - 5. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
 - 6. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
 - 7. Unit shall include belt driven, unhoused, backward curved, plenum exhaust fans.
 - 8. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
- F. Cooling Coils
 - 1. Evaporator Coils
 - a. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
 - b. Coil shall be standard capacity.
 - c. Coils shall be 6 row high capacity.
 - d. Coils shall be hydrogen or helium leak tested.
 - e. Coils shall be furnished with factory installed expansion valves.
- G. Refrigeration System
 - 1. Unit shall be factory charged with R-410A refrigerant.
 - 2. Compressors shall be scroll type with thermal overload protection and carry a 5 year nonprorated warranty, from the date of original equipment shipment from the factory.
 - 3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
 - 4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
 - 5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
 - 6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed liquid line filter driers.
 - 7. Unit shall include a variable capacity scroll compressor on the refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.
 - 8. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit which shall be capable of modulation from 10-100% of its capacity and a two-stage compressor on the lag circuit that shall modulate between two capacity settings, 67% and 100%.
 - 9. Refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

PHASE 2: 2022 BOND

UNITS

- 10. Unit shall be configured as an air-source heat pump. Refrigeration circuit shall be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump cooling mode of operation.
- 11. Refrigeration circuit shall be equipped with a liquid line sight glass.
- 12. Each refrigeration circuit shall be equipped with a liquid line sight glass.
- 13. Unit shall be provided with a fixed 55F compressor lockout.
- 14. Unit shall be provided with an adjustable compressor lockout.
- 15. Unit shall be provided with an adjustable compressor lockout for each compressor.
- H. Condensers
 - 1. Air-Cooled Condenser
 - a. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
 - b. Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
 - c. Heat pump outdoor coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
 - d. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
 - e. Coils shall be hydrogen or helium leak tested.
 - f. Condenser fans shall be high efficiency electrically commutated motor driven with factory installed head pressure control module. Condenser airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 35°F with adjustable compressor lockout.
- I. Electric Heating
 - 1. Unit shall include an electric heater consisting of electric heating coils, fuses and a high temperature limit switch, with capacities as shown on the plans.
 - 2. Electric heating coils shall be located in the reheat position downstream of the cooling coil.
 - 3. Electric heater shall have full modulation capacity controlled by an SCR (Silicon Controlled Rectifier). A 0-10 VDC heating control signal shall be field provided to control the amount of heating.
 - 4. [Auxiliary electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is in operation. Dual fuel auxiliary heating capacity shall be available for operation when heat pump heating is in operation. Unit shall include 1 stage of auxiliary electric heating capacity.] [Heat Pump Auxiliary Heat Sizing]
 - 5. [Emergency electric heating capacity shall be sized by determining the maximum electric heating capacity not to exceed the amp draw of all compressors and adding that electric heating capacity to the auxiliary electric heating capacity. Auxiliary electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is in operation. Unit shall include 1 stage of auxiliary electric heating capacity.] [Heat Pump MCA Limited Heat Sizing]
 - 6. [Emergency electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is not in operation. Auxiliary electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is in operation. Unit shall include 1 stage of auxiliary electric heating capacity.] [Heat Pump Emergency Heat Sizing]
- J. Filters
 - 1. Unit shall include 4 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil. Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4 inch standard filters.
 - 2. Unit shall include a clogged filter switch.
 - 3. Unit shall include a Magnehelic gauge mounted in the controls compartment.
- K. Outside Air/Economizer

PHASE 2: 2022 BOND

- 1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return DDCactuator. Unit shall include outside air opening bird screen and outside air hood. Unit, except for horizontal series, shall also include barometric relief dampers.
- L. Energy Recovery
 - 1. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.
 - 2. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
 - 3. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.
 - 4. Unit shall include 2 inch thick, pleated panel outside air filters with an ASHRAE MERV rating of 8, upstream of the wheels.
 - 5. Hinged service access doors shall allow access to the wheel.
 - 6. Unit shall include energy recovery wheel rotation detection sensors and a set of normally open and normally closed contracts for field indication of wheel rotation.
 - a. Polymer Energy Recovery Wheels
 - 1) Shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
 - 2) All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive.
 - 3) Polymer Energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Airxchange. The 5-year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the Airxchange written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts. Refer to the Airxchange Energy Recovery Cassette Limited Warranty Certificate.

- 4) Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- M. Controls
- N. Accessories
 - 1. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.

2.03 CURBS

A. Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.

PART 3 - EXECUTION

3.01 INSTALLATION, OPERATION, AND MAINTENANCE

- A. Installation, Operation, and Maintenance manual shall be supplied with the unit.
- B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation, and Maintenance manual instructions.
- C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

This page intentionally left blank

SECTION 238126.13 SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air-source heat pumps.
- B. Air cooled condensing units.
- C. Indoor air handling (fan and coil) units for ducted systems.
- D. Indoor air handling (fan and coil) units for ductless systems.
- E. Controls.

1.02 RELATED REQUIREMENTS

- A. Section 233100 HVAC Ducts and Casings.
- B. Section 260583 Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.
- B. AHRI 520 Performance Rating of Positive Displacement Condensing Units; 2004.
- C. ASHRAE Std 15 Safety Standard for Refrigeration Systems; 2022, with Errata (2023).
- D. ASHRAE Std 23.1 Methods for Performance Testing Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Pressures of the Refrigerant; 2019.
- E. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- F. NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.
- G. UL 207 Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Design Data: Indicate refrigerant pipe sizing.
- D. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturers warranty for solid state ignition modules.
- C. Provide five year manufacturers warranty for heat exchangers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fujitsu - Basis of Design.

2.02 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factoryengineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator; auxiliary electric heat.
 - 2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- B. Performance Requirements: See Drawings for additional requirements.
- C. Electrical Characteristics:
 - 1. ____ kW.
 - 2. ____ volts, single phase, 60 Hz.
 - 3. _____ amperes maximum fuse size.
 - 4. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 260583.

2.03 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 - 2. Manufacturer: System manufacturer.

2.04 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
- B. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
- C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
 - 1. Provide thermostatic expansion valves.
- D. Operating Controls:
 - 1. Control by room thermostat to maintain room temperature setting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.
- C. Verify that proper fuel supply is available for connection.

3.02 INSTALLATION

- A. Install in accordance with NFPA 90A and NFPA 90B.
- B. Install refrigeration systems in accordance with ASHRAE Std 15.

SECTION 238129 VRF SYSTEM

THE HVAC SYSTEM SHALL BE A HEAT-RECOVERY VRF SYSTEMS. IT SHALL CONSIST OF ONE OR MULTIPLE OUTDOOR UNITS PER REFRIGERANT CIRCUIT, ONE OR MULTIPLE INDOOR UNITS, ONE OR MULTIPLE REFRIGERANT UNIT BOXES AND DIGITAL CONTROLS. THE OUTDOOR UNIT SHALL BE A 208-230V/3-PHASE VR-II. EACH OF THE INDOOR UNITS SHALL BE CAPABLE OF CHANGING ITS MODE (HEATING, COOLING) INDEPENDENTLY OF OTHER INDOOR UNITS' MODES.

1.01 APPROVED MANUFACTURERS AND MODELS

A. Fujitsu shall be the Base of Design (BOD) using the Airstage VRF system.

1.02 QUALITY ASSURANCE

- A. The VRF system shall be manufactured in facilities registered to follow the International Standard Organization (ISO) ISO 9001 - Quality Management and ISO 14001 - Environmental Management Standards.
- B. All outdoor and indoor units shall be listed under Electrical Testing Laboratories (ETL) and caries the ETL label.
- C. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 -"Construction and System Start-up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- E. All wiring shall be in accordance with the National Electric Code (NEC).

1.03 DELIVERY, STORAGE, AND HANDLING

A. All outdoor units, indoor units, refrigerant branch units, controls, and piping components shall be stored and handled according to the manufacturer's recommendation.

1.04 WARRANTY

- A. The outdoor units and indoor units shall be covered by a minimum of (1) year parts and (2) years compressor manufacturer's Limited Standard Warranty. The warranty shall only cover any defects in material or workmanship as long as the VRF system is used for human thermal comfort or other approved applications under normal use and service. Any repaired or replaced component or part shall be warranted for the remainder of the original Standard Limited Warranty period or thirty (30) days after shipment of replacement part, whichever is longer.
- B. The Manufacturer shall offer a (10) year Extended Warranty. The outdoor units and indoor units shall qualify to receive the manufacturer's Extended Warranty when installed according to all the manufacturer's Qualified System requirements listed:
 - 1. The system is designed using the VRF manufacturer system design software.
 - 2. The system is installed for human thermal comfort or other manufacturer approved applications.
 - 3. The system is installed by the VRF manufacturer trained and approved contractor.
 - 4. The system is commissioned by the VRF manufacturer certified commissioning agent within 120 days of installation and start-up.
 - 5. The commissioning agent shall submit full commissioning report(s) within 21 days of completing commissioning.
 - 6. The VRF manufacturer shall issue an Extended Warranty Approval Letter indicating that all reports are complete and without errors.

1.05 INSTALLER TRAINING

A. Variable Refrigerant Flow system manufacturers vary in requirements. Contractor must verify requirements and complete installation training prior to installing the system. The contractor shall comply with the specified manufacturer system installation requirements without change in cost to Owner. Equipment supplier must inspect installation at various stages to ensure proper installation.

1.06 PRODUCTS – OUTDOOR UNITS

1.07 OUTDOOR UNITS – HEAT-RECOVERY 208-230V/3-PHASE

A. General

- 1. The VRF heat-recovery system components; outdoor unit(s), indoor unit(s), refrigerant branch unit(s) and control(s) system shall be made by the same manufacturer. If multiple outdoor units are to connect together, they shall be connected by the manufacturer specified branch kits based on the following list.
- B. The outdoor units must have the following capabilities:
 - 1. Each outdoor unit shall be capable of providing static pressure up to 0.32 in.WG to allow connection of discharge ductwork and to prevent discharge air short-circuiting.
 - 2. Each of the outdoor units shall have only one inverter driven twin rotary compressor. The use of multiple compressors or other types of compressors is not allowed.
 - 3. The system shall be able to provide heating during oil recovery. Oil recovery operation shall not last more than 6 minutes after the first oil recovery.
 - 4. The system must defrost all circuits simultaneously in order to resume full heating more quickly. Defrost time shall not last more than 15 minutes. Partial defrost which may extend the no heating or reduced heating periods shall not be allowed.
 - 5. The system refrigerant circuit shall be capable of having its indoor to outdoor units' connectable capacity as high as 150%.
 - 6. The outdoor unit shall provide refrigerant pressure and temperature safety protection.
 - 7. Systems greater than 24 tons shall be split into smaller systems to help comply with refrigerant limitation regulations.
 - 8. The system shall be capable of connecting to a minimum of 3280 ft of triple refrigerant piping. Shorter piping length limitation shall not be acceptable.
 - 9. The outdoor unit coil fins shall be coated with a blue corrosion resistance for longer service life.
 - 10. The outdoor unit shall offer quite operation option.
 - 11. The following shall be the number of condensers and separation tubes used for each size:
 - a. Branch Kit
 - b. Units Model Quantity
 - c. 1 None -
 - d. 1 None -
 - e. 1 None -
 - f. 2 UTP-CX567A 1
 - q. 2 UTP-CX567A 1
 - h. 2 UTP-CX567A 1
 - i. 2 UTP-CX567A 1
 - j. 2 UTP-CX567A 1
 - k. 3 UTP-CX567A 2
 - I. 3 UTP-CX567A 2

1.08 REFERENCE STANDARDS

- A. ASTM Ameican Society for Testing and Materials; Current.
- B. ISO 9001 Quality management systems -- Requirements; 2015.
- C. ISO 14001 Environmental Management Systems Requirements with Guidance for Use; 2015.

D. Outdoor Temperatures:

- The heat-recovery outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperature and cooling or simultaneous heating/cooling mode down to 14°F ambient temperature without any additional low ambient control kits or controls. The selection of an alternate manufacturer shall deem the contractor responsible for any additional material, cost, and labor to meet low ambient operating condition and performance.
- E. Compressor:
 - 1. Each outdoor unit module shall be equipped with one inverter driven dual rotary compressor. The use of multiple compressors, scroll and/or non-inverter driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
 - 2. The compressor shall be equipped with automatic thermal overload protection.
 - 3. The compressor shall be equipped with high and low pressure overload protection.
 - 4. The compressor modulating capacity shall be between 17% and 100%.
- F. Fan:
 - 1. Each outdoor unit fan shall be equipped with at least one propeller type fan.
 - 2. The fan motor shall be variable speed DC inverter driven.
 - 3. The fan motors shall be electrically protected.
 - 4. The fan(s) shall be enclosed within outdoor unit and shall be protected with metal grille.
 - 5. The fan motor shall be factory set to 0 in.WG. In addition, it shall be capable of providing static pressure up to 0.32 in.WG to allow connection of discharge ductwork and to prevent discharge air short-circuiting.
- G. Coil:
 - 1. The outdoor unit shall have two outdoor coils. The unit shall be capable of regulating the flow of the refrigerant independently in each coil to improve part load operation. The use of a single outdoor unit coil shall not be acceptable.
 - 2. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
 - 3. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
 - 4. The coil shall be protected with an integral metal guard.
- H. Electrical Power:
 - 1. The outdoor unit shall be powered by 208-230V/3-phase, 60 Hz.
 - 2. The outdoor unit shall be able to operate satisfactorily within the 187 to 253 Voltage range.
 - 3. The outdoor unit shall have built-in protection against single-phasing and reverse-phasing through electrical power.
 - 4. Outdoor unit electronic circuits shall be electrically protected using fuses.
- I. Control and Communication:
 - 1. The outdoor unit shall be controlled by integral microprocessors.
 - 2. The main control board shall have a four-digit seven-segment display along with mode/exit, select and enter buttons to enter function codes and obtain OU operating data (pressures, temperatures, EEV positions and compressor load details).
 - 3. The outdoor unit shall have a specific function to verify only the number of indoor units connected to the outdoor unit. A second function shall register the indoor units to the outdoor units and verify connected capacity
 - 4. The control circuit between the outdoor unit(s) and the different indoor units shall be completed using non-polar, 22-AWG, solid-core, twisted-pair, and shielded LonWorks communication cable to provide total integration of the system. The communication network shall be capable of extending up to a length of 11,800 ft of cable. Shorter cable length capability shall not be acceptable.
- J. Unit Cabinet:

1. The outdoor unit casing(s) shall be fabricated of painted galvanized steel.

1.09 REFRIGERANT BRANCH BOX -SINGLE

- A. General
 - 1. The Refrigerant Branch Box shall be used to allow indoor units to operate in a heating or cooling mode independent from the rest of the heat-recovery system indoor unit operating mode. The unit shall be mounted indoors, with access and service clearance provided for each controller. The Refrigerant Branch Box shall be connected to only one indoor unit or to multiple indoor units operating in the same mode. The maximum capacity of the Refrigerant Branch Box shall be equal to or greater than the total indoor units' capacity connected to it.
- B. Unit Cabinet
 - 1. The unit shall be made of galvanized sheet metal.
 - 2. The unit shall have the flexibility of being mounted with the control box on either side or the top to ease installation.
- C. Piping
 - 1. The Refrigerant Branch Box shall connect to only two of the three heat-recovery pipes.
 - 2. The indoor unit shall connect to the Refrigerant Branch Box using two pipes only.
 - 3. The Refrigerant Branch Box built-in pipes shall have built-in reducers for each pipe to ease connecting to different piping sizes.
- D. Electrical:
 - 1. The Refrigerant Branch Box shall be powered by 208-230V/single-phase, 60 Hz.
 - 2. The Refrigerant Branch Box shall be able to operate satisfactorily within the 187 to 253 Voltage range.
 - 3. Refrigerant Branch Box electric circuits shall be electronically protected using fuses.

1.10 MULTI-REFRIGERANT BRANCH BOX -MULTIPLE

- A. General
 - 1. The Multi-Refrigerant Branch Box shall be used to allow up to four indoor connections to operate in a heating or cooling mode independent from the rest of the heat-recovery system indoor unit operating mode. The unit shall be mounted indoors, with access and service clearance provided for each controller. Each of the Multi-Refrigerant Branch Box connections shall be connected to only one indoor unit or to multiple indoor units operating in the same mode. The maximum capacity of the Multi-Refrigerant Branch Box branch shall be equal to or greater than the total indoor units' capacity connected to it.
- B. Unit Cabinet
 - 1. The unit shall be made of galvanized sheet metal.
- C. Piping
 - 1. The Multi-Refrigerant Branch Box shall connect to all three heat-recovery pipes.
 - 2. The indoor unit shall connect to the Multi-Refrigerant Branch Box using two pipes only.
 - 3. The Multi-Refrigerant Branch Box built-in pipes shall have built-in reducers for each pipe to ease connecting to different piping sizes.
 - 4. Up to two Multi-Refrigerant Branch Box can be connected in series to provide a total of 8 refrigerant branches.
 - 5. A minimum of three refrigerant branch per Multi-Refrigerant Branch Box must be used for proper system operation.
- D. Electrical:
 - 1. The Refrigerant Branch Box shall be powered by 208-230V/single-phase, 60 Hz.
 - 2. The Refrigerant Branch Box shall be able to operate satisfactorily within the 187 to 253 Voltage range.
 - 3. Refrigerant Branch Box electric circuits shall be electronically protected using fuses.

1.11 PRODUCT – INDOOR UNITS

1.12 INDOOR UNITS - COMPACT CASSETTE

- A. General
 - 1. The VRF Compact Cassette style indoor unit shall be designed to be recessed into different types of ceilings. The unit shall provide 4-way air distribution away from the unit. The air distribution shall be controlled by electronically controlled louvers. The return air shall be in the center of the unit and shall have a built-in filter. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating Electronic Expansion Valve (EEV), high-lift condensate pump, and control circuit board and fan motor. The indoor unit shall have an Auto-restart function that allows the unit to resume operation after power interruption.
- B. Unit Cabinet
 - 1. The cabinet shall be designed to be recessed in a standard suspended ceiling square grid of 2 ft x 2 ft without any alterations.
 - 2. The unit shall have provisions for a field installed filtered outside air intake.
 - 3. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way airflow using optional air-outlet shutter plates.
 - 4. Each of the louvers shall be individually adjusted using remote controller.
- C. Fan
 - 1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
 - 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - 3. The indoor fan shall offer three (3) speeds, Low, Mid, and High.
 - 4. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
 - 5. The indoor unit vanes shall have 4 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
 - 6. The indoor unit shall have an adjustable air outlet system offering 4-way, 3-way or 2-way airflow.
 - 7. The indoor unit shall offer optional provisions for fresh air intake.
- D. Filter:
 - 1. Return air shall be filtered by means of a long-life washable filter.
- E. Coil:
 - 1. The indoor coil shall be of nonferrous construction with louvered fins on copper tubing.
 - 2. The tubing shall have inner grooves for high efficiency heat exchange.
 - 3. The coil fins shall have hydrophilic coating.
 - 4. All tube joints shall be brazed with phos-copper or silver alloy.
 - 5. The coils shall be pressure tested at the factory.
- F. Drainage:
 - 1. The unit shall be equipped with an integral insulated drain pan and condensate pump.
 - 2. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water at least 27 1/2" inches above the bottom of the unit.
- G. Electrical:
 - 1. The indoor unit shall be powered by 208-230V/single-phase, 60 Hz.
 - 2. The indoor unit shall be able to operate satisfactorily within the 187 to 253 Voltage range.
 - 3. Indoor unit electric circuits shall be electronically protected using fuses.
- H. Controls:
 - 1. This indoor unit shall use controls provided by the specified manufacturer to perform functions necessary to operate the system.
 - 2. The indoor unit shall be equipped with Infrared wireless receiver that is compatible with the optional wireless remote controller.

- The indoor unit shall offer an auxiliary-heat output and functionality. The indoor unit shall offer an option for the auxiliary-heat output to function while outdoor unit has an error.
 The indoor unit shall offer fresh air intake fan control option.

1.13 INDOOR UNITS - CASSETTE

- A. General
 - 1. The VRF Cassette style indoor unit shall be designed to be recessed into different types of ceilings. The unit shall provide 4-way air distribution away from the unit. The air distribution shall be controlled by electronically controlled louvers. The return air shall be in the center of the unit and shall have a built-in filter. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating Electronic Expansion Valve (EEV), high-lift condensate pump, and control circuit board and fan motor. The indoor unit shall have an Auto-restart function that allows the unit to resume operation after power interruption.
- B. Unit Cabinet
 - 1. The cabinet shall be designed to be recessed in a standard suspended ceiling square grid of 3 ft x 3 ft without any alterations.
 - 2. The unit shall have provisions for a field installed filtered outside air intake.
 - 3. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way airflow using optional air-outlet shutter plates.
 - 4. Each of the louvers shall be individually adjusted using remote controller.
- C. Fan
 - 1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
 - 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - 3. The indoor fan shall offer three (3) speeds, Low, Mid, and High.
 - 4. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
 - 5. The indoor unit vanes shall have 4 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
 - 6. The indoor unit shall have an adjustable air outlet system offering 4-way, 3-way or 2-way airflow.
 - 7. The indoor unit shall offer optional provisions for fresh air intake.
- D. Filter:
 - 1. Return air shall be filtered by means of a long-life washable filter.
- E. Coil:
 - 1. The indoor coil shall be of nonferrous construction with louvered fins on copper tubing.
 - 2. The tubing shall have inner grooves for high efficiency heat exchange.
 - 3. The coil fins shall have hydrophilic coating.
 - 4. All tube joints shall be brazed with phos-copper or silver alloy.
 - 5. The coils shall be pressure tested at the factory.
- F. Drainage:
 - 1. The unit shall be equipped with an integral insulated drain pan and condensate pump.
 - 2. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water at least 33 1/2" inches above the bottom of the unit.
- G. Electrical:
 - 1. The indoor unit shall be powered by 208-230V/single-phase, 60 Hz.
 - 2. The indoor unit shall be able to operate satisfactorily within the 187 to 253 Voltage range.
 - 3. Indoor unit electric circuits shall be electronically protected using fuses.
- H. Controls:
 - 1. This indoor unit shall use controls provided by the specified manufacturer to perform functions necessary to operate the system.

- The indoor unit shall offer an auxiliary-heat output and functionality. The indoor unit shall offer an option for the auxiliary-heat output to function while outdoor unit has an error.
 The indoor unit shall offer fresh air intake fan control option.
- 1.14 INDOOR UNITS SLIM DUCT
 - A. General
 - 1. The VRF Slim Ducted style indoor unit shall be designed to be installed above ceiling or behind walls and shall be connected to ducting system. Contained within the unit shall be all factory wiring, piping, electronic modulating Electronic Expansion Valve (EEV), condensate pan, high-lift condensate pump, built-in removable filter, control circuit board and 2 or 3 fans and fan motor. The unit shall be capable of providing static pressure between 0 to 0.36 in.WG. The unit shall be less than 8 in. in height and shall require a ceiling vertical installation space of less than 10 in. The unit shall be suitable for use in plenums. The indoor unit shall have an Auto-restart function that allows the unit to resume operation after power interruption.
 - B. Unit Cabinet
 - 1. The unit shall have a low profile to be installed in plenum space of 10 in or less in height.
 - 2. The indoor unit shall be designed to be installed vertically. In this case, an external separate condensate pump shall be installed.
 - 3. The unit shall have the capability of connecting to return air duct from the back or bottom of the unit.
 - 4. The unit shall have provisions for factory supplied louvers that can be controlled using VRF manufacturer remote.
 - C. Fan
 - 1. The indoor fan shall be an assembly with two or three fans direct driven by a single motor.
 - 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - 3. The unit shall be factory to a static pressure of 0 in.WG. In addition, the unit shall be capable of providing a static pressure up to 0.36 in.WG.
 - 4. The indoor fan shall offer three (3) speeds, Low, Mid, and High.
 - 5. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
 - 6. The unit shall have an auxiliary heat output with function control. The unit shall be capable of operating the auxiliary heat and fan based on ambient set point even when the outdoor unit produces error codes.
 - 7. The unit shall offer the capability of preventing the fan from operating when the temperature is satisfied in heating mode.
 - 8. The indoor unit shall offer provisions for fresh air intake.
 - D. Filter:
 - 1. Return air shall be filtered by means of air filter.
 - 2. The filter shall be adaptable to be mounted to the back or bottom of unit.
 - 3. The filter construction shall include a Fungicide agent.
 - E. Coil:
 - 1. The indoor coil shall be of nonferrous construction with louvered fins on copper tubing.
 - 2. The tubing shall have inner grooves for high efficiency heat exchange.
 - 3. The coil fins shall have hydrophilic coating.
 - 4. All tube joints shall be brazed with phos-copper or silver alloy.
 - 5. The coils shall be pressure tested at the factory.
 - F. Drainage:
 - 1. The unit shall be equipped with an integral insulated drain pan and condensate pump.
 - 2. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water at least 33 1/2" inches above the bottom of the unit drain pan.

- G. Electrical:
 - 1. The indoor unit shall be powered by 208-230V/single-phase, 60 Hz.
 - 2. The indoor unit shall be able to operate satisfactorily within the 187 to 253 Voltage range.
 - 3. Indoor unit electric circuits shall be electronically protected using fuses.
- H. Controls:
 - 1. This indoor unit shall use controls provided by the specified manufacturer to perform functions necessary to operate the system.
 - 2. For systems with required auxiliary heat, the indoor unit shall offer an auxiliary-heat output and functionality. The indoor unit shall offer an option for the auxiliary-heat output to function while outdoor unit has an error. No substitute to this functionality shall be allowed.
 - 3. The indoor unit shall offer fresh air intake fan control option.

1.15 INDOOR UNITS - FLOOR/CEILING 12KBTU TO 24KBTU

- A. General
 - 1. The VRF Floor/ceiling style indoor unit shall be designed to mount vertically on the floor or be suspended from the ceilings. The unit shall provide swinging air distribution in 2 directions away from the unit. The air distribution shall be controlled by electronically controlled louvers. The louvers shall close when the unit is not in operation. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating Electronic Expansion Valve (EEV), and control circuit board and fan motor. The indoor unit shall have an Auto-restart function that allows the unit to resume operation after power interruption.
- B. Unit Cabinet
 - 1. The cabinet shall be designed to be made out of durable plastic and can be installed on the floor or ceiling suspended.
 - 2. Each of the louvers shall be individually adjusted using remote controller.
- C. Fan
 - 1. The indoor fan shall be an assembly with a high powered DC fan direct motor.
 - 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - 3. The indoor fan shall offer three (3) speeds, Low, Mid, and High.
 - 4. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
 - 5. The indoor unit vanes shall be capable of swinging in two parallel directions to provide extensive and uniform air distribution.
- D. Coil:
 - 1. The indoor coil shall be of nonferrous construction with louvered fins on copper tubing.
 - 2. The tubing shall have inner grooves for high efficiency heat exchange.
 - 3. The coil fins shall have hydrophilic coating.
 - 4. All tube joints shall be brazed with phos-copper or silver alloy.
 - 5. The coils shall be pressure tested at the factory.
 - 6. A condensate pan and drain shall be provided under the coil.
- E. Drainage:
 - 1. The unit shall provide a condensate outlet to connect to an external condensate pump.
 - 2. The unit shall have an optional condensate lift mechanism that will be able to raise drain water at least 27" inches above the bottom of the unit drain pan.
- F. Electrical:
 - 1. The indoor unit shall be powered by 208-230V/single-phase, 60 Hz.
 - 2. The indoor unit shall be able to operate satisfactorily within the 187 to 253 Voltage range.
 - 3. Indoor unit electric circuits shall be electronically protected using fuses.
- G. Controls:

- 1. This indoor unit shall use controls provided by the specified manufacturer to perform functions necessary to operate the system.
- 2. The indoor unit shall be equipped with Infrared wireless receiver that is compatible with the optional wireless remote controller.
- 3. For systems with required auxiliary heat, the indoor unit shall offer an auxiliary-heat output and functionality. The indoor unit shall offer an option for the auxiliary-heat output to function while outdoor unit has an error. No substitute to this functionality shall be allowed.

1.16 PRODUCT – CONTROLS AND REMOTES

1.17 REMOTE CONTROL – SIMPLE WIRED REMOTE WITHOUT OPERATION MODE

A. General

- 1. The VRF Simple Wired Remote shall be capable of displaying settings and values and controlling a single group of indoor units. The group shall consist of up to 16 indoor units. This remote shall be small in size measuring 3" x 4-¾". The screen shall be equipped with a back-lit display. The remote shall be equipped with buttons to facilitate its settings and display of information. The remote shall connect to and be powered by the indoor unit using the manufacturer specified wiring. The remote shall not require any additional controls or equipment to facilitate its operation. The remote shall offer the following features:
 - a. Temperature settings in Fahrenheit and Celsius.
 - b. Back-lit display.
 - c. Automatic Change over (Heat/Cool) with a dead band.
 - d. Temperature set point adjustment, and fan speed.
 - e. Temperature sensing at the remote or at the indoor unit return air.
 - f. Additional features shall include: Clean filter reset, Error History.
 - g. Central Control EDGE UTY-DSGYZ2 Controller with Internet Communication
- B. General
 - The VRF Central touch controller shall be capable of viewing and controlling the operation of up to 400 indoor units from up to 16 refrigerant systems. In addition, the controller shall be capable of connecting up to 100 outdoor units. The controller shall be equipped with a 7.5" touch LCD color display. The controller shall be equipped with Ethernet port for TCP/IP network communication over LAN/WAN or the Internet. The controller shall be equipped with USB connection for exporting a variety of reports. No additional remotes, controls or equipment are required to facilitate its operation. The controller shall be powered by an integrated 100 -240VAC 50/60Hz power supply. The controller shall offer the following features:
 - a. Remote communication over the LAN/WAN or the internet.
 - b. Email of errors of indoor, outdoor, or touch controller to registered addresses.
 - c. Export of operation history or error history to USB.
 - d. Languages: English, Spanish, French, German, Chinese, Polish, and Russian.
 - e. Temperature settings in Fahrenheit and Celsius.
 - f. Individual and grouped indoor unit(s) Temperature set point adjustment, fan speed control, louver control, and remote control temperature set point range limitation.
 g. External input for individual and grouped indoor unit(s) On/Off, emergency stop.
 - g. External input for individual and grouped indoor unit(s) On/Off, emergency sto
 2. Up to 20 yearly schedules that can be applied to indoor units or their groups.
 - Up to 20 yearly schedules that can be applied to indoor
 - a. Registering of indoor units.
 - b. A minimum of three levels of user security access.
 - c. Up to 100 operation users and 5 administrative users can be set.
 - d. Management of remote control(s) individual function limitation.
 - e. Daylight savings time support.
- C. Additional features shall include: defrost status display, room temperature, and Error history. It shall provide settings for the following features; Energy Saving Management, Economy mode setting, Day-Off mode, Clean filter reset, Anti-freeze setting, Test operation, Low Noise setting.

D. The controller shall offer an optional Energy Charge Apportionment and Subtenant billing addon.

1.18 PIPING:

- A. It shall be insulated according to the manufacturer and applicable national and local codes.
- B. Refrigerant piping shall meet ASTM B 280 of the ACR type that is authorized by the manufacturer.
- C. The piping shall be factory cleaned with both ends capped to protect cleanliness of pipe interiors prior to shipping.
- D. All piping shall be stored according to the manufacturer's instructions.
- E. The piping shall be sized using the manufacturer system design software.
- F. The piping shall be installed according to the manufacturer's installation instructions and national and local code requirements.
- G. All pipe brazing must be done with Dry Nitrogen gas flowing through the piping.
- H. A startup filter drier can be installed with R410A rated isolation ball valves with a valveregulated bypass connection.
- I. Headers shall be used to connect multiple indoor units.
- J. Connecting the heat-recovery outdoor unit(s) refrigeration piping to one/multiple indoor units requires the use of the manufacturer's refrigerant branch box units, separation tubes, ranch kits, and. No alternate piping components are allowed.
- K. The system shall be capable of operation with the outdoor unit being installed higher than the furthest indoor unit by a maximum of 164 ft. The system shall be capable of operation with the outdoor unit being installed below than the furthest indoor unit by a maximum of 131 ft. All piping lengths must be attainable without the need for line size changes.
- L. The system shall be specified to operate with a total refrigerant piping length of up to 3280 ft. All piping lengths must be attainable without the need for line size changes or traps.
- M. The connection between the outdoor unit and refrigerant branch units shall use 3-pipe refrigerant system design. To maximize system efficiency and reduce piping, the use of 2-pipe refrigerant system design shall not be allowed.
- N. The use of refrigerant branch boxes with more than four refrigerant circuit outputs is not allowed.
- O. Refrigerant branch boxes shall not be equipped with drain piping. The use of refrigerant branch boxes with drain piping shall be prohibited.
- P. The outdoor unit shall have the capability of being piped from front and bottom.

1.19 COMMISSIONING:

- A. Each VRF refrigerant system shall be commissioned using the manufacturer's specified procedure and software.
 - 1. All VRF System Commissioning activities shall be completed by the manufacturer's certified VRF commissioning agent. The certified VRF commissioning agent shall be an employee of the VRF manufacturer or an employee of the manufacturer's VRF distributor or VRF representative.
 - 2. The installing contractor shall be certified by the manufacturer to install the specified VRF system(s). Upon request, a copy of this certificate shall be presented as part of the VRF equipment submittal process.
 - 3. Upon proper equipment start up by the contractor, following the manufacturers guidelines and specifications, an employee of the VRF manufacturer shall complete a review of the system performance and complete the following tasks:
 - 4. Check and confirm all communication addressing of system components.

- 5. Check and confirm each indoor unit, individually, is properly piped and wired by commanding the indoor unit on, in either heat or cool mode and verifying proper response.
- 6. This process shall be digitally recorded and included as part of the close out documentation.
- 7. Electronically record a minimum of one-hour of operational data per refrigeration system.
- 8. Electronically record selector switch positions on all indoor and outdoor equipment.
- 9. The VRF manufacturer shall retain the electronically recorded data, collected during the start-up and equipment commissioning process, at a designated location within the US for future reference.
- 10. Upon completion of the VRF equipment Commissioning, the VRF manufacturer shall provide a formal report outlining the status of the system in electronic format. Contained within this report shall be copies of all field inspection reports, required action items and status, Manufacturers design software As-Built, equipment model & serial numbers.
- 11. Completion of the Equipment VRF Commissioning process shall verify that the VRF system has been installed per the Engineer's design intent and complies with the VRF manufacturer's engineering and installation specifications related to the used equipment.
- 12. Compliance with federal, state and local codes as well as other authorities having jurisdictions are not part of this process and are the responsibility of the installing contractor.

This page intentionally left blank

SECTION 238200 CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic or steam finned tube radiation.
- B. Hydronic or steam unit heaters.
- C. Hydronic or steam cabinet unit heaters.

1.02 RELATED REQUIREMENTS

- A. Section 230513 Common Motor Requirements for HVAC Equipment-CPL.
- B. Section 230719 HVAC Piping Insulation-CPL.
- C. Section 230913 Instrumentation and Control Devices for HVAC.
- D. Section 230993 Sequence of Operations for HVAC Controls.
- E. Section 232113 Hydronic Piping.
- F. Section 232114 Hydronic Specialties.
- G. Section 232300 Refrigerant Piping.
- H. Section 233100 HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.
- B. AHRI 410 Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).
- C. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible; 2021.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - 2. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
 - 3. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - 4. Indicate mechanical and electrical service locations and requirements.
- D. Selection Samples: For each finish product specified, color chart representing manufacturer's full range of available colors.
- E. Verification Samples: For each finish product specified, color chip representing actual product in color and texture.
- F. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
- G. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- I. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 Product Requirements for additional provisions.

2. Extra Filters: Two sets of each type and size.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 HYDRONIC FINNED TUBE RADIATION

- A. Manufacturers:
 - 1. Modine Manufacturing Company: www.modineHVAC.com/#sle.
 - 2. Slant/Fin Corporation: www.slantfin.com/#sle.
 - 3. Zehnder Rittling: www.rittling.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Required Directory Listing: AHRI Directory of Certified Product Performance Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
- C. Heating Elements: 1 inch ID seamless copper tubing, mechanically expanded into evenly spaced aluminum fins sized as noted on drawings, suitable for soldered fittings.
- D. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- E. Enclosures: 18 gauge, 0.0478 inch sheet steel up to 18 inches in height, 16 gauge, 0.0598 inch sheet steel over 18 inches in height or aluminum as detailed, with easily jointed components for wall to wall installation.
 - 1. Support rigidly, on wall or floor mounted brackets.
- F. Finish: Factory applied baked primer coat.
- G. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.

2.02 HEATING UNITS

- A. HYDRONIC CABINET UNIT HEATERS
- B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
- C. Coils:

1. Evenly spaced aluminum fins mechanically bonded to copper tubes.

- D. Cabinet: Minimum 16 gauge, 0.0598 inch thick sheet steel front panel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles.
- E. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.
- F. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- G. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- H. Control: Factory wired, solid state, infinite speed control, located in cabinet.
- I. Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.
PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Do not damage equipment or finishes.
- C. Finned Tube Radiation:
 - 1. Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated.
 - 2. Center elements under window with elements of equal length centered under each window for multiple windows.
 - 3. Install wall angles and end caps where units butt against walls.
 - 4. Align cabinet joints with window mullions.
- D. Units with Hydronic Coils:
 - 1. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping.
 - 2. If not easily accessible, extend air vent to exterior surface of cabinet for ease of servicing.
- E. Units with Cooling Coils: Connect drain pan to condensate drain.
- F. Air Coils:
 - 1. Install in ducts and casings in accordance with SMACNA (DCS).
 - a. Support coil sections independent of piping on steel channel or double angle frames and secure to casing.
 - b. Arrange supports to avoid piercing drain pans.
 - c. Provide airtight seals between coil and casing or duct.
 - d. See Section 233100.
 - 2. Coil Safeguards:
 - a. Protect coils to prevent damage to flanges and fins.
 - b. Comb out damaged fins.
 - 3. Install all coils level except cleanable coils with 1:50 pitch.
 - 4. Cooling Coils:
 - a. Cooling Condensate Drain Pan and Drain Connection:
 - 1) Pipe drains individually to location as indicated on drawings with water seal trap.
 - 5. Refrigerant Coils:
 - a. See Section 232300.

3.03 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections
 - 1. Leak test: After installation, charge system and test for leasks. Repair leaks and retest until no leaks exist.
- B. Units will considered defective if they do not pass test and inspections.
- C. Prepare test and inspection reports.

3.04 CLEANING

- A. See Section 017419 Construction Waste Management and Disposal for additional requirements.
- B. After construction and painting is completed, clean exposed surfaces of units.
- C. Vacuum clean coils and inside of units.

- D. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
- E. Install new filters.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 017800 Closeout Submittals for closeout submittals.
- B. See Section 017900 Demonstration and Training for additional requirements.

3.06 PROTECTION

A. Provide finished cabinet units with protective covers during the balance of construction.

SECTION 238216 AIR COILS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electric coils.

1.02 RELATED REQUIREMENTS

- A. Section 220719 Plumbing Piping Insulation.
- B. Section 230719 HVAC Piping Insulation-CPL.
- C. Section 232114 Hydronic Specialties.
- D. Section 260583 Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AHRI 410 Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).
- B. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible; 2021.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

1.05 QUALITY ASSURANCE

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for _____

PART 2 PRODUCTS

2.01 WATER HEATING COILS

- A. Tubes: 5/8 inch OD seamless copper or brass arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
- B. Casing: Die formed channel frame of 16 gauge, 0.0598 inch galvanized steel with mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.
- C. Headers: Cast iron with tubes expanded into header.
- D. Testing: Air test under water to 200 psi for working pressure of 200 psi and 220 degrees F.

2.02 ELECTRIC COILS

- A. Manufacturers:
 - 1. INDEECO (Industrial Engineering and Equipment Company): www.indeeco.com/#sle.
- B. Assembly: UL listed and labelled, with terminal control box and hinged cover, splice box, coil, casing, and controls.
- C. Coil: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material.
- D. Casing: Die formed channel frame of 16 gauge, 0.0598 inch galvanized steel with 3/8 inch mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.

E. Controls: Automatic reset thermal cut-out, built-in magnetic contactors, control circuit transformer and fuse, manual reset thermal cut-out, air flow proving device, fused disconnect, load fuses.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Install in ducts and casings in accordance with SMACNA (DCS).
- C. Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Ensure water coils are drainable and provide drain connection at low points.
- D. Electric Duct Coils: Wire in accordance with NFPA 70. Refer to Section 260583.

SECTION 260010 GENERAL PROVISIONS FOR ELECTRICAL WORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The work included in this Contract is shown on the drawings and described in these specifications. It consists of furnishing all labor, material, services, supervision and connection of all systems shown and/or specified including the requirements of:
 - 1. DIVISION 00 BIDDING AND CONTRACT REQUIREMENTS
 - 2. DIVISION 1 GENERAL REQUIREMENT
 - 3. DIVISION 26,27,28 GENERAL REQUIREMENT
- B. Contractor is responsible to review and understand all drawings and all work of all trades to ensure a complete and thorough project.
- C. Provide all labor, tools, materials, equipment, coordination, and plans necessary for installation and proper operation of the electrical systems.
- D. Contract drawings and specifications are complementary and must be so used to ascertain all requirements of the work.

1.02 DEFINITIONS

- A. Provide, furnish, install, and furnish and install shall have the same meaning. That is, the Contractor shall purchase, transport to the site and install all required components of the work unless specifically stated otherwise in the contract documents.
- B. Wiring pertains to raceway, fittings, conductors, terminations, hangers, supports, etc. as required to form a complete system.

1.03 DRAWINGS AND SPECIFICATIONS

- A. The plans are diagrammatic and indicate only the sizes and general arrangement of conduit, devices, and equipment; exact locations of all elements shall be determined as work progresses, in cooperation with the work of other trades. It is not intended to show every item of work or minor piece of equipment, but every item shall be furnished and installed without additional remuneration as necessary to complete the system in accordance with the best practice of the trade.
- B. As previously stated, the exact locations of electrical devices and equipment are diagrammatic. The owner may request for any devices or equipment to be installed at different locations than what is indicated on the drawings in a specific area or room. It is the responsibility of the Electrical Contractor to coordinate the locations of devices in all areas prior to installation.

1.04 PRODUCT EQUIVALENTS

- A. Where, in these specifications or on drawings, certain kinds, types, brands, or manufacturers of materials are named, they shall be regarded as required standard of quality. Where two or more are named these are presumed to be equal, and Contractor may select one of those items.
- B. If Contractor desires to use any kind, type, brand, or manufacturer of material other than those named in specification, he may submit the request for approval to the Architect well in advance of the bid date.
- C. Requests for approval of proposed equivalents will be received by Architect only from the Contractor.
- D. If the Architect approves a proposed equivalent prior to receipt of Bids, such approval will be set forth in an Addendum.
- E. After the bid opening the apparent low bidder or bidders will be notified by the Architect or Owner and shall submit to the Architect in writing, within ten (10) calendar days what equivalent kind, type, brand, or manufacture is included in bid in lieu of specified items. No equivalents will be considered after this submission.

- F. Contractor shall have burden of proving, at Contractor's own cost and expense, to satisfaction of Owner/Architect, that proposed product is similar and equal to named product. In making such determination Owner/Architect will be sole judge of objective and appearance criteria that proposed product must meet in order for it to be approved.
 - 1. Supporting data on equivalency is responsibility of bidder. For each equivalent to base specification, included in products list, submit information describing in specific detail:
 - a. Wherein it differs from quality and performance required by base specification.
 - b. Changes required in other elements of work because of equivalent.
 - c. Effect on construction schedule.
 - d. Any required license fees or royalties.
 - e. Availability of maintenance service, and source of replacement materials.
 - f. Such other information as may be required by Owner.
- G. Owner, through Architect, shall be judge of acceptability of proposed equivalents. Risk of whether bid equivalents will be accepted is borne by Contractor.
- H. Submission of an equivalent product and/or material constitutes a representation that Contractor:
 - 1. Has investigated proposed product and determined it is equal to or superior in all respects to that specified.
 - 2. Will provide same warranties or bonds for equivalent as for product specified.
 - 3. Will coordinate installation of an accepted equivalent into work and make such other changes as may be required to make work complete in all respects.
 - 4. Waives all claims for additional costs, under his responsibility, which may subsequently become apparent.
 - 5. Will provide, at own cost and expense, any different quantity and/or arrangement of ductwork, piping, wiring, conduit or any part of work from that specified, detailed or indicated in Contract Documents if required for proper installation of an approved equivalent.
 - 6. Will provide, at own cost and expense, all such revision and redesign and all new drawings and details required by Architect for approval if proposed equivalent product requires a revision or redesign of any part of work covered by this contract.
- I. Contractor must sign the "Equivalent Certification" following this specification section and deliver it to the Architect along with a complete list of proposed equivalents within ten (10) calendar days after notification from the Architect or Owner. This is mandatory and must be done prior to award of contracts.

1.05 APPLICABLE STANDARDS

- A. All equipment shall bear the UL label.
- B. The latest edition of the following minimum standards shall apply wherever applicable:
 - 1. American Standards Association
 - 2. American Society for Testing Materials
 - 3. Electrical Testing Laboratories, Inc.
 - 4. Institute of Electrical and Electronic Engineers
 - 5. Insulated Power Cable for Engineers Association
 - 6. Occupational Safety and Health Act
 - 7. National Electric Code
 - 8. National Electrical Manufacturers Association
 - 9. National Electrical Safety Code
 - 10. National Fire Protection Association
 - 11. Underwriters Laboratories, Inc.
 - 12. Power company standards and regulations.
 - 13. Local and state codes.

C. In the event there are conflicts between specifications and standards, standards shall govern unless specifications are in excess of standards.

1.06 PERMITS AND INSPECTIONS

- A. Permits: The Contractor shall apply for and pay the cost for any local permits necessary for the work of this contract.
- B. Inspections: The Contractor shall be responsible for obtaining a 3rd party electrical inspection of and the certificate by the approved inspection agency for the entire electrical system.
- C. The undertaking of periodic inspections by the Owner or Engineer shall not be construed as supervision of actual construction. The Owner or Engineer is not responsible for providing a safe place of work for the Contractor, Contractor's employees, suppliers or subcontractors for access, visits, use, work, travel or occupancy by any person.

1.07 CODES AND REGULATIONS

- A. Comply with all applicable rules and regulations of the municipal laws and ordinances and latest revisions thereof. All work shall be done in full conformity with the requirements of all authorities having jurisdiction. Modifications required by the above authorities will be made without additional charges to the Owner. Where alterations to and/or deviations from the Contract Documents are required by the authorities, report the requirements to the Engineer and secure approval before work is started.
- B. Furnish and file with the proper authorities, all drawings required by them in connection with the work. Obtain all permits, licenses, and inspections and pay all legal and proper fees and charges in this connection.
- C. Should any work shown or specified be of lighter or smaller material than Code requires, same shall be executed in strict accordance with the regulations.
- D. Heavier or larger size material than Code requires shall be furnished and installed, if required by the Plans and Specifications.
- E. This Contractor shall have the electrical work inspected from time to time by authorized inspectors and shall pay all expense incurred by same. At the completion of the work, the Contractor shall furnish a Certificate of Approval, in triplicate, indicating full approval of the work furnished and installed in this Contract from the local authority having jurisdiction.
- F. Equipment and components parts thereof shall bear manufacturer's name-plate, giving manufacturer's name, size, type and model number or serial number, electrical characteristic to facilitate maintenance and replacements. Name plates of distributors or contractors are not acceptable.
- G. Engineer will have privilege of stopping any work or use of any material that in his opinion is not being properly installed and each Contractor shall remove all materials delivered, or work erected, which does not comply with Contract Drawings and Specifications, and replace with proper materials, or correct such work as directed by the Engineer, at no additional cost to Owner.
- H. If equipment or materials are installed before proper approvals have been obtained, each Contractor shall be liable for their removal and replacement including work of other trades affected by such work, at no additional cost to Owner, if such items do not meet intent of the Drawings and Specifications.

1.08 RECORD DRAWINGS

- A. The Electrical Contractor shall keep an accurate location record of all underground and concealed piping, and of all changes from the original design. He is required to furnish this information to the Engineer prior to his application for final payment.
 - 1. Submit prior to final acceptance inspection, one complete marked-up set of reproducible engineering design drawings.
 - a. Fully illustrate all revisions made by all crafts in course of work.

- b. Include all field changes, adjustments, variances, substitutions and deletions, including all Change Orders.
- c. Exact location of raceways, equipment and devices.
- d. Exact size and location of underground and under floor raceways, grounding conductors and duct banks.
- e. These drawings shall be for record purposes for Owner's use and are not considered shop drawings.
- B. At completion of the project, all changes and deviations from the Contract Documents shall be recorded by the Contractor.
- C. Four (4) corrected sets of all operating and maintenance instructions and complete parts lists bound in hard covers shall be furnished to the Owner.

1.09 SLEEVES

- A. Sleeves: furnished, set in Electrical Work; built-in under General Construction Work.
- B. Sleeves shall be as follows:
 - 1. Sleeves in floors and partitions shall be galvanized steel with lock seam joints or a manufactured conduit floor seal.
 - 2. Sleeves of extra heavy cast iron pipe or galvanized steel pipe shall be used in outside walls, foundations, and footing or manufactured compression-type wall seal (waterproof).
 - 3. Conduit sleeves shall be two (2) sizes larger than the conduit passing through it.
 - 4. Terminate sleeves flush with walls, partitions, and ceilings. Sleeves in floor shall terminate 1/4" above floors.
 - 5. Fill space between sleeve and conduit in foundation walls with oakum and caulk with lead on both sides of wall. When using pipe sleeves, fill space between sleeve and pipe with fiberglass blanket insulation when sleeve does not occur in a foundation wall.
 - 6. An approved fire stop seal shall be used when conduits penetrate fire stopping walls and floors (between fire zone).
- C. Set sleeves, obtain review of their locations in ample time to permit pouring of concrete or progressing of other construction work as scheduled.

1.10 CLEANING CONDUIT, EQUIPMENT

A. Conduit, equipment: thoroughly cleaned of dirt, cuttings, other foreign substances. Should any conduit, other part of systems be stopped by any foreign matter, disconnect, clean wherever necessary for purpose of locating, removing obstructions. Repair work damaged in course of removing obstructions.

1.11 VIBRATION ISOLATION

- A. Vibration isolators shall prevent, as far as practicable, transmission of vibration, noise or hum to any part of building.
- B. Design isolators to suit vibration frequency to be absorbed; provide isolator units of area, distribution to obtain proper resiliency under machinery load, impact.
- C. Wiring and other electrical connections to equipment mounted on vibration isolators; made flexible with minimum 180 degree loop of "greenfield" in order to avoid restraining equipment and short circuiting vibration isolator.

1.12 BALANCED LOAD

- A. It is intended that design and features of the work as indicated will provide balanced load on the feeders and main service. Contractor shall provide material and installation to provide this balance load insofar as possible.
- B. Contractor shall take current and voltage measurements at all panels of at least 1/2 hour. Reconnections of loads shall be made when deemed necessary by the Engineers.

1.13 JOB CONDITIONS

- A. Examine site related work and surfaces before starting work of any Section. Failure to do so shall in no way relieve the Contractor of the responsibility to properly install the new work.
 - 1. Report to the Engineer, in writing, conditions, which will prevent proper provision of this work ten (10) days prior to bid date, in time for an addendum to be issued .
 - 2. Beginning work of any Section without reporting unsuitable conditions to the Engineer constitutes acceptance of conditions by the Contractor.
 - 3. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to Owner.
 - 4. The Contractor is responsible for performing routine maintenance and cleaning of any existing equipment where he is making connections to new work and to the building where his work adds debris.
- B. Connections to existing work:
 - 1. Install new work and connect to existing work with minimum interference to existing facilities.
 - 2. Provide temporary shutdowns of existing services only with written consent of Owner at no additional charges and at time not to interfere with normal operation of existing facilities.
 - 3. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
 - 4. Do not interrupt alarm and emergency systems.
 - 5. Connect new work to existing work in neat and acceptable manner.
 - 6. Restore existing disturbed work to original condition including maintenance of wiring and continuity as required. Replace damaged or rusted conduit to which new equipment is being installed and connected.
- C. Removal and relocation of existing work.
 - 1. Disconnect, remove or relocate electrical material, equipment and other work noted and required by removal or changes in existing construction.
 - 2. Provide new material and equipment required for relocated equipment.
 - 3. Disconnect load and line end of conductors feeding existing equipment.
 - 4. Remove conductors from existing raceways to be rewired.
 - 5. Remove conductors and cap outlets on raceways to be abandoned.
 - 6. Cut and cap abandoned floor raceways flush with concrete floor or behind walls and ceilings.
 - 7. Dispose of removed raceways and wire.
 - 8. Dispose of removed electrical equipment as directed by Owner. The Owner shall provide a list of equipment of the Contractor of equipment to be delivered to the Owner.

1.14 SPECIAL TOOLS AND LOOSE ITEMS

- A. Furnish to Owner at completion of work:
 - 1. One set of any special tools required to operate, adjust, dismantle or repair equipment furnished under any section of this Division.
 - 2. "Special Tools": Those not normally found in possession of mechanics or maintenance personnel.
 - 3. Keys
 - 4. Redundant components and spare parts.
- B. Deliver items to Owner and obtain receipt prior to approval of final payment.

1.15 REVIEW OF CONSTRUCTION

- A. Work may be reviewed at any time by representative of the Engineer.
- B. Advise Architect and Engineer that work is ready for review at following times:
 - 1. Prior to backfilling buried work.
 - 2. Prior to concealment of work in walls and above ceilings.
 - 3. When all requirements of contract have been completed.

C. Neither backfill nor conceal work without Engineer's consent.

1.16 SHOP DRAWING SUBMITTALS

- A. Submit required shop drawings, samples and product information in accordance with Division 1, requirements and as required in the various sections of these specifications.
- B. Submittals shall show evidence of checking by the Contractor for accuracy. Product information (catalog sheets) shall indicate complete catalog number, color, accessories, etc., as well as, name of manufacturer and local distributor or manufacturer's representative.
- C. Submit for review detailed coordination drawings 3/8" or larger scale plans for all major electrical equipment and any areas of conflicts by drafting location of equipment, lighting fixtures, cable trays and conduits larger than 1-1/2" trade size. Contractor shall refer to Division 1 for preparing coordination drawings.
- D. Incomplete submittals will be rejected.
- E. Additionally, the Contractor will submit data on the following:
 - 1. All electrical equipment including all panelboards and switching devices (disconnects, switches, occupancy sensors, etc.).
 - 2. Fire stop seals used for wall penetrations.
 - 3. Any proposed variation in specified wiring plans and circuitry.
 - 4. All special items and panels, made or constructed specifically for this project, including wiring diagrams, component layout and component data or materials list.
 - 5. All settings of installed equipment, such as overcurrent protection, overload settings, temperature settings, time settings, etc. This includes equipment provided by other contractors or subcontractors and connected and tested by this Contractor.
- F. All submittals of NON SPECIFIED equipment and components will be reviewed. It is the submitting Contractor's responsibility to prove compliance and not the Architect/Engineer to prove non-compliance. The submitting Contractor will be charged the prevailing wage of the reviewing Engineer for all submittals requiring over one (1) hour to review that were not originally specified.
- G. It is the Contractor's responsibility to provide submittals in an organized and timely manner so as not to delay the project schedule and hamper the work of other trades.

1.17 OPERATING INSTRUCTIONS

A. It shall be the Contractor's responsibility to insure that the Owner's representative is given adequate instruction on the operation of all equipment prior to final payment.

1.18 TEMPORARY POWER

A. The Contractor shall provide all temporary power to all trades throughout all phases of construction throughout the duration of this project. This will include but not be limited to temporary lighting, power outlets, temporary elevator operation, controls for temporary heating, and job trailers. Contractor shall be responsible for providing temporary power via adjacent building(s) and/or a temporary diesel fired generator and associated fuel costs. Contractor shall coordinate temporary power source with project manager prior to demolition. Contractor is responsible for all costs associated with temporary power.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All materials and equipment shall be new and as specified or of equal or better quality.
- B. Basic hardware and miscellaneous items shall meet existing trade standards of quality and shall carry UL or FM listings where applicable.
- C. All equipment supplied shall be the standard equipment of the manufacturer.
- D. Multiple items such as panelboards, wiring devices, switches, breakers, raceways, etc., shall be from the same manufacturer.

E. Drawings and specifications are based on specific manufacturer's equipment. Therefore, the Contractor shall assume all responsibility, cost and coordination involved in making any necessary revisions to apply another manufacturer's equipment, even though it may be approved as an "equal" item by the Engineer.

PART 3 EXECUTION

3.01 COORDINATION OF WORK

- A. All work shall be executed in accordance with recognized standards of workmanship. All work shall be installed in a neat and orderly manner.
- B. The Contractor shall exchange information with other Contractors and the Owner in order to insure orderly progress of the work.
- C. The Contractor must contact the Owner's representative and schedule all work ten (10) days prior to start.
- D. The Contractor shall check for possible interference before installing any items. If any work is installed, and later develops interference with other features of the design, the Contractor will be responsible to make such changes to eliminate the interference.

3.02 CEILING REMOVAL

- A. Existing ceilings which must be removed for the installation of new work or demolition of existing conditions shall be done by the Contractor. No ceiling shall be removed without prior approval of the Owner. Ceilings which must be removed shall be restored to their original condition as soon as practical and prior to final payment.
- B. The removed tile of lay-in type ceilings shall be stored either in the ceiling space or at a designated space in the building. No tiles shall be stored in the occupied space.
- C. The Contractor shall take all necessary precautions to prevent damage to the existing ceilings. All damaged ceilings shall be replaced with new ceiling construction to match the existing and to the Owner's satisfaction.

This page intentionally left blank

SECTION 260505 SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

1.02 RELATED REQUIREMENTS

A. Section 017000 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Demolition drawings are based on casual field observation and existing record documents.
- C. Report discrepancies to Architect before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 48 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.
 - 3. Make notifications at least 48 hours in advance.
 - 4. Make temporary connections to maintain service in areas adjacent to work area.
- F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner at least 48 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. See Section 017419 Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

SECTION 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Metal-clad cable.
- C. Wiring connectors.
- D. Electrical tape.
- E. Heat shrink tubing.
- F. Wire pulling lubricant.
- G. Cable ties.
- H. Firestop sleeves.

1.02 RELATED REQUIREMENTS

- A. Section 078400 Firestopping.
- B. Section 260526 Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 260553 Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. ASTM B3 Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).
- B. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.
- C. ASTM B33 Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
- D. ASTM B787/B787M Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).
- E. ASTM D3005 Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.
- F. ASTM D4388 Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2020.
- G. NECA 1 Standard for Good Workmanship in Electrical Construction; 2023.
- H. NECA 120 Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable; 2018.
- I. NEMA WC 70 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.
- J. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- K. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 44 Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- M. UL 83 Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- N. UL 267 Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.
- O. UL 486A-486B Wire Connectors; Current Edition, Including All Revisions.

260519

- P. UL 486C Splicing Wire Connectors; Current Edition, Including All Revisions.
- Q. UL 486D Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- R. UL 510 Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- S. UL 1569 Metal-Clad Cables; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
- 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
- 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- D. Field Quality Control Test Reports.
- E. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.

260519

14457.20

CABLES

- b. Where concealed in hollow stud walls and above accessible ceilings for branch circuits up to 20 A.
- 2. In addition to other applicable restrictions, may not be used:
 - a. Where exposed to damage.
 - b. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- H. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 100 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
- I. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- J. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 - 3. Color Code:
 - a. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - b. Equipment Ground, All Systems: Green.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. General Cable Technologies Corporation: www.generalcable.com/#sle.
 - d. Service Wire Co: www.servicewire.com/#sle.

SOUTH ORANGETOWN CSD

14457.20 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND

- e. Southwire Company: www.southwire.com/#sle.
- f. Substitutions: See Section 016000 Product Requirements.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2.

2.04 METAL-CLAD CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 - 2. Encore Wire Corporation: www.encorewire.com/#sle.
 - 3. Service Wire Co: www.servicewire.com/#sle.
 - 4. Southwire Company: www.southwire.com/#sle.
 - 5. Substitutions: See Section 016000 Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- F. Provide dedicated neutral conductor for each phase conductor where indicated or required.
- G. Grounding: Full-size integral equipment grounding conductor.
- H. Armor: Steel, interlocked tape.
- I. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.05 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 260526.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.

14457.20

- 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
- 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
- 6. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
- G. Push-in Wire Connectors: Rated 600 V, 221 degrees F.
 - 1. Manufacturers:
 - a. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - b. NSI Industries LLC: www.nsiindustries.com/#sle.
 - c. Wago Corporation: www.wago.us/#sle.
- H. Mechanical Connectors: Provide bolted type.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Ilsco: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Ilsco: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Ilsco: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.

2.06 ACCESSORIES

- A. Electrical Tape:
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Plymouth Rubber Europa: www.plymouthrubber.com/#sle.
 - c. Substitutions: See Section 016000 Product Requirements.
 - 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.

14457.20

- Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying 3. with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with 4. ASTM D4388: minimum thickness of 30 mil: suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
- Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 5. mil; suitable for continuous temperature environment up to 176 degrees F.
- Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-6. weather vinyl backing; minimum thickness of 90 mil.
- Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; Β. suitable for direct burial applications; listed as complying with UL 486D.
- C. Wire Pulling Lubricant:
 - Manufacturers: 1.
 - a. 3M: www.3m.com/#sle.
 - American Polywater Corporation: www.polywater.com/#sle. b.
 - Ideal Industries. Inc: www.idealindustries.com/#sle. C.
 - Substitutions: See Section 016000 Product Requirements. d.
 - 2. Listed and labeled as complying with UL 267.
 - Suitable for use with conductors/cables and associated insulation/jackets to be installed. 3.
 - Suitable for use at installation temperature. 4.
 - Products: 5.
 - American Polywater Corporation; Polywater J Cable Pulling Lubricant: a. www.polvwater.com/#sle.
 - American Polywater Corporation; Polywater LZ Cable Pulling Lubricant: b. www.polywater.com/#sle.
- D. Cable Ties: Material and tensile strength rating suitable for application.
 - Manufacturers: 1.
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- Sealing Systems for Roof Penetrations: Premanufactured components and accessories as E. required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.
 - Products: 1.
 - Menzies Metal Products; Electrical Roof Stack and Cap: www.menziesa. metal.com/#sle.
 - Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle. b
 - Substitutions: See Section 016000 Product Requirements. C.
- Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building F. elements.
 - Products: 1.
 - HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro а Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - Substitutions: See Section 016000 Product Requirements. b.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.

260519

CABLES

- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 - 5. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
 - 6. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install metal-clad cable (Type MC) in accordance with NECA 120.
- E. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
- H. Terminate cables using suitable fittings.
 - Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- I. Install conductors with a minimum of 12 inches of slack at each outlet.

1.

- J. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- K. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- L. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- M. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
- N. Insulate ends of spare conductors using vinyl insulating electrical tape.
- O. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- P. Identify conductors and cables in accordance with Section 260553.
- Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

SECTION 260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.

1.02 RELATED REQUIREMENTS

- A. Section 260519 Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 260553 Identification for Electrical Systems: Identification products and requirements.
- C. Section 265600 Exterior Lighting: Additional grounding and bonding requirements for polemounted luminaires.

1.03 REFERENCE STANDARDS

- A. IEEE 81 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.
- B. NECA 1 Standard for Good Workmanship in Electrical Construction; 2023.
- C. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- D. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 467 Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:

- 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
- 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- F. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
- G. Bonding and Equipment Grounding:
 - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 - 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 - 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 - 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 - 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 - 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

- 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
- 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
- 4. Manufacturers Mechanical and Compression Connectors:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Harger Lightning & Grounding: www.harger.com/#sle.
 - c. nVent ERICO: www.nvent.com/#sle.
 - d. Thomas & Betts Corporation: www.tnb.com/#sle.
- 5. Manufacturers Exothermic Welded Connections:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. nVent ERICO; Cadweld: www.nvent.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

This page intentionally left blank

SECTION 260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260533.13 Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- C. Section 260533.16 Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- D. Section 262513 Low-Voltage Busways: Additional support and attachment requirements for busway.
- E. Section 265100 Interior Lighting: Additional support and attachment requirements for interior luminaires.
- F. Section 265600 Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- D. MFMA-4 Metal Framing Standards Publication; 2004.
- E. NECA 1 Standard for Good Workmanship in Electrical Construction; 2023.
- F. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
 - 4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 033000.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.06 QUALITY ASSURANCE

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
 - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
 - 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. nVent; Caddy: www.nvent.com/#sle.
 - f. Substitutions: See Section 016000 Product Requirements.
 - 2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 3. Conduit Clamps: Bolted type unless otherwise indicated.
 - 4. Products:
 - a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
 - b. Gripple, Inc; Fast Trak: www.gripple.com/#sle.
 - c. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
 - d. Gripple, Inc; Low Profile Bracket Kits: www.gripple.com/#sle.
 - e. Substitutions: See Section 016000 Product Requirements.

- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. nVent; Caddy: www.nvent.com/#sle.
 - f. Substitutions: See Section 016000 Product Requirements.
- D. Metal Channel/Strut Framing Systems:
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - c. Custom Strut and Roll Forming, LLC: www.customstrut.com/#sle.
 - d. Eaton Corporation: www.eaton.com/#sle.
 - e. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
 - f. Substitutions: See Section 016000 Product Requirements.
 - g. Source Limitations: Furnish channel/strut and associated fittings, accessories, and hardware produced by single manufacturer.
 - 2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 - 3. Comply with MFMA-4.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch diameter.
 - b. Busway Supports: 1/2-inch diameter.
 - c. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - d. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - e. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
 - f. Outlet Boxes: 1/4-inch diameter.
 - g. Luminaires: 1/4-inch diameter.
- F. Anchors and Fasteners:
 - 1. Manufacturers Mechanical Anchors:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 016000 Product Requirements.
 - 2. Manufacturers Powder-Actuated Fastening Systems:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 016000 Product Requirements.
 - 3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
 - 4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 6. Hollow Masonry: Use toggle bolts.
 - 7. Hollow Stud Walls: Use toggle bolts.
 - 8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 - 9. Sheet Metal: Use sheet metal screws.

- 10. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 - 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Conduit Support and Attachment: See Section 260533.13 for additional requirements.
- I. Busway Support and Attachment: See Section 262513 for additional requirements.
- J. Interior Luminaire Support and Attachment: See Section 265100 for additional requirements.
- K. Exterior Luminaire Support and Attachment: See Section 265600 for additional requirements.
- L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- M. Secure fasteners in accordance with manufacturer's recommended torque settings.
- N. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

SECTION 260533.13 CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Stainless steel rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Galvanized steel electrical metallic tubing (EMT).
- F. Stainless steel electrical metallic tubing (EMT).

1.02 RELATED REQUIREMENTS

- A. Section 078400 Firestopping.
- B. Section 260519 Low-Voltage Electrical Power Conductors and Cables: Cable assemblies consisting of conductors protected by integral metal armor.
- C. Section 260526 Grounding and Bonding for Electrical Systems.
 1. Includes additional requirements for fittings for grounding and bonding.
- D. Section 260529 Hangers and Supports for Electrical Systems.
- E. Section 260533.16 Boxes for Electrical Systems.
- F. Section 260553 Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.
- B. ANSI C80.3 American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.
- C. NECA 1 Standard for Good Workmanship in Electrical Construction; 2023.
- D. NECA 101 Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.
- E. NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- F. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 1 Flexible Metal Conduit; Current Edition, Including All Revisions.
- H. UL 6 Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- I. UL 6A Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- J. UL 360 Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.
- K. UL 514B Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- L. UL 746C Polymeric Materials Use in Electrical Equipment Evaluations; Current Edition, Including All Revisions.
- M. UL 797 Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- N. UL 797A Electrical Metallic Tubing Aluminum and Stainless Steel; Current Edition, Including All Revisions.
- O. UL 2419 Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
- 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
- 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
- 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
- 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

1.06 QUALITY ASSURANCE

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Concealed Within Hollow Stud Walls: Use galvanized steel electrical metallic tubing (EMT).
- D. Concealed Above Accessible Ceilings: Use galvanized steel electrical metallic tubing (EMT).
- E. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC).
- F. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).
- G. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- H. Exposed, Interior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).
 - 1. Locations subject to severe physical damage include, but are not limited to:
 - a. High traffic industrial and warehouse areas where exposed below 8 feet, except within electrical and communication rooms or closets.
 - b. Where exposed below 20 feet in industrial manufacturing areas.
- I. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).
- J. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).

2.02 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Fittings for Grounding and Bonding: See Section 260526 for additional requirements.
- D. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 3/4-inch trade size.
 - 2. Branch Circuit Homeruns: 3/4-inch trade size.
 - 3. Flexible Connections to Luminaires: 3/8-inch trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular.com/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 - 5. Substitutions: See Section 016000 Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. Substitutions: See Section 016000 Product Requirements.
 - 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 - 2. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
 - 3. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.
 - 1. Material: Type 304 or 316 stainless steel.
- C. Fittings:
 - 1. Manufacturers:
 - a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 - b. Eaton: www.eaton.com/#sle.

- c. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
- d. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
- e. Substitutions: See Section 016000 Product Requirements.
- 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
- 3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
- 4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.

2.07 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 - 5. Substitutions: See Section 016000 Product Requirements.

- B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. _____
 - f. Substitutions: See Section 016000 Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use compression/gland type.
 - a. Do not use indenter type connectors and couplings.

2.08 STAINLESS STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 - 2. Substitutions: See Section 016000 Product Requirements.
- B. Description: NFPA 70, Type EMT stainless steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797A.
- C. Fittings:
 - 1. Manufacturers:
 - a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 - b. Substitutions: See Section 016000 Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
 - 4. Connectors and Couplings: Use compression/gland type.

2.09 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- E. Adhesive for HDPE and RTRC Conduit:
 - Specifically designed for bonding dissimilar materials in lieu of transition fittings, including but not limited to polyethylene, fiberglass, PVC, aluminum, and steel; UL 746C recognized.
 - 2. Approved by adhesive manufacturer for use with materials to be joined.
- F. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- G. Sealing Systems for Concrete Penetrations:
 - 1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
 - 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
 - 3. Products:

- a. American Polywater Corporation; PZVR Cement-Coated Concrete Wall Sleeves: www.polywater-haufftechnik.com/#sle.
- b. American Polywater Corporation; PHSD Mechanical Seals: www.polywaterhaufftechnik.com/#sle.
- c. American Polywater Corporation; PHSI 150 Varia Double Wall Inserts: www.polywater-haufftechnik.com/#sle.
- d. American Polywater Corporation; PGKD Modular Seals: www.polywaterhaufftechnik.com/#sle.
- e. Substitutions: See Section 016000 Product Requirements.
- H. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
 - 1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menziesmetal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
 - c. Substitutions: See Section 016000 Product Requirements.
- I. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
 - 1. Products:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
 - b. Substitutions: See Section 016000 Product Requirements.
- J. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
 - 1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - b. Substitutions: See Section 016000 Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - 5. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 6. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
- 7. Arrange conduit to provide no more than 150 feet between pull points.
- 8. Route conduits above water and drain piping where possible.
- 9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
- 10. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
- E. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 - 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 - 5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 - 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 - 7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
 - 8. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
 - 9. Use of spring steel conduit clips for support of conduits is not permitted.
 - a. Support of electrical metallic tubing (EMT) up to 1-inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.
 - 10. Use of wire for support of conduits is not permitted.
 - 11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.
- F. Connections and Terminations:
 - 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 - 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 - 3. Use suitable adapters where required to transition from one type of conduit to another.
 - 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 - 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 - 6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
 - 7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
 - 8. Secure joints and connections to provide mechanical strength and electrical continuity.
- G. Penetrations:
 - 1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 - 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 - 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 - 4. Conceal bends for conduit risers emerging above ground.
 - 5. Provide suitable sealing system where conduits penetrate exterior wall below grade.

- 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
- 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
- 8. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 078400.
- H. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
 - 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 - 2. Where conduits are subject to earth movement by settlement or frost.
- I. Conduit Sealing:
 - 1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
 - 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- J. Provide grounding and bonding; see Section 260526.
- K. Identify conduits; see Section 260553.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

SECTION 260533.16 BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.

1.02 RELATED REQUIREMENTS

- A. Section 078400 Firestopping.
- B. Section 083100 Access Doors and Panels: Panels for maintaining access to concealed boxes.
- C. Section 260529 Hangers and Supports for Electrical Systems.
- D. Section 260533.13 Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- E. Section 260553 Identification for Electrical Systems: Identification products and requirements.
- F. Section 262726 Wiring Devices:
 - 1. Wall plates.
 - 2. Additional requirements for locating boxes for wiring devices.
- G. Section 271000 Structured Cabling: Additional requirements for communications systems outlet boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 Standard for Good Workmanship in Electrical Construction; 2023.
- B. NECA 130 Standard for Installing and Maintaining Wiring Devices; 2016.
- C. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- D. NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- E. NEMA OS 1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).
- F. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A Metallic Outlet Boxes; Current Edition, Including All Revisions.
- K. UL 1203 Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
- 4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
- 5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
- 6. Coordinate the work with other trades to preserve insulation integrity.
- 7. Coordinate the work with other trades to provide walls suitable for installation of flushmounted boxes where indicated.
- 8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 Product Requirements, for additional provisions.
 - 2. Keys for Lockable Enclosures: Two of each different key.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 - 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 - 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 - 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 - 3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
 - 4. Use suitable concrete type boxes where flush-mounted in concrete.

- 5. Use suitable masonry type boxes where flush-mounted in masonry walls.
- 6. Use raised covers suitable for the type of wall construction and device configuration where required.
- 7. Use shallow boxes where required by the type of wall construction.
- 8. Do not use "through-wall" boxes designed for access from both sides of wall.
- 9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
- 10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
- 11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
- 12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
- 13. Wall Plates: Comply with Section 262726.
- 14. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
 - c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
 - f. Substitutions: See Section 016000 Product Requirements.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
 - 1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 - 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 - 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 - 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 - 5. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
 - 1. Locate boxes to be accessible. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
 - 2. Unless dimensioned, box locations indicated are approximate.
 - Locate boxes as required for devices installed under other sections or by others.
 a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 262726.
 - b. Communications Systems Outlets: Comply with Section 271000.
 - 4. Locate boxes so that wall plates do not span different building finishes.
 - 5. Locate boxes so that wall plates do not cross masonry joints.
 - 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 8. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260533.13.
 - 9. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
 - Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
 - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 - 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 - 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.

- M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- O. Close unused box openings.
- P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- Q. Provide grounding and bonding in accordance with Section 260526.
- R. Identify boxes in accordance with Section 260553.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

This page intentionally left blank

SECTION 260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Warning signs and labels.

1.02 RELATED REQUIREMENTS

- A. Section 099113 EXTERIOR PAINTING.
- B. Section 099123 Interior Painting.
- C. Section 260519 Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 262726 Wiring Devices Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- E. Section 271000 Structured Cabling: Identification for communications cabling and devices.

1.03 REFERENCE STANDARDS

- A. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 969 Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

- 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
- 2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.

a. Panelboards:

- 1) Identify ampere rating.
- 2) Identify voltage and phase.
- 3) Identify power source and circuit number. Include location when not within sight of equipment.
- 4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
- 5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
- 2. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
- 3. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
- 4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
- 5. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
- 6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
- 7. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
- 8. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
- C. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
 - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 - 3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
 - 4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
- D. Identification for Raceways:
 - 1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
 - 2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
 - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Color Code:
 - 2) Field-Painting: Comply with Section 099123 and 099113.
 - 3) Vinyl Color Coding Electrical Tape: Comply with Section 260519.

- 3. Use identification labels or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
- E. Identification for Boxes:
 - 1. Use voltage markers to identify highest voltage present.
 - 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 099123 and 099113 per the same color code used for raceways.
 - 3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- F. Identification for Devices:
 - 1. Identification for Communications Devices: Comply with Section 271000.
 - 2. Wiring Device and Wallplate Finishes: Comply with Section 262726.
 - 3. Factory Pre-Marked Wallplates: Comply with Section 262726.
 - 4. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
 - 5. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
 - 6. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
- G. Identification for Luminaires:
 - 1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 - 1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com/#sle.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - c. Seton Identification Products: www.seton.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - 2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 - 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically nonconductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
 - 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 - 5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laseretched text.
 - 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

- B. Identification Labels:
 - 1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 - d. Substitutions: See Section 016000 Product Requirements.
 - 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
 - 1. Minimum Size: 1 inch by 2.5 inches.
 - 2. Legend:
 - a. Equipment designation or other approved description.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height:
 - a. Equipment Designation: 1/2 inch.
 - 5. Color:
 - a. Normal Power System: White text on black background.
 - 1) 208Y/120 V, 3 Phase Equipment: White text on Black background.
 - b. Emergency Power System: White text on red background.
- D. Format for Receptacle Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Power source and circuit number or other designation indicated.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Black text on clear background.
- E. Format for Fire Alarm Device Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Designation indicated and device zone or address.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Red text on white background.

2.03 WIRE AND CABLE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradyid.com/#sle.
 - 2. HellermannTyton: www.hellermanntyton.com/#sle.
 - 3. Panduit Corp: www.panduit.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- D. Minimum Size:
 - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- E. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
- F. Color: Black text on orange background unless otherwise indicated.

2.05 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.brimar.com/#sle.
 - 2. Clarion Safety Systems, LLC: www.clarionsafety.com/#sle.
 - 3. Insite Solutions, LLC: www.stop-painting.com/#sle.
 - 4. Seton Identification Products: www.seton.com/#sle.
 - 5. Substitutions: See Section 016000 Product Requirements.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- D. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or selfadhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.

- 2. Flush-Mounted Equipment: Inside of equipment door.
- 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
- 4. Elevated Equipment: Legible from the floor or working platform.
- 5. Branch Devices: Adjacent to device.
- 6. Interior Components: Legible from the point of access.
- 7. Conduits: Legible from the floor.
- 8. Boxes: Outside face of cover.
- 9. Conductors and Cables: Legible from the point of access.
- 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Secure rigid signs using stainless steel screws.
- G. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

SECTION 260583 WIRING CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

- A. Section 260519 Low-Voltage Electrical Power Conductors and Cables.
- B. Section 260533.13 Conduit for Electrical Systems.
- C. Section 260533.16 Boxes for Electrical Systems.
- D. Section 262726 Wiring Devices.
- E. Section 262816.16 Enclosed Switches.

1.03 REFERENCE STANDARDS

- A. NEMA WD 1 General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- B. NEMA WD 6 Wiring Devices Dimensional Specifications; 2021.
- C. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Wiring Devices: As specified in Section 262726.
- B. Flexible Conduit: As specified in Section 260533.13.
- C. Wire and Cable: As specified in Section 260519.
- D. Boxes: As specified in Section 260533.16.

2.02 EQUIPMENT CONNECTIONS

- A. HVAC Equipment:
 - 1. Electrical Connection: Flexible conduit.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

SECTION 260923 LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Occupancy sensors.
- B. Daylighting controls.

1.02 RELATED REQUIREMENTS

- A. Section 260526 Grounding and Bonding for Electrical Systems.
- B. Section 260529 Hangers and Supports for Electrical Systems
- C. Section 260533.16 Boxes for Electrical Systems.
- D. Section 260553 Identification for Electrical Systems: Identification products and requirements.
- E. Section 262726 Wiring Devices: Devices for manual control of lighting, including wall switches and wall dimmers.
- F. Section 265100 Interior Lighting.

1.03 REFERENCE STANDARDS

- A. NECA 1 Standard for Good Workmanship in Electrical Construction; 2023.
- B. NECA 130 Standard for Installing and Maintaining Wiring Devices; 2016.
- C. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
 - 3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
 - 4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
 - 5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install lighting control devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
 - 1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.
- C. Shop Drawings:
 - 1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
 - 2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.

- D. Field Quality Control Reports.
- E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Include detailed information on device programming and setup.
- G. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.02 OCCUPANCY SENSORS

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 - 3. RAB Lighting, Inc: www.rablighting.com/#sle.
 - 4. Sensor Switch Inc: www.sensorswitch.com/#sle.
 - 5. WattStopper: www.wattstopper.com/#sle.
 - 6. Substitutions: See Section 016000 Product Requirements.
 - 7. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. All Occupancy Sensors:
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:
 - a. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.
 - 3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.

- 4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
- 5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
- 6. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
- 7. Sensitivity: Field adjustable.
- 8. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
- 9. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, lowvoltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
- C. Wall Switch Occupancy Sensors:
 - 1. All Wall Switch Occupancy Sensors:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
 - b. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
 - c. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
 - d. Finish: Match finishes specified for wiring devices in Section 262726, unless otherwise indicated.
 - 2. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
- D. Ceiling Mounted Occupancy Sensors:
 - 1. All Ceiling Mounted Occupancy Sensors:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - c. Provide field selectable setting for disabling LED motion detector visual indicator.
 - d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
 - 2. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
- E. Power Packs for Low Voltage Occupancy Sensors:
 - 1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
 - 2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
 - 3. Input Supply Voltage: Dual rated for 120/277 V ac.
 - 4. Load Rating: As required to control the load indicated on drawings.

2.03 DAYLIGHTING CONTROLS

- A. Manufacturers:
 - 1. Hubbell Control Solutions: www.hubbell.com/hubbellcontrolsolutions/en/#sle.Hubbell Control Solutions: www.hubbell.com/hubbellcontrolsolutions/en/#sle.Hubbell Control Solutions: www.hubbell.com/hubbellcontrolsolutions/en/#sle.
 - 2. Lutron Electronics Company, Inc: www.lutron.com/#sle.

- 3. Sensor Switch Inc: www.sensorswitch.com/#sle.
- 4. WattStopper: www.wattstopper.com/#sle.
- 5. Substitutions: See Section 016000 Product Requirements.
- 6. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.
- C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.
 - 1. Sensor Type: Filtered silicon photo diode.
 - 2. Sensor Range:
 - a. Indoor Photo Sensors: 5 to 100 footcandles.
 - 3. Finish: White unless otherwise indicated.
- D. Dimming Photo Sensors: Photo sensor units with integral controller compatible with specified dimming ballasts, for direct continuous dimming of up to 50 ballasts.
- E. Daylighting Control Switching Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors, for switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
 - 1. Operation: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with a no switching dead band between set points to prevent unwanted cycling.
 - 2. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
 - 3. Control Capability:
 - a. Single Zone Switching Modules: Capable of controlling one programmable channel.
 - b. Multi-Zone Switching Modules: Capable of controlling up to three separately programmable channels.
- F. Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming ballasts, for both continuous dimming of compatible dimming ballasts and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
 - 1. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
 - 2. Control Capability: Capable of controlling up to three separately programmable channels, with up to 50 ballasts per channel.
 - 3. Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
 - 4. Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.
- G. Power Packs for Low Voltage Daylighting Control Modules:
 - 1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage daylighting control modules for switching of line voltage loads. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
 - 2. Input Supply Voltage: Dual rated for 120/277 V ac.
 - 3. Load Ratings: As required to control the load indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of lighting control devices provided under this section.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- E. Install lighting control devices plumb and level, and held securely in place.
- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.
- G. Provide required supports in accordance with Section 260529.
- H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- I. Identify lighting control devices in accordance with Section 260553.
- J. Occupancy Sensor Locations:
 - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
 - 2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.
- K. Daylighting Control Photo Sensor Locations:
 - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for proper control of respective room or area based on manufacturer's recommendations for installed devices.
 - 2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.

- 3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.
- L. Lamp Burn-In: Operate lamps at full output for minimum of 100 hours or prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.
- M. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
- E. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
- D. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 017800 Closeout Submittals, for closeout submittals.
- B. See Section 017900 Demonstration and Training, for additional requirements.

SECTION 262416 PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

- A. Section 260526 Grounding and Bonding for Electrical Systems.
- B. Section 260529 Hangers and Supports for Electrical Systems.
- C. Section 260553 Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).
- B. NECA 1 Standard for Good Workmanship in Electrical Construction; 2023.
- C. NECA 407 Standard for Installing and Maintaining Panelboards; 2015.
- D. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- E. NEMA PB 1 Panelboards; 2011.
- F. NEMA PB 1.1 General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000 Volts or Less; 2023.
- G. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- H. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 50E Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 67 Panelboards; Current Edition, Including All Revisions.
- L. UL 489 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flushmounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.
- E. Field Quality Control Test Reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 See Section 016000 Product Requirements, for additional provisions.
 - 2. Panelboard Keys: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB/GE: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- E. Substitutions: See Section 016000 Product Requirements.
- F. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- J. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.03 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

- 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Aluminum.
 - 2. Ground Bus Material: Aluminum.
- D. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
- E. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
 - 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
 - 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 4. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

2.05 SOURCE QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 260529.
- F. Install panelboards plumb.

- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Provide grounding and bonding in accordance with Section 260526.
- J. Install all field-installed branch devices, components, and accessories.
- K. Provide filler plates to cover unused spaces in panelboards.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than _____ amperes. Tests listed as optional are not required.
- D. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

This page intentionally left blank

SECTION 262726 WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.

1.02 RELATED REQUIREMENTS

- A. Section 260519 Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- B. Section 260526 Grounding and Bonding for Electrical Systems.
- C. Section 260533.16 Boxes for Electrical Systems.
- D. Section 260553 Identification for Electrical Systems: Identification products and requirements.
- E. Section 260923 Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 Connector, Electrical, Power, General Specification for; 2014h (Validated 2022).
- B. FS W-S-896 Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2017g, with Amendment.
- C. NECA 1 Standard for Good Workmanship in Electrical Construction; 2023.
- D. NECA 130 Standard for Installing and Maintaining Wiring Devices; 2016.
- E. NEMA WD 1 General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- F. NEMA WD 6 Wiring Devices Dimensional Specifications; 2021.
- G. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 20 General-Use Snap Switches; Current Edition, Including All Revisions.
- I. UL 498 Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- J. UL 514D Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- K. UL 943 Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- L. UL 1472 Solid-State Dimming Controls; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
 - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:

1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Operation and Maintenance Data:
 - 1. Wall Dimmers: Include information on operation and setting of presets.
 - 2. GFCI Receptacles: Include information on status indicators.
- E. Project Record Documents: Record actual installed locations of wiring devices.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 Product Requirements, for additional provisions.
 - 2. Extra Wall Plates: Five of each style, size, and finish.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide tamper resistant receptacles for receptacles installed in dwelling units.
- E. Provide GFCI protection for receptacles installed within 6 feet of sinks.
- F. Provide GFCI protection for receptacles installed in kitchens.
- G. Provide GFCI protection for receptacles serving electric drinking fountains.
- H. Unless noted otherwise, do not use combination switch/receptacle devices.

2.02 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: White with stainless steel wall plate.
- C. Wiring Devices Installed in Finished Spaces: White with stainless steel wall plate.
- D. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
- E. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.

2.03 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.

- B. Wall Switches General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with decorator style rocker type switch actuator and maintained contacts; as indicated on the drawings.

2.04 WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 - 2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
- B. Wall Dimmers General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

2.05 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 - 3. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
 - 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 - 5. Substitutions: See Section 016000 Product Requirements.
 - 6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Receptacles General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
 - 1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 - Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
 - 1. GFCI Receptacles General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 - 2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 - Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.06 WALL PLATES

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.
 - 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 - 3. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 - 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 - 5. Substitutions: See Section 016000 Product Requirements.
 - 6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard.
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- E. Weatherproof Covers for Wet Locations: Gasketed, thermoplastic, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of wiring devices provided under this section.
 - 1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 2. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 - 3. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.

- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.
- K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Identify wiring devices in accordance with Section 260553.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

This page intentionally left blank

SECTION 265100 INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Emergency lighting units.
- C. Exit signs.
- D. Ballasts and drivers.
- E. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 260529 Hangers and Supports for Electrical Systems.
- B. Section 260533.16 Boxes for Electrical Systems.
- C. Section 260553 Identification for Electrical Systems: Identification products and requirements.
- D. Section 260923 Lighting Control Devices.
- E. Section 262726 Wiring Devices: Manual wall switches and wall dimmers.

1.03 REFERENCE STANDARDS

- A. IES LM-63 Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information; 2019.
- B. IES LM-79 Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products; 2019.
- C. IES LM-80 Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources; 2021.
- D. NECA 1 Standard for Good Workmanship in Electrical Construction; 2023.
- E. NECA/IESNA 500 Standard for Installing Indoor Lighting Systems; 2006.
- F. NECA/IESNA 502 Standard for Installing Industrial Lighting Systems; 2006.
- G. NEMA 410 Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2023.
- H. NEMA LE 4 Recessed Luminaires, Ceiling Compatibility; 2023.
- I. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. NFPA 101 Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 924 Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- L. UL 1598 Luminaires; Current Edition, Including All Revisions.
- M. UL 8750 Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.

- 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
- 3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
- 4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 - 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
 - 2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
- D. Field quality control reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Provide 3-year manufacturer warranty for LED luminaires, including drivers.
- C. Provide 5-year pro-rata warranty for batteries for emergency lighting units.
D. Provide 10-year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 016000 Product Requirements.

2.02 LUMINAIRES

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - 2. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - 3. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
 - 4. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 - 5. Philips Lighting North America Corporation: www.lightingproducts.philips.com/#sle.
 - 6. RAB Lighting, Inc: www.rablighting.com/#sle.
 - 7. Substitutions: See Section 016000 Product Requirements.
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
- I. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- J. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 EMERGENCY LIGHTING UNITS

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - 2. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - 3. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
 - 4. Substitutions: See Section 016000 Product Requirements.
- B. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- C. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- D. Battery:

- 1. Sealed maintenance-free lead calcium unless otherwise indicated.
- 2. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- F. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
- H. Accessories:
 - 1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
 - 2. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.04 EXIT SIGNS

- A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single- or double-face as indicated or as required for installed location.
 - 2. Directional Arrows: As indicated or as required for installed location.
- B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.
 - 1. Manufacturers:
 - a. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - b. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - c. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
 - d. Philips Lighting North America Corporation: www.lightingproducts.philips.com/#sle.
 - e. Substitutions: See Section 016000 Product Requirements.
- C. Accessories:
 - 1. Provide compatible accessory high-impact polycarbonate vandal shields where indicated.
 - 2. Provide compatible accessory wire guards where indicated.

2.05 BALLASTS AND DRIVERS

- A. Manufacturers:
 - 1. Alloy LED: www.alloyled.com/#sle.
 - 2. California Accent Lighting, Inc: www.calilighting.com/#sle.
 - 3. General Electric Company/GE Lighting: www.gelighting.com/#sle.
 - 4. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 - 5. OSRAM Sylvania, Inc: www.osram.us/ds/#sle.
 - 6. Philips Lighting North America Corporation: www.usa.lighting.philips.com/#sle.
 - 7. Substitutions: See Section 016000 Product Requirements.
 - 8. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.
 - 9. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.
- B. Ballasts/Drivers General Requirements:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
 - 3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.
- C. Dimmable LED Drivers:

- 1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
- Control Compatibility: Fully compatible with the dimming controls to be installed.
 a. Daylighting Controls: See Section 260923.

2.06 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.
- C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.
- PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of luminaires provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- E. Provide required support and attachment in accordance with Section 260529.
- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
 - 4. Secure pendant-mounted luminaires to building structure.
 - 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
 - 7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- H. Recessed Luminaires:

- 1. Install trims tight to mounting surface with no visible light leakage.
- I. Install accessories furnished with each luminaire.
- J. Bond products and metal accessories to branch circuit equipment grounding conductor.
- K. Emergency Lighting Units:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
- L. Exit Signs:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
- E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
- C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.06 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 017800 Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

REQUIREMENTS FOR COMMUNICATIONS SYSTEMS

270511

SECTION 27 05 11

REQUIREMENTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

- A. This Section, Requirements for Communications Installations, applies to all sections of Division 27.
- B. Furnish and install communications cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, and other items and arrangements for the specified items are shown on drawings.

1.02 MINIMUM REQUIREMENTS

- A. References to industry and trade association standards and codes are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.03 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
 - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
 - 2. The Owner reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.04 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and with the total assembly for the intended service.

REQUIREMENTS FOR COMMUNICATIONS SYSTEMS

270511

- 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
 - 1. The Owner shall have the option of witnessing factory tests. The contractor shall notify the Owner a minimum of 15 working days prior to the manufacturers making the factory tests.
 - 2. Four copies of certified test reports containing all test data shall be furnished to the Engineer prior to final inspection and not more than 90 days after completion of the tests.
 - 3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Owner.

1.05 EQUIPMENT REQUIREMENTS

A. Where variations from the contract requirements are requested in accordance with the GENERAL CONDITIONS, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.06 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
 - 1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
 - 2. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
 - 3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
 - 4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.07 1.7 WORK PERFORMANCE

- A. Job site safety and worker safety is the responsibility of the contractor.
- B. For work on existing stations, arrange, phase and perform work to assure communications service for other buildings at all times.
- C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by GENERAL CONDITIONS.
- D. Coordinate location of equipment and pathways with other trades to minimize interferences. See the GENERAL CONDITIONS.

REQUIREMENTS FOR COMMUNICATIONS SYSTEMS

270511

1.08 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Inaccessible Equipment:
 - 1. Where the Owner determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
 - 2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.09 EQUIPMENT IDENTIFICATION

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

1.10 SUBMITTALS

- A. Submit in accordance with GENERAL CONDITIONS.
- B. The Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 - 3. Submit each section separately.
- E. The submittals shall include the following:
 - 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
 - 2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.

270511

- 3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- F. Manuals: Submit in accordance with GENERAL CONDITIONS.
 - 1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
 - Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
 - 3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
 - 4. The manuals shall include:
 - a) Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b) A control sequence describing start-up, operation, and shutdown.
 - c) Description of the function of each principal item of equipment.
 - d) Installation and maintenance instructions.
 - e) Safety precautions.
 - f) Diagrams and illustrations.
 - g) Testing methods.
 - h) Performance data.
 - i) Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j) Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.

1.11 TRAINING

- A. Training shall be provided in accordance with the GENERAL CONDITIONS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the Engineer at least 30 days prior to the planned training.

270511

REQUIREMENTS FOR COMMUNICATIONS SYSTEMS

END OF SECTION

This page intentionally left blank

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

270526

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

- **1.01** DESCRIPTION
 - A. This section specifies general grounding and bonding requirements of telecommunication installations for equipment operations.
 - B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, telecommunications system grounding electrodes.
 - C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.02 RELATED WORK

- A. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 27.
- B. Section 27 10 00, STRUCTURED CABLING: Low Voltage power and lighting wiring.

1.03 SUBMITTALS

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Engineer:
 - 1. Certification that the materials and installation is in accordance with the drawings and specifications.
 - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.04 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. American Society for Testing and Materials (ASTM):
 - 1. B1-2001 Standard Specification for Hard-Drawn Copper Wire
 - 2. B8-2004 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. 81-1983 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
 - 1. 70-2005 National Electrical Code (NEC)
 - 2. Telecommunications Industry Association, (TIA)
- D. J-STO-607-A-2002 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - 1. E. Underwriters Laboratories, Inc. (UL):
 - 2. 44-2005 Thermoset-Insulated Wires and Cables
 - 3. 83-2003 Thermoplastic-Insulated Wires and Cables
 - 4. 467-2004 Grounding and Bonding Equipment
 - 5. 486A-486B-2003 Wire Connectors

PART 2 - PRODUCTS

- 2.01 GROUNDING AND BONDING CONDUCTORS
 - A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.
 - B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.
 - C. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.
 - D. Telecom System Grounding Riser Conductor: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 50mm² (1/0 AWG) insulated stranded copper grounding conductor unless indicated otherwise.
- 2.02 GROUND RODS
 - A. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
 - B. Quantity of rods shall be as required to obtain the specified ground resistance.

2.03 SPLICES AND TERMINATION COMPONENTS

A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.04 TELECOMMUNICATION SYSTEM GROUND BUSBARS

- A. Provide solid copper busbar, pre-drilled from two-hole lug connections with a minimum thickness of 6 mm (1/4 inch) for wall and backboard mounting using standard insulators sized as follows:
 - 1. Room Signal Grounding: 300 mm x 100 mm (12 inches x 4 inch).

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

270526

2. Master Signal Ground: 600 mm x 100 mm (24 inches x 4 inch).

2.05 GROUND CONNECTIONS

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
 - 1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
 - 2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
 - 3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.
- C. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

2.06 EQUIPMENT RACK AND CABINET GROUND BARS

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinetenclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x ³/₄ inch).
- 2.07 GROUND TERMINAL BLOCKS
 - A. At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.
- 2.08 SPLICE CASE GROUND ACCESSORIES
 - A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

PART 3 - EXECUTION

3.01 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. System Grounding:
 - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
 - 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
 - 3. Isolation transformers and isolated power systems shall not be system grounded.
- C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

3.02 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3.03 SECONDARY EQUIPMENT AND CIRCUITS

- A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
 - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
 - 2. Provide a supplemental ground electrode and bond to the grounding electrode system.
- C. Conduit Systems:
 - 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
 - 2. Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
 - 3. Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.
- D. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
- E. Boxes, Cabinets, Enclosures, and Panelboards:
 - 1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
 - 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
 - 3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- F. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.
- G. Raised Floors: Provide bonding of all raised floor components. //See details on the drawings.

3.04 CORROSION INHIBITORS

A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

3.05 CONDUCTIVE PIPING

- A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- B. In operating rooms and at intensive care and coronary care type beds, bond the gases and suction piping, at the outlets, directly to the room or patient ground bus.

3.06 TELECOMMUNICATIONS SYSTEM

- A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.
- B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.
- D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milli ohms or less.
- E. Below-Grade Grounding Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use exothermic welding cartridges and molds in accordance with the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly cleaned the joint area. Notify the Engineer prior to backfilling any ground connections.
- F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.
- G. Bonding Jumpers:
 - 1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 16 mm² (6 AWG) insulated copper wire.
 - 2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
 - 3. Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.
- H. Bonding Jumper Fasteners:
 - Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
 - 2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
 - 3. Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

270526

4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

3.07 COMMUNICATION ROOM GROUNDING

- A. Telecommunications Ground Busbars:
 - 1. Provide communications room telecommunications ground busbar hardware at 950 mm (18 inches) at locations indicated on the Drawings.
 - 2. Connect the telecommunications room ground busbars to other room grounding busbars as indicated on the Grounding Riser diagram.
- B. Telephone-Type Cable Rack Systems: aluminum pan installed on telephone-type cable rack serves as the primary ground conductor within the communications room. Make ground connections by installing the following bonding jumpers:
 - 1. Install a 16 mm² (6 AWG) bonding between the telecommunications ground busbar and the nearest access to the aluminum pan installed on the cable rack.
 - 2. Use 16 mm² (6 AWG) bonding jumpers across aluminum pan junctions.
- C. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:
 - 1. When ground bars are provided at the rear of lineup of bolted together equipment racks, bond the copper ground bars together using solid copper splice plates supplied by the ground bar manufacturer.
 - 2. Bond together nonadjacent ground bars on equipment racks and cabinets with 16 mm² (6 AWG) insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
 - 3. Provide a 16 mm² (6 AWG) bonding jumper between the rack and/or cabinet ground busbar and the aluminum pan of an overhead cable tray or the raised floor stringer as appropriate.
- D. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near the top of backboards used for communications cross-connect systems. Connect backboard ground terminals to the aluminum pan in the telephone-type cable tray using an insulated 16 mm² (16 AWG) bonding jumper.
- E. Other Communication Room Ground Systems: Ground all metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to the cable tray pan or the telecommunications ground busbar, whichever is closer, using insulated 16 mm² (6 AWG) ground wire bonding jumpers.

3.08 COMMUNICATIONS CABLE GROUNDING

- A. Bond all metallic cable sheaths in multipair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.
 - 1. At terminal points, install a cable shield bonding connector provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

3.09 COMMUNICATIONS CABLE TRAY SYSTEMS:

- A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout this cable tray systems as follows:
 - Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The Subcontractor shall verify this loss by testing across one slice plate connection in the presence of the Contractor.
 - 2. Install a 16 mm² (6 AWG) bonding jumper across each cable tray splice or junction where splice plates cannot be used.
 - 3. When cable tray terminations to cable rack, install 16 mm² (6 AWG) bonding jumper between cable tray and cable rank pan.

3.10 COMMUNCIATIONS RACEWAY GROUNDING

- A. Conduit: Use insulated 16 mm² (6 AWG) bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.
- B. Wireway: use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.
- C. Cable Tray Systems: Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 16 meters (50 feet).

3.11 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Services at power company interface points shall comply with the power company ground resistance requirements.

3.12 GROUND ROD INSTALLATION

A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

270526

- B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.
- C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

END OF SECTION

14457.20

SECTION 27 05 28

INTERIOR PATHWAYS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for all communications cabling unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.
- C. Provide all labor, materials, tools and equipment required for the complete installation of work called for in the contract documents.

1.02 RELATED WORK

- A. Bedding of conduits.
- B. Mounting board for communication closets.
- C. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 13, FIRESTOPPING.
- D. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building. Refer to Section 079200 – Joint Sealants.
- E. Identification and painting of conduit and other devices.
- F. General electrical requirements and items that is common to more than one section of Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- G. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.03 SUBMITTALS

In accordance with GENERAL CONDITIONS, furnish the following:

- A. Shop Drawings:
 - 1. Size and location of panels and pull boxes
 - 2. Layout of required conduit penetrations through structural elements.
 - 3. The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. Certification: Prior to final inspection, deliver to the Engineer A certification that the material is in accordance with the drawings and specifications and has been properly installed.

INTERIOR PATHWAYS

14457.20

270528

1.04 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):
 - 1. 70-05 National Electrical Code (NEC)
- C. Underwriters Laboratories, Inc. (UL):
 - 1. 1-03 Flexible Metal Conduit
 - 2. 5-01 Surface Metal Raceway and Fittings
 - 3. 6-03 Rigid Metal Conduit
 - 4. 50-03 Enclosures for Electrical Equipment
 - 5. 360-03 Liquid-Tight Flexible Steel Conduit
 - 6. 467-01 Grounding and Bonding Equipment
 - 7. 514A-01 Metallic Outlet Boxes
 - 8. 514B-02 Fittings for Cable and Conduit
 - 9. 514C-05 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
 - 10. 651-02 Schedule 40 and 80 Rigid PVC Conduit
 - 11. 651A-03 Type EB and A Rigid PVC Conduit and HDPE Conduit
 - 12. 797-03 Electrical Metallic Tubing
 - 13. 1242-00 Intermediate Metal Conduit
- D. National Electrical Manufacturers Association (NEMA):
 - 1. TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
 - 2. FB1-03 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

PART 2 - PRODUCTS

2.01 CONDUIT:

- A. Conduit Size: In accordance with the NEC, but not less than 13 mm (1/2 inch) unless otherwise shown.
 - 1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
 - 2. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.
 - 3. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
 - 4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.
 - 5. Flexible galvanized steel conduit: Shall Conform to UL 1.
 - 6. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
 - 7. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high-density polyethylene (PE).

- 14457.20
 - 8. Surface metal raceway: Shall Conform to UL 5.

2.02 CONDUIT FITTINGS:

- A. Rigid steel and IMC conduit fittings:
 - 1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
 - 2. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 - 3. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
 - 4. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - 5. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
 - 6. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
- B. Rigid aluminum conduit fittings:
 - 1. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
 - 2. Locknuts and bushings: As specified for rigid steel and IMC conduit.
 - 3. Set screw fittings: Not permitted for use with aluminum conduit.
- C. Electrical metallic tubing fittings:
 - 1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
 - 2. Only steel or malleable iron materials are acceptable.
 - 3. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
 - 4. Indent type connectors or couplings are prohibited.
 - 5. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
- D. Flexible steel conduit fittings:
 - 1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
 - 2. Clamp type, with insulated throat.
- E. Liquid-tight flexible metal conduit fittings:
 - 1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
 - 2. Only steel or malleable iron materials are acceptable.

14457.20

- 3. Fittings must incorporate a threaded grounding cone.
 - Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- F. Direct burial plastic conduit fittings:
 - 1. Fittings shall meet the requirements of UL 514C and NEMA TC3.
 - 2. As recommended by the conduit manufacturer.
- G. Surface metal raceway fittings: As recommended by the raceway manufacturer.
 - 1. Expansion and deflection couplings:
 - a) Conform to UL 467 and UL 514B.
 - b) Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30-degree angular deflections.
 - c) Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
 - d) Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

2.03 CONDUIT SUPPORTS:

- A. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
- B. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
- C. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
- D. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

2.04 OUTLET, JUNCTION, AND PULL BOXES:

- A. UL-50 and UL-514A.
- B. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
- C. Sheet metal boxes: Galvanized steel, except where otherwise shown.
- D. Flush mounted wall or ceiling boxes shall be installed with raised covers so that front face of raised cover is flush with the wall. Surface mounted wall or ceiling boxes shall be installed with surface style flat or raised covers.

2.05 WIREWAYS:

A. Equip with hinged covers, except where removable covers are shown.

2.06 INNERDUCT:

- A. Standard HDPE
 - 1. Textile Innerduct: Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape as manufactured by MaxCell:
 - a) MaxCell Group/TVC Communications

- b) 600 Plum Creek Dr.
- c) Wadsworth, OH. 44281
- d) 1-888-387-3828
- 2. Textile innerduct fittings
 - a) Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.: a 4inch plug with nine holes for cables in a 3 pack (9-cell) configuration
 - b) Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.
 - c) Pull Tape: measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.

2.07 SURFACE METALLIC RACEWAY

- A. Refer to drawings for additional surface raceway sizes, cable fill tables, and cable radius requirements.
- B. TYPE SR-2 (V2400 series)
 - 1. .875" H x 1.875" W
 - 2. Metallic two-piece raceway with single compartment.
 - 3. Color shall be lvory color and have a durable finish with a scratch-resistant surface that can be field painted.
 - 4. Refer to Drawings for additional information and requirements.
 - 5. Provide the following fittings:
 - a) Entrance end fitting nominal maximum dimensions of 2.62" W x 2.25" H x 3" L. and 1" conduit knockout.
 - b) Back entrance end fitting same as entrance end fitting with internal radius.
 - c) Tee fittings to connect to SR-3 (3000 Series) and SR-4 (4000 Series) raceway where T section to SR-2 (2400 Series) has maximum width equal to SR-2 raceway
 - d) Bridge fitting with radius for spanning existing raceways in varying widths from $\frac{1}{2}$ " to 2.
 - e) Flat Internal and external elbows UL verified for a 2" [51mm] bend radius and exceeding the recommendations of EIA/TIA 569A. Internal or external radius control must be provided. Derate fill capacities when internal radius control is provided, as recommended by the manufacturer.
 - f) Surface 2" x 4" or 4" x 4" boxes, with 2.25" depth as called for.
 - 6. Design Make: Wiremold V2400 series raceway, V2475D series bridge fittings, V2410 series entrance end fittings, V2415 T fittings.
 - 7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.
- C. TYPE SR-3 (V3000 Series)
 - 1. 1.5" H x 2.75"W
 - 2. Metallic two piece raceway with single compartment.

270528

- 3. Color shall be lvory color and have a durable finish with a scratch-resistant surface that can be field painted.
- 4. Refer to Drawings for additional information and requirements.
- 5. Provide the following fittings:
 - a) Entrance end fitting nominal maximum dimensions of 2.75"W x 2"H x 2.125" L. and 1" conduit knockout.
 - b) Back entrance end fitting same as entrance end fitting with internal radius.
 - c) Tee fittings to connect to SR-2 (2400 Series) raceway where T section to SR-2 has maximum width equal to SR-2 raceway
 - d) Flat Internal and external elbows UL verified for a 2" [51mm] bend radius and exceeding the recommendations of EIA/TIA 569A using internal or external radius components. Internal or external radius control must be provided. Derate fill capacities when internal radius control is provided, as recommended by the manufacturer.
- 6. Design Make: Wiremold V3000 series raceway, with V3011, V3010 and V3018 fittings.
- 7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.
- D. TYPE SR-4 and SR-4d (V4000 Series)
 - 1. 1.75" H x 4.75" W
 - 2. Metallic two-piece raceway with single or divided compartment as called for on plans.
 - 3. Color shall be lvory color and have a durable finish with a scratch-resistant surface that can be field painted.
 - 4. Provide the following fittings:
 - a) Entrance end fitting nominal maximum dimensions of 4.75" W x 2.75"H x 6.5" L. and 1.25" conduit knockout.
 - b) Back entrance end fitting same as entrance end fitting with internal radius.
 - c) T fittings to connect to SR-2 (2400 Series) raceway where T section to SR-2 has maximum width equal to SR-2 raceway
 - d) Flat Internal and external elbows with fiber optic radius
 - 5. Design Make: Wiremold V4000 Series raceway, with V4010, V4017FO, V4015FO and V4011FO fittings.
 - 6. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal
- E. TYPE SR-7 (V700 Series)
 - 1. One-piece raceway
 - 2. Color shall be lvory color and have a durable finish with a scratch-resistant surface that can be field painted.
 - 3. Utilized for wall mounted phones and miscellaneous branch circuit power only.
 - 4. Provide internal and external 90-degree fittings with radius.
 - 5. Provide miscellaneous boxes, extension rings, fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.
 - 6. Design Make: Wiremold V700

14457.20

7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.

2.08 WIRE MESH CABLE TRAY

- A. Cable Tray Finish: Carbon Steel with Zink plating.
- B. Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe/T/Edge T/welded top side wire to protect cable insulation and installers.
- C. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.
 - 1. Mesh: 2 x 4 inches (50 x 100 mm).
 - 2. Straight Section Lengths: 118 inches (3,000 mm).
 - 3. Wire Diameter: Patented design includes varying wire sizes to meet application load requirements; to optimize tray strength; and to allow tray to remain lightweight.
 - 4. Safe/T/Edge: Patented Safe/T/Edge technology on side wire to protect cable insulation and installers' hands.
 - 5. Fittings: Wire mesh cable tray fittings are field/fabricated from straight tray sections, in accordance with manufacturer's instructions and Item 2.3.
 - 6. CF Series Cable Tray Size:
 - 7. Depth: Cable tray shall be available in the following depths:
 - a) [1 inch (30 mm)]
 - b) [2 inches (54 mm)]
 - c) [4 inches (105 mm)]
 - d) [6 inches (150 mm)]
 - 8. Width: Cable tray width will be available in the following widths:
 - a) [2 inches (50 mm)]
 - b) [4 inches (100 mm)]
 - c) [6 inches (150 mm)]
 - d) [8 inches (200 mm)]
 - e) [12 inches (300 mm)]
 - f) [18 inches (450 mm)]
 - g) [20 inches (500 mm)]
 - h) [24 inches (600 mm)]
 - 9. Length: Cable tray section length will be 118 inches (3000mm) unless otherwise shown on drawings.
- D. Support cable tray as recommended by manufacture. Provide a safety loading factor of 1.5 for uniformly distributed loads when supported as a simple span in accordance with the NEMA standard listed.
- E. Refer to drawing for additional Cable Tray details and requirements
- F. Design Makes: Legrand Cablofil Wire Mesh

- 14457.20
 - G. Acceptable Manufacturers:
 - 1. Cooper B/line Flextray
 - 2. Approved equal

2.09 CABLE HANGERS (J-HOOK)

- A. Provide prefabricated, zinc coated, carbon steel hangers designed specifically for UTP and Optical Fiber cable installations.
- B. Hangers shall have open top, rolled edges and a 3" or 4" minimum diameter loop.
- C. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.
- D. Design Make CADDY CAT CM

2.10 COMMUNICATIONS/POWER POLES

- A. Provide aluminum multi-service power pole.
- B. Pole shall include 2 electrically isolated channels to act as raceway for communications cabling and future electrical wiring.
- C. Include ceiling trim plate, low voltage entrance fitting, T-bar mounting bracket and carpet / floor grippers.
- D. Design Make: Legrand TPP series or approved equal

2.11 Floor Boxes

- A. ACCEPTABLE MANUFACTURERS
 - 1. FSR
 - a) FL-500P-4
 - b) COVER PART# FL-500P-PLP-GRY-C

PART 3 - EXECUTION

3.01 PENETRATIONS

- A. Cutting or Holes:
 - 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Engineer prior to drilling through structural sections.
 - 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Engineer as required by limited working space.
- B. Fire Stop: Where conduits, wireways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

3.02 INSTALLATION, GENERAL

- A. Install conduit as follows:
 - 1. In complete runs before pulling in cables or wires.
 - 2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
 - 3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
 - 4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
 - 5. Mechanically continuous.
 - 6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
 - 7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
 - 8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
 - 9. Conduit installations under fume and vent hoods are prohibited.
 - 10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 - 11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
 - 12. Do not use aluminum conduits in wet locations.
 - 13. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.
- B. Conduit Bends:
 - 1. Make bends with standard conduit bending machines.
 - 2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
 - 3. Bending of conduits with a pipe tee or vise is prohibited.
- C. Layout and Homeruns:
 - 1. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Engineer.

3.03 CONCEALED WORK INSTALLATION

- A. In Concrete:
 - 1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
 - 2. Align and run conduit in direct lines.
 - 3. Install conduit through concrete beams only when the following occurs:
 - a) Where shown on the structural drawings.

- 14457.20
- b) As approved by the Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
- 4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
 - a) Conduit outside diameter larger than 1/3 of the slab thickness is prohibited.
 - b) Space between conduits in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
 - c) Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (3/4 inch) of concrete around the conduits.
- 5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.
- B. Furred or Suspended Ceilings and in Walls:
 - 1. Conduit for conductors 600 volts and below:
 - a) Rigid steel, IMC, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
 - 2. Align and run conduit parallel or perpendicular to the building lines.
 - 3. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (six feet) of flexible metal conduit extending from a junction box to the fixture.
 - 4. Tightening set screws with pliers is prohibited.

3.04 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 volts and below:
 - 1. Rigid steel, IMC, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- E. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.
- F. Surface metal raceways: Use only where shown.
- G. Painting:
 - 1. Paint exposed conduit.

3.05 EXPANSION JOINTS

- A. Conduits 75 mm (3 inches) and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 75 mm (3 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper

green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.

- C. Install expansion and deflection couplings where shown.
- D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

3.06 CONDUIT SUPPORTS, INSTALLATION

- A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
 - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - 2. Existing Construction:
 - a) Steel expansion anchors not less than 6 mm (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.
 - b) Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
 - c) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.07 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush mounted.

270528

14457.20

- 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example, "SIG-FA JB No. 1".

3.08 COMMUNICATION SYSTEM CONDUIT

- A. Install the communication raceway system as shown on drawings.
- B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings.
- C. All conduit ends shall be equipped with insulated bushings.
- D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90-degree bends. Size boxes per the NEC.
- E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.
- F. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.
- G. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.
- H. All empty conduits located in communication closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.
- I. Conduit runs shall contain no more than four quarter turns (90-degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

Sizes of Conduit Trade Size	Radius of Conduit Bends mm, Inches
3/4	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)
2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

- J. Furnish and install 19 mm (3/4 inch) thick fire-retardant plywood specified in Section 06 10 00, ROUGH CARPENTRY on the wall of communication closets where shown on drawings. Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.
- K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).
- L. Furnish SMART LB Fittings shall be utilized on all communication conduits. Refer to <u>www.smartlb.com</u> for additional information. Smart LB Die cast Aluminum LB fitting shall be used with Liquidtight, "EMT", "IMC" or "Rigid" Metallic conduit and fittings. Smart LB PVC LB fitting shall be used with Sch 40 rigid PVC", "Sch 80 rigid PVC", "ENT", "PVC Flex Duct", "PVC General Purpose Duct", "PVC Riser Duct", Type NM Liquidtight conduit and "rigid nonmetallic Power and Communication Ducts"
- M. Textile Innerduct (MaxCell):
 - 1. Aboveground, Exterior and Interior Conduit Installations: Outdoor textile innerduct (Standard or Detectable as desired).
 - 2. Interior Exposed Locations
 - a) Non-plenum Areas: Indoor textile innerduct
 - b) Plenum Areas: Plenum-listed indoor innerduct
 - 3. When installed in 4" conduit, use two 3" 3-Cell packs with an additional pull tape on the outside for future pulls in each conduit.
 - 4. Cable Tray: use standard outdoor or indoor textile innerduct

END OF SECTION

This page intentionally left blank

STRUCTURED CABLING GENERAL REQUIREMENTS

271000

SECTION 27 10 00

STRUCTURED CABLING GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
 - 1. Contract Documents
 - 2. Division 00 Procurement & Contracting Requirements Group
 - 3. Division 1 General Requirements
 - 4. Section 27 11 00 Equipment Room Fittings
 - 5. Section 27 15 00 Horizontal Cabling CAT 6

1.02 REFERENCES

- A. All work shall be performed in accordance with the following Codes and industry Standards, unless noted otherwise:
 - 1. NFPA 70 National Electrical Code, current version adopted by local or State AHJ.
 - 2. TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard, current version.
 - 3. TIA/EIA 569-B Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
 - 4. TIA/EIA 606-A Administration Standard for Commercial Telecommunications Infrastructure, current version.
 - 5. J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
 - 6. IEEE 241 IEEE Recommended Practice for Electric Power Systems in Commercial Buildings, pertaining to communication systems.
 - 7. TIA/EIA 758-A Customer-Owned Outside Plant Telecommunications Cabling Standard

1.03 WARRANTY

A. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.

1.04 SUMMARY

- A. This Section includes general requirements specifically applicable to Division 27.
- B. The Contractor shall be responsible for:

STRUCTURED CABLING GENERAL REQUIREMENTS

- 1. Providing all additional materials, and the necessary labor and services required to ensure all components of the system are completely installed in accordance with the intent of the Contract Documents.
- 2. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
- 3. Coordinating the details of facility equipment and construction for all specification divisions that affect the work covered under this Division.
- 4. Coordinating all activities with the overall construction schedule.
- 5. Developing bill of materials, perform material management and efficient use of the materials whether they are issued by the Contractor, the owner or purchased by the Contractor.
- 6. Ensure materials in excess of those required to complete the project are kept in their original condition and packaging for restocking.
- 7. Ensure project is properly registered for the specified manufacturer's copper & fiber cable extended warranty programs.
- C. Intent of Drawings:
 - 1. Communications plan drawings show only general locations of equipment, devices, raceways, cable trays, boxes, etc. All dimensioned locations and elevations are approximate. The Contractor is responsible for the field coordination of communications work with the other trades prior to beginning work.
 - 2. The Contractor shall be responsible for the proper placement and routing of equipment, cable, raceways, cable tray, and related components according to the Contract Documents and subject to prior review by Designer.
 - 3. Refer all conflicts between Contract Documents to contractor for resolution.

1.05 DEFINITIONS

- A. Active Equipment: Electronic equipment used to develop various WAN and LAN services.
- B. Backbone: Collective term sometimes used to describe the campus and vertical distribution subsystem facilities and media interconnecting service entrances, communications rooms, and communications cabinets.
- C. Bonding: Permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed on it.
- D. Building Equipment Room (BER): Room in each building used to distribute communications services to Telecommunications Rooms (TR) in the same building. Typically, the BER contains passive equipment used for electrical protection (protectors) and building cross-connect, and active network equipment used for LANs. The BER may also serve the function of a TR.
- E. Cabinet: Freestanding, floor-mounted modular enclosure designed to house and protects rack-mounted electronic equipment.
- F. Cable Tray: Vertical or horizontal open supports usually made of aluminum or steel that is fastened to a building ceiling or wall. Cables are laid in and fastened to the trays. A cable tray is not a raceway.

14457.20

STRUCTURED CABLING GENERAL REQUIREMENTS

- G. Campus: Grounds and buildings of a multi-building premises environment.
- H. Channel: The end-to-end transmission path between two points at which application specific equipment is connected; may include one or more links, cross-connect jumper and/or patch cords, and work area station cords. Does not include connection to active equipment.
- I. Communications Equipment Room See Telecommunications Room (TR)
- J. Cross-Connect: Equipment used to terminate and tie together communications circuits.
- K. Cross-Connect Jumper: A cluster of twisted-pair conductors without connectors used to establish a circuit by linking two cross-connect termination points.
- L. Fiber Optic Distribution Unit (FDU): Cabinet with terminating equipment used to develop fiber optic cross-connect facilities.
- M. Grounding: A conducting connection to earth, or to some conducting body that serves in place of earth.
- N. Hinged Cover Enclosure: Wall-mounted box with a hinged cover that is used to house and protect electrical devices.
- O. Horizontal: Pathway facilities and media connecting Telecommunications Rooms (TR) to Telecommunications Outlets (TO).
- P. Innerduct: Flexible sheath used to enclose cables and protect them from damage. It is commonly used when running fiber optic cable through underground conduits originally designed for large-diameter telephone cables. Max-Cell Innerduct is a fabric based innerduct that enables a higher density of communication cables to be pulled.
- Q. Jack: Receptacle used in conjunction with a plug to make electrical contact between communications circuits, e.g., eight-position/eight-contact modular jacks.
- R. Link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables; one continuous section of conductors or fiber, including the connecting hardware at each end.
- S. Local Area Network (LAN): Data transmission facility connecting a number of communicating devices, e.g., serial data, Ethernet, token ring, etc. Typically, the network is limited to a single site.
- T. Main Equipment Room (MER): The room used to distribute communication services to all Building Equipment Rooms (BER's) on the premises, and to interconnect premises services with the telephone companies. Typically, the MER contains passive equipment used for electrical protection (protectors) and main campus cross-connect, and active equipment used for PBX, WAN, and LAN.
- U. Media: Twisted-pair, coaxial, and fiber optic cable or cables used to provide signal transmission paths.
- V. Mounting Frame: Rectangular steel framework which can be equipment rack or wall mounted to support wiring blocks, patch panels, and other communications equipment.
- W. Passive Equipment: Non-electronic hardware and apparatus, e.g., equipment racks, cable trays, electrical protection, wiring blocks, fiber optic termination hardware, etc.
- X. Patch Cords: A length of wire or fiber cable with connectors on one or both ends used to join communications circuits at a cross-connect.

14457.20

STRUCTURED CABLING GENERAL REQUIREMENTS

- Y. Patch Panel: System of terminal blocks or connectors used with patch cords that facilitate administration of cross-connect fields.
- Z. Pathway: Facility for the placement of communications cable. A pathway facility can be composed of several components including conduit, wireway, cable tray, surface raceway, underfloor systems, raised floor, ceiling support wires, etc.
- AA. Private Branch Exchange (PBX): Private communications switching system located on the user's premises. A PBX switches voice and data calls within a building or premises and between the premises and facilities provided by public common carrier networks.
- BB. Protectors: Electrical protection devices used to limit foreign voltages on metallic communications circuits.
- CC. Raceway: An enclosed channel designed expressly for holding wires or cables; may be of metal or insulating material. The term includes conduit, tubing, wireway, underfloor raceway, and surface raceway; does not include cable tray.
- DD. Racks: An open, freestanding, floor-mounted structure, typically made of aluminum or steel, used to mount equipment; usually referred to as an equipment rack.
- EE. Telecommunication Outlet (TO): Connecting device mounted in a work area used to terminate horizontal cable and interconnect cabling with station equipment.
- FF. Telecommunications Room (TR): Distributes communications services to users within a serving zone and interconnects with the BER. Typically, the TER contains passive equipment used for cross-connect and active network equipment used for LANs. TR is sometimes referred to as the communications equipment room.
- GG. Wide Area Network (WAN): Active communications transmission facilities extending beyond the premises.
- HH. Wiring Block: Punch down terminating equipment used to develop twisted-pair cross-connect facilities.

1.06 SYSTEM DESCRIPTION

- A. The Owner will implement a comprehensive integrated communications distribution system, as described in paragraph B below, to provide wiring infrastructure which may be used to support one or more of the following services and systems:
 - 1. Voice & Data Telecommunications.
 - 2. Mass Notification Systems.
- B. The communications distribution system consists of the following major subsystems, as specified elsewhere:
 - Inter-building Backbone: The inter-building subsystem refers to all twisted pair and fiber optic backbone communications cabling connecting the Main Building Equipment Room (BER) to each building equipment room (BER) in all buildings on the campus / region. This project includes modification to the fiber backbone as shown on the drawings and further detailed in the Specifications.
 - 2. Intra-building Backbone: The intra-building subsystem refers to all twisted-pair and fiber optic backbone communications cabling connecting the Main Telecommunications Room (TR) to each Telecommunication Room (TR) in the buildings.
STRUCTURED CABLING GENERAL REQUIREMENTS

271000

- 3. Communication Rooms: The communications room contains the distribution subsystem comprised of the passive components used to terminate cabling subsystems and distribute communications services. This subsystem includes installations in the Building Equipment Rooms (BERs), in Telecommunications Rooms (TRs) and Telecommunications Enclosures (TEs). Complete work as shown in the drawings and as specified in Section 271100.
- 4. Horizontal Distribution: Horizontal distribution building cable to telecommunication outlets (TOs). Section 271500 is included for termination & testing required for the installation of Cat 6patch panels in the Telecommunications Rooms (TRs) as described by the drawings and also in the case any additional wiring is identified as necessary as a result of field conditions and approved by the Designer
- 5. Work Area Distribution Subsystem: Patch cords, adapters, and devices located between the TO and station equipment. Complete work as shown in the drawings and as specified in Section 271500.
- C. The communications distribution system is based on a combination of, but not limited to, the following communications transmission technologies:
 - 1. 100-ohm 4-pair unshielded twisted-pair cable. (Cat 6)
 - 2. 100-ohm multi-pair unshielded twisted-pair cable. (Cat 3)
 - 3. 8.3/125-micron single-mode fiber optic cable.
 - 4. 8-position telecommunications jacks.
 - 5. 8-position telecommunications patch panels
 - 6. Insulation displacement connector (IDC) type field terminated wiring blocks
 - 7. Outside plant copper splice enclosures
 - 8. Building entrance protection
 - 9. Factory Terminated copper patch cords
 - 10. Rack mount fiber optic hardware
 - 11. Wall mounted fiber optic hardware
 - 12. Fiber optic connectors & hardware
 - 13. Factory terminated fiber optic patch cords
 - 14. Outside plant fiber splice enclosures
- D. The work locations and limits of work are shown on the drawings.

1.07 DESIGN CRITERIA

- A. Compliance by the Contractor with the provisions of this specification does not relieve him of the responsibilities of furnishing materials and equipment of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.
- B. The following are incorporated into the design:
 - 1. The communications room installations are designed to be as similar as possible.
 - 2. Electrical protection is provided for all exposed inter-building twisted-pair cabling.

14457.20

STRUCTURED CABLING GENERAL REQUIREMENTS

271000

3. The location of communication rooms is intended to restrict the maximum horizontal subsystem wiring length (defined as a channel between a telecommunications room crossconnect termination field and a served TO) to 295 feet (90 meters).

1.08 WARRANTY

- A. The Contractor shall provide a manufacturer's warranty on the horizontal and backbone systems as specified in Section 27 15 00.
- B. In addition to the standard warranty requirements, the Contractor shall provide the following during the warranty period:
 - 1. Within 24 hours after notification of a defect, the Contractor shall start to make the necessary corrections and inform the appropriate Project Manager of the planned corrective actions. The Contractor shall follow this initial contact with continuous effort and complete any required corrective work within 15 days after notification.

1.09 QUALIFICATIONS

- A. Communications Pathway Installation: The Contractor shall have 5 years of documented experience installing raceway and cable tray systems for each of the types and system material components specified in the Contract Documents, e.g., cable tray. In the case of newer technologies that do not have a 3-year history, the contractor shall have documented experience for at least half of the lifetime of the new technology.
- B. The Contractor selected for this project must be certified by the manufacturer of the products installed, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project.
- C. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.
- D. Company certificate & letter from manufacturer stating Contractor's certification is in good standing, shall be included with submittal.
- E. Certified Installer must register project with the specified cable manufacturers, as applicable, and must provide a warranty on the installation workmanship & testing for a length of no less than twenty (20) years.
- F. 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. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical, Category 5e, Category 6 and Category 6a premise distribution systems and have personnel who are adequately trained in the use of such tools and equipment.
- G. A resume of qualification shall be submitted with the Contractor's proposal indicating the following:
 - 1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 - 2. A list of test equipment proposed for use in verifying the installed integrity of metallic and fiber optic cable systems on this project.
 - 3. A technical resume of experience for the contractor's Project Manager and on-site installation supervisor who will be assigned to this project.

14457.20

STRUCTURED CABLING GENERAL REQUIREMENTS

271000

- 4. A list of technical product training attended by the contractor's personnel that will install the structured cabling system shall be submitted with the response.
- 5. Any sub-contractors, who will assist the Contractor in performance of this work, shall have the same training and certification as the Contractor.

1.10 SUBMITTALS

- A. General:
 - 1. Provide ongoing inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
 - 2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of same are clearly indicated and non-applicable portions clearly deleted or crossed out.
 - 3. When the specifications include product descriptions, model numbers, part numbers, etc. that have been superseded, changed, or discontinued, the contractor shall submit a comparable substitution for review by the A/E.
 - 4. The specified manufacturer's copper & fiber cable extended warranty program certificates stating that the communications installer is in good standing in applicable program.
- B. Provide all applicable portions of the following information with the Bid:
 - 1. Documentation establishing qualifications to perform installation functions as required in 1.9 above:
 - 2. Statement demonstrating an understanding of project scope and schedule which includes the following information:
 - a) Where (city, office) the project will be staffed.
 - b) Project organizational chart with team names; e.g., project manager, A/Es, principal skilled technicians, and contractors.
- C. Provide all applicable portions of the following information within 10 days after award:
 - 1. Project schedule in hard copy. Include, at a minimum, major tasks, milestones, dependencies, staffing, and durations for each task.
 - 2. Contractor shall then work with contractor to merge this schedule into the overall construction schedule.
 - 3. Provide the following information for materials, components, and equipment to be furnished by the contractor:
 - a) Descriptive literature, manufacturer's specification data sheets, and manuals.
 - b) Individual price and delivery schedules.
 - c) Manufacturer's product test data with indicator arrows. The submittal shall be in the same order as products in 27 15 00and 27 17 01.
 - d) Final Performance testing criteria and data for communications distribution system cabling systems.

1.11 DEFINITION OF ACCEPTANCE

STRUCTURED CABLING GENERAL REQUIREMENTS

- A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:
 - 1. All submittals and documentation have been submitted, reviewed, and approved.
 - 2. The complete system has successfully completed all testing requirements.
 - 3. All Owner staff personnel training programs have been completed.
 - 4. All punch list items have been corrected and accepted.
 - 5. Project registration for warranty by manufacturer.

1.12 PROJECT RECORD DOCUMENTS

- A. Provide detailed project record documentation within 30 days after completion of the work.
 - 1. Maintain separate sets of red-lined record drawings for the communications work which show the exact placement and identification of as-built system components.
 - 2. Provide communication pathway record drawings which indicate exact placement and routing for all components, e.g., maintenance holes, handholes, conduit, wireway, cable tray, pull boxes, enclosures, telecommunications outlet boxes, etc.
 - 3. Provide communication room record drawings which indicate exact placement for all components; e.g., conduit, wireway, cable tray, backboards, equipment cabinets, equipment racks, cross-connect equipment, etc.
 - 4. Provide communication wiring and cabling record "As-Builds" drawings and schedules which indicate exact placement, cable foot marking, routing, and connection details for all components, e.g., twisted-pair and fiber optic cables, splices, cable cross-connect termination locations, enclosures, telecommunications outlets, cross-connect jumpers, patch cords, etc.
 - 5. Provide network schematics when appropriate.

PART 2 PRODUCTS

2.01 APPROVALS AND SUBSTITUTIONS

A. Equivalent product(s) may be considered for substitution for those products specified, however, the equivalent product(s) must be approved and show demonstrated and documented equivalence to the product(s) specified. Documentation shall include, but is not limited to: product samples, data sheets, and actual test data. The request for product substitution, and supporting documentation, must be submitted, in writing, prior to submitting the bid. Written approval for product substitution must be submitted with the bid.

PART 3 EXECUTION

3.01 WORKMANSHIP

- A. Manufactured products, materials, equipment, and components shall be provided, conditioned, applied, installed, connected, and tested in accordance with the manufacturer's specifications and printed instructions
- B. The installation of all system components shall be carried out under the direction of qualified personnel. Appearance shall be considered as important as mechanical and electrical efficiency. Workmanship shall meet or exceed industry standards.

STRUCTURED CABLING GENERAL REQUIREMENTS

271000

3.02 SERVICE CONTINUITY

- A. Maintain continuity of communications services to all functioning portions of the process or buildings during hours of normal use.
- B. Arrange temporary outages for cutover work with electrical contractor or general contractor. Keep outages to a minimum number and a minimum length of time in order to provide minimum impact.

3.03 LAYOUT AND TOLERANCES

- A. Follow as closely as practicable the design shown on the drawings. Make all necessary measurements in the field to verify exact locations and ensure precise location and fit of specified items in accordance with the drawings. Make no substantial alterations without prior approval of the Designer and the A/E.
- B. Perform all work to the lines, grades, and elevations indicated on the drawings. Provide experienced, competent personnel to locate and lay out the work and provide them with suitable tools, equipment, and other materials required to complete layout and measurement work. Use lasers or other approved methods to establish line and grade.

3.04 CONSTRUCTION REVIEW

- A. The A/E and the Designer will review and observe installation work to ensure compliance by the Contractor with requirements of the Contract Documents.
- B. The Contractor shall inspect and test completed communications installations to demonstrate specified performance levels including the following:
 - 1. Furnish all instruments and personnel required for the inspections and tests.
 - 2. Perform tests in the presence of the A/E and Designer.
 - 3. Demonstrate that the system components operate in accordance with the Contract Documents.
- C. Review, observation, assistance, and actions by the Architect/Engineer (A/E) or General Contractor (GC) shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The A/E's and General Contractor's review and observation activities shall not relieve the contractor from the responsibilities of these Contract Documents.
- D. The fact that the A/E, GC or the owner does not make early discovery of faulty or omitted work shall not bar the A/E, GC or the owner from subsequently rejecting this work and insisting that the contractor make the necessary corrections.
- E. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the A/E, GC or the Owner for an increase in the Subcontract price, or for any payment on account of increased cost, damage, or loss.

END OF SECTION

This page intentionally left blank

EQUIPMENT ROOM FITTINGS

SECTION 27 11 00

EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

14457.20

1.01 SUMMARY

A. The communications equipment room will be referred as Telecommunications Room (TR) in this document is intended to house racks, cabinets and equipment necessary for the support of the communications cabling infrastructure.

1.02 RELATED DOCUMENTS

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
 - 1. Contract Documents
 - 2. Division 00 Procurement & contracting Requirements Group
 - 3. Division 1 General Requirements
 - 4. Section 27 10 00 Structured Cabling General Requirements
 - 5. Section 27 13 00 Backbone Cabling
 - 6. Section 27 15 00 Horizontal Cabling CAT 6

1.03 REFERENCES

- A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:
- B. NFPA 70 National Electrical Code, current version adopted by local or State AHJ.
- C. TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard, current version.
- D. TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
- E. TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure, current version.
- F. J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
- G. IEEE 241 IEEE Recommended Practice for Electric Power Systems in Commercial Buildings, pertaining to communication systems.
- H. TIA-310- D Cabinets, Rack, and Associated Equipment

1.04 WARRANTY

A. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.

PART 2 PRODUCTS

2.01 APPROVALS AND SUBSTITUTIONS

- A. All products shall be provided as specified, without exception, unless approved in writing prior to the bid. All products shall be "NEW".
- B. Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor.

2.02 TELECOMMUNICATIONS BACKBOARDS

A. AC-rated plywood, fire-retardant treated, 3/4 inches by 48 inches by 96 inches (19 by 1220 by 2440 mm).

2.03 FREE STANDING 2 POST EQUIPMENT RACKS

- A. 7-foot-high, 19 inches wide, 6.5-inch channel depth, EIA free-standing rack, UL listed, black finish
 - 1. Ortronics Mighty Mo 6 OR-MM6706
 - 2. Refer to Drawings

2.04 EQUIPMENT ENCLOSURE (HALF RACK)

- A. EIA compliant 19" gangable equipment enclosure 25 rack units and 32 Inches Deep.
 - 1. Fully welded construction for strength
 - 2. Standard front and rear adjustable 10-32 threaded rackrail with numbered spaces
 - 3. Includes full ventilated front door and rear doors.
 - 4. Include solid top panel with side cable entry grommets.
 - 5. Include solid side panels
 - 6. Provide 4 castors to allow cabinet movement. Part No. CBS BGR.
 - 7. Middle Atlantic BGR Series
 - a. Frame & Rear Door: BGR2532
 - b. Front Door: BVFD-25
 - c. Side Panels: BSPN-25-32
 - 8. Refer to Drawings

2.05 EQUIPMENT ENCLOSURES

- A. EIA compliant 19" gangable equipment enclosure 42 rack units and 42 Inches Deep.
 - 1. Fully welded construction for strength
 - 2. 24-¹/₄" overall width provides space for side cabling or cooling airflow
 - 3. Convenient lacing points and slotted rail brackets for cable management
 - 4. Standard front and rear adjustable 10-32 threaded rackrail with numbered spaces
 - 5. Extra-wide rackrail features cable pass-throughs to facilitate front-to-rear cabling
 - 6. Includes full profile mesh front door and rear doors.
 - 7. Include solid top panel with side cable entry grommets.
 - 8. Include solid side panels

- 9. Provide 4 castors to allow cabinet movement.
- 10. Mid Atlantic Part No. SNE24-4242-P2.
- 11. Provide (4) Horizointal Wire Managers. Mid Atlantic Part No. PHCM-1-4.
- 12. Provide (2) Vertical Cable Fingers. Mid Atlantic Part No. SNE-IVCMF-42.
- 13. Provide (1) Power Strip. Mid Atlantic Part No. PDT-2015C-NS.
- 14. Refer to Drawings.

2.06 WALL MOUNT CABINET

- A. EIA compliant 19" gangable equipment enclosure rack units shown on drawings
- B. 3 section wall cabinet (wall section, equipment section and lockable door.)
- C. Swing open center ventilated equipment section allows front and rear access
- D. Cabinet shall be 26" wide with integrated cable management.
- E. Usable equipment depth is 24"
 - 1. Middle Atlantic Products CWR –XX-26PD (XX = rack unit height shown on drawings)

2.07 VERTICAL WALL MOUNTED RACKS

- A. EIA compliant 19" gangable equipment enclosure rack units shown on drawings
- B. Cabinet shall have 4 rack units and 31 inches of vertical mounting depth.
- C. Legrand Model # VWMFD-4RU-36-B.
- D. Provide a Hoffman Model No. DAH2001A Aux. Cabinet Heater with Thermostat. Mount in lower section of vertical data cabinet.

2.08 VERTICAL WIRE MANAGERS

- A. 7-foot-high, 6 inches wide, 8 inches deep with dual-hinged door and integral one rack unit high horizontal management, black finish.
 - 1. Ortronics Mighty Mo 6 OR-MM6VMD706
 - 2. Provide as shown on Drawings.

2.09 HORIZONTAL WIRE MANAGERS

- A. 19 inches wide, two rack units high with cover, for copper management
 - 1. Refer to Paragraph 2.05.
- B. 19 inches wide, one rack unit high with cover, for fiber management
 - 1. Corning CJP-01U
 - 2. Provide as shown on Drawings.

2.10 TELECOMMUNICATIONS GROUNDING BUSBAR

- A. Solid copper busbar kit, 12.0 inches long X 4.0-inch-wide, wall-mounted, with standoffs.
 - 1. Ortronics P/N WMBB-12

2. Provide as shown on Drawings.

2.11 CABLE RUNWAY

- A. 12 inches wide, 10-foot lengths, steel construction, Telco Style.
- B. Cablofil 09-8104-0010-12
- C. Refer to Ortronics-Cablofil catalog for additional part numbers and accessories required proper installation of specified cable runway.

PART 3 EXECUTION

3.01 INSTALLATION PRACTICES

- A. All materials shall be installed as per the manufacturers' instructions, unless noted otherwise.
- B. Furnish and install telecommunication backboards on wall of communication equipment rooms as indicated. The bottom of the backboards shall be placed approximately six inches above finished floor (AFF), and must extend to a minimum height AFF of eight feet. Mount backboards with the smooth side facing away from the wall, and paint the backboard with two coats of fire-resistant white paint prior to mounting. A minimum of six appropriate fasteners shall be used for every sixteen square feet of backboard.
- C. Free-standing equipment racks shall be fastened to the communications room floor using a minimum of four 3/8-inch concrete anchors.
- D. Equipment racks shall be positioned according to drawings with a minimum of 3 feet clearance in front and back. The contractor shall field verify the dimensions of the room prior to installation of racks and report any discrepancies to the owner or owner's representative.
- E. Vertical wire managers for free-standing racks shall be bolted to the side or front of the rack using the manufacturers recommended hardware.
- F. All equipment racks, cabinets, enclosures, cable tray, conduits, and patch panels shall be bonded to the Telecommunications Grounding Busbar (TMG) (one per Telecommunications Room), which shall be bonded to the Telecommunications Main Grounding Busbar (TMGB), which shall be grounded to the main electrical ground in the main electrical room. Coordinate with electrical contractor. Coordinate exact routing and connection points with the electrical work. All surfaces that are used as a bond shall be filed to bare metal before completing connections.
- G. Install cable tray as shown in drawing package. The locations shown may need to be adjusted slightly in the field to assure proper placement.
- H. All tray sections shall be field cut to length as required with a minimum number of splice points. All field cuts shall be made using the manufacturers recommended equipment.

3.02 LABELING

- A. Label all racks within the BEF, TR, and TE with a unique identifier beginning with the number one, i.e. TR1-1. (Coordinate with Designer)
- B. Label the telecommunications grounding busbar and bonding conductor within the BEF, TR, and TE with a unique identifier, beginning with the number one, i.e. TGB-TR-1. (Coordinate with Designer).

C. Label all patch panels and wiring blocks within the BEF, TR, and TE with a number and a unique identifier, beginning with the AA, i.e. TR1-AA. (Coordinate with Designer)

END OF SECTION

14457.20

This page intentionally left blank

271500

SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. The project includes the installation of new Cat. 6 cabling and associated components. The existing raceways and pathways will be utilized in most case and new raceways and pathways will be required in locations where cabling does not currently exist. Pathways and raceways may need to be modified to accommodate cable fill and bend requirements. Refer to drawing and related specifications sections for additional information.
- B. Horizontal (distribution) communications wiring and connecting hardware from the Telecommunications Room (MDF, IDF, TR) to Telecommunication Outlets / Network Jacks throughout the site.

1.2 RELATED DOCUMENTS

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
 - 1. Contract Documents
 - 2. Division 00 Procurement & Contracting Requirements Group
 - 3. Division 1 General Requirements
 - 4. Section 27 10 00 Structured Cabling General Requirements
 - 5. Section 27 05 26 Grounding and Bonding for Communications Systems
 - 6. Section 27 11 00 Communications Equipment Room Fittings
 - 7. Section 27 17 01 Testing, Identification and Administration for Category 6 Cables

1.3 REFERENCES

A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:

1. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.

2. TIA/EIA-568-B – Commercial Building Telecommunications Cabling Standard, current version.

271500

- 3. TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
- 4. TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure, current version.
- 5. J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
- 6. IEEE 241 IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to communication systems.

1.4 SYSTEM DESCRIPTION

- A. The horizontal distribution subsystem refers to all intra-building twisted-pair and fiber optic communications cabling connecting Telecommunication Rooms (MDF, IDF, TR's) to telecommunication outlets / network jacks located at individual work areas.
- B. Horizontal cabling may consist of a combination of the following types of cable:
 - 1. Category 6, (100 Ohm, 23 Gauge AWG, 4-pair, unshielded twisted pair) cables.
- C. The Horizontal System includes cables, jacks, patch panels, connecting blocks, patch cords, fiber connectors and jumpers as well as the necessary support systems, such as cable managers and faceplates.
- D. Cables may be routed through conduit, cable trays, spaces below raised floors, open ceiling areas, non-ventilated spaces above ceiling tile, and through plenum air-handling spaces above ceiling tile.
- E. Furnish and install all materials necessary for a complete and working system.

1.5 WARRANTY

A. The contractor must be an approved certified installer of the cabling manufacturer and is responsible for workmanship and installation practices in accordance with the cabling manufacturer's guidelines. The certified contractor shall have 30% of their technicians trained on copper & fiber installations and testing by the cabling manufacturer. Provide a one (1) year warranty.

PART 2 - PRODUCTS

2.1 APPROVALS AND SUBSTITUTIONS

A. All products shall be provided as specified, unless an approved equal is provided.

COMMUNICATIONS HORIZONTAL CABLING

- B. Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).
- C. All products shall be "NEW".

2.2 CATEGORY 6 STATION CABLING

- A. Category 6 unshielded twisted pair (Superior Essex Data Gain)
 - 1. 100 ohm, Category 6+, 23AWG, 4-pair unshielded twisted pair, CMP rated,
 - a. Maximum insertion loss of 2.0 dB/100M at 1 MHz, 19.7 dB/100M at 100 MHz, 32.6 dB/100M at 250 MHz and 42.7 dB/100M at 400 MHz.
 - b. Electrical characteristics must be characterized to 550 MHz.
 - c. Each pair in the cable must be insulated with FEP
 - d. Cable must be third party verified by ETL.
 - e. 0.22" (5.5mm) Nominal Diameter
 - f. Refer to Color Coding for various systems and applications

2.3 MODULAR JACKS

- A. Category 6 modular jacks
 - 1. 8-position modular jack, Category 6, IDC terminals, T568A/B wiring scheme
 - 2. Each jack must be stamped or have icons to identify it as CAT 6.
 - 3. Panduit NetKey Part # NK688M*. Color Refer to Color Coding for various systems and applications.

2.4 FIELD TERMINATABLE RJ-45 JACKS:

- A. Category 6 modular jacks
 - 1. 8-position modular jack, Category 6, IDC terminals, T568A/B wiring scheme
 - 2. Terminates 22-26AWG Solid Conductors
 - 3. Legrand Part # FTPUC65E 5 pk
 - 4. Install on end of Cat 6 cables supporting Electronic Devices and IP Classroom Modules.
 - 5. Provide Cable Labels on new cables within 3 inches of jack.

2.5 WORK AREA OUTLETS

- A. Face Plates:
 - 1. One port wall telephone faceplate with mounting lugs for wall phone, constructed from stainless steel, mounts within a single gang wall box.
 - a. Panduit Part No. KWPY.

2. One port faceplate, constructed from high impact thermo-plastic, with recessed label fields, mounts within a single gang wall box.

a. Panduit NetKey Part No. NK1FIWY.

3. Two port faceplate, constructed from high impact thermo-plastic, with recessed label fields, mounts within a single gang wall box.

a. Panduit NetKey Part No. NK2FIWY.

4. Four port faceplate, constructed from high impact thermo-plastic, with recessed label fields, mounts within a single gang wall box.

a. Panduit NetKey Part No. NK4FIWY.

5. Six port faceplate, constructed from high impact thermo-plastic, with recessed label fields, mounts within a single gang wall box.

a. Panduit NetKey Part No. NK6FIWY.

- 6. All faceplate colors are to be coordinated with architect to match finish.
- B. Surface mounted outlet boxes:
 - 1. Two port surface mount box, constructed from high impact thermo-plastic, with recessed label fields, rated for plenum spaces.

a. Panduit NetKey Part No. NK2BXIW-AY.

- 2. Four port surface mount box, constructed from high impact thermo-plastic, with recessed label fields.
 - a. Panduit NetKey Part No. NK4BXIW-AY.
- 3. Six port surface mount box, constructed from high impact thermo-plastic, with recessed label fields.
 - a. Panduit NetKey Part No. NK6BXIW-AY.

2.6 TERMINATION BLOCKS

- A. Category 6 110-style blocks
 - 1. Category 6, 288 Pair, 110-style, with mounting legs, wall -mount.

a. Ortronics OR-110ABC6300.

2. Category 6, 96 Pair, 110-style, with mounting legs, wall -mount.

a. Ortronics OR-110ABC6100.

3. Category 6, 288 Pair, 110-style, without mounting legs, rack-mount.

a. Ortronics OR-110DBC6300.

COMMUNICATIONS HORIZONTAL CABLING

4. Category 6, 96 Pair, 110-style, without mounting legs, rack-mount.

a. Ortronics OR-110DBC6100.

- B. Wiring Troughs
 - 1. Horizontal trough for routing of patch cords and cross-connect wire, with mounting legs.
 - a. Ortronics OR-30200140.
 - 2. Horizontal trough for routing of patch cords and cross-connect wire, without mounting legs.
 - a. Ortronics OR-70400272.
- C. 110 block labels (Cat 6)
 - 1. Clear plastic holder for 110 blocks with paper inserts, for blocks with legs
 - a. Ortronics OR-70400646.
 - Clear plastic holder for 110 blocks with paper inserts, for blocks without legs

 a. Ortronics OR-70400680.
- D. Mounting Brackets
 - 1. 19 inch rack mount brackets for 200 pair 110 termination blocks and wiring troughs.
 - a. Ortronics OR-30600150.

271500

2.7 PATCH PANELS

A. Category 6 modular patch panels

- 1. 24 port, 8-position modular jack flat panel, high density, 6 port modules, Category 6, IDC terminals, T568A/B wiring scheme.
 - a. Panduit NetKey Part #NKPP24FMY

2.8 COLOR CODING

- 1. Various systems in the facilities have color coded network cabling, jacks and patch cables. Maintain this color coding for all of the new network cabling, jacks and patch cables.
 - a. Yellow: Standard in wall desk jacks, this would also be used for Printers, Copiers, Projectors and Displays
 - b. Purple / Violet: Sound & Lockdown System
 - c. Green: Wireless Access Point
 - d. Blue: IP Telephones
 - e. ORANGE: IP Cameras
 - f. White: VAP Detectors
 - g. Pink: Door Access Control (IP Control Panels above doors)
 - h. BEIGE: Analog Telephone / Fax Lines

2.9 PATCH CORDS/JUMPERS

- 1. Category 6 modular patch cords (Legrand Q-Series)
- 2. Factory terminated double ended, 8-position to 8-position, modular, stranded conductors, Category 6, 4 pair, 28 gauge, Legrand #576-RDXX-00X.
- 3. Color: Refer to Color Coding for various systems and applications.
- 4. Provide the following quantities and lengths for use to interconnect horizontal cabling to the Network Switches in telecom closets:
 - a. (500) 1 foot patch cables Yellow for Standard wall jacks
 - b. (50) 1 foot patch cables Blue for IP Telephones
 - c. (50) 1 foot Patch Cables Green for WAP's
 - d. (50) 1 Foot Patch Cables ORANGE for IP Cameras
- 5. Confirm Patch Cable colors and lengths with Owner prior to ordering.

PART 3 - EXECUTION

3.1 GENERAL

- A. Horizontal cabling includes cables, jacks, patch panels, connecting blocks, and patch cords, as well as the necessary support systems, such as cable managers and faceplates.
- B. Contractor shall furnish and install all materials necessary for a complete and working system.
- C. Contractor must be a certified manufacturer installer prior to, during, and through completion of the system installation.
- D. Field terminated copper and fiber optic patch cords and jumpers shall not be allowed. All patch cords shall be pre-terminated by the manufacturer.
- E. All work shall be performed in a professional manner.
- F. Install cable after interior of building has been physically protected from the weather and all mechanical work likely to damage cabling has been completed.
- G. Before installing cabling, ensure all cable pathways are completely and thoroughly cleaned:
- H. Inspect conduit, wireway, cable trays, and innerduct installed by others.
- I. Clean any additional enclosed raceway and innerduct systems furnished.
- J. Provide protection for exposed cables where subject to damage.
- K. Provide abrasion protection for any cable or wire bundles, which pass through holes or across edges of sheet metal. Protective bushings shall be used to protect cables.
- L. Cable ties and other cable management clamps shall be no more than hand tightened and shall fit snugly, but not compress, crimp, or otherwise change the physical characteristics of the cable jacket or distort the placement of twisted-pair components. Replace any cable exhibiting stresses due to over tightening of cable management devices. Plenum spaces require Plenum rated cable ties.
- M. Where possible, route cables in overhead cable trays and inside wire management systems attached to the equipment cabinets and racks. Use plastic ties or ducts to restrain cabling

installed outside of wire management systems on racks or in cabinets. Cable trays shall not exceed 50% fill.

- N. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- O. Cable raceways shall not be filled greater than the TIA/EIA-569-A maximum fill for the particular raceway type.
- P. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids, plumbing pipes, and electrical conduits.
- Q. Horizontal distribution cables shall be bundled in groups of no more than the amount of cables designed for by the cable support manufacturer recommends based on cable OD and weight. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- R. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
- S. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- T. All Conduit Sleeves and wire way trays penetrating fire walls shall have 3M Fire Barrier Pillows installed. Contractor is responsible to place fire barrier pillows on all existing penetrations that will be reused to run new cable and all new penetrations required for the new cable installation. Fire barrier Pillows shall be placed per manufacturer's recommendation to create a 2 hour fire barrier.

3.2 UNSHIELDED TWISTED PAIR CABLE INSTALLATION PRACTICES

- A. Cable shall be installed in accordance with manufacturer recommendations and best industry practices.
- B. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- C. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.

- D. The cable's minimum bend radius and maximum pulling tension shall not be exceeded Bend radius for UTP = 4 X Cable OD, FTP = 8 X Cable OD.
- E. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- F. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable. Separation from Power Lines:
- G. Provide the following minimum separation distances between pathways for copper communications cables and power wiring of 480 volts or less:
 - 1. Open or Nonmetal Communications Pathways:
 - a. 12 inches from electric motors, fluorescent light fixtures, and unshielded power lines carrying up to 3 kVA.
 - b. 36 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
 - c. 48 inches from large electrical motors or transformers.
 - 2. Grounded Metal Conduit Communications Pathways:
 - a. 2 1/2 inches from electrical equipment and unshielded power lines carrying up to 2 kVA.
 - b. 6 inches from electrical equipment and unshielded power lines carrying from 2 kVA to 5 kVA.
 - c. 12 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
 - d. 3 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA.
 - e. 6 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying more than 5 kVA.

3.3 UNSHIELDED TWISTED PAIR TERMINATION

- A. Cables shall be coiled to house the cable coil without exceeding the manufacturers bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored; Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
- B. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B.1 document, manufacturer's recommendations and best industry practices.

14457.20

- C. All 4 pair cables shall be terminated on the jack and patch panels using T568-B wiring scheme.
- D. Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- E. Bend radius of the horizontal cable shall not be less than 4 times the outside diameter of the UTP cable. 8 times for FTP cables.
- F. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.
- G. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- H. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- I. The cable jacket shall be maintained as close as possible to the termination point. Cable shall not have more than 1.0" removed.

3.4 TESTING AND LABELING PROCEDURES

- A. Refer to Specifications Section 271701 Testing, Identification and Administration for Category 6 Cable.
- B. All horizontal cables are to be labeled using a machine printed label at each end of the cable at approximately 12 inches of the termination point, and again at approximately 48 inches from the termination point. Handwritten labels shall not be used.
- C. All patch panel ports and telecommunication outlet ports shall be labeled with the cable identifier.
- D. The labels shall denote the Telecommunications outlet ID, as well as the unique cable number for that Telecom Outlet, i.e. A-001-A for cable number 1, A-001-B for cable number 2, and so forth. Owner may provide specific labeling requirements coordinate with owner.
- E. Note all labeling information on the as-built drawings.

END OF SECTION

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

271701

SECTION 27 17 01

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.
- B. In order to conform to the overall project event schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.
- C. In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.

1.02 SCOPE

- A. This Section includes the minimum requirements for the test certification, identification and administration of horizontal balanced twisted pair cabling.
- B. This Section includes minimum requirements for:
 - 1. Copper cabling test instruments
 - 2. Copper cabling testing
 - 3. Identification
 - a) Labels and labeling
 - 4. Administration
 - a) Test results documentation
 - b) As-built drawings
- C. Testing shall be carried out in accordance with this document.
- D. Testing shall be performed on each cabling link. (100% testing)
- E. All tests shall be documented and submitted to Owner for review

1.03 QUALITY ASSURANCE

- A. All testing procedures and field-test instruments shall comply with applicable requirements of:
 - 1. ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - 2. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
 - 3. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard
 - 4. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
 - 5. ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

271701

- B. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
 - 1. Manufacturer of the connectors or cable.
 - 2. Manufacturer of the test equipment used for the field certification.
 - 3. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)
- C. The Owner or the Owner's representative shall be invited to witness and/or review field-testing.
 - 1. The Owner or the Owner's representative shall be notified of the start date of the testing phase five (5) business days before testing commences.
 - 2. The Owner or the Owner's representative will select a random sample of 5% of the installed links. The Owner or the Owner's representative shall test these randomly selected links and the results are to be stored in accordance with Part 3 of this document. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% testing at no cost to the Owner.

1.04 SUBMITTALS

- A. Manufacturers catalog sheets and specifications for the test equipment.
- B. A schedule (list) of all balanced twisted-pair copper links to be tested.
- C. Sample test reports.

1.05 ACCEPTANCE OF TEST RESULTS

- A. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in tested for:
 - 1. Wire Map
 - 2. Length
 - 3. Propagation Delay
 - 4. Delay Skew
 - 5. DC Loop Resistance recorded for information only
 - 6. DC Resistance Unbalance recorded for information only
 - 7. Insertion Loss
 - 8. NEXT (Near-End Crosstalk)
 - 9. PS NEXT (Power Sum Near-End Crosstalk)
 - 10. ACR-N (Attenuation to Crosstalk Ratio Near-End) recorded for information only
 - 11. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) recorded for information only
 - 12. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - 13. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - 14. Return Loss

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

- 15. TCL (Transverse Conversion Loss) recorded for information only
- 16. ELTCTL (Equal Level Transverse Conversion Transfer Loss) recorded for information only
- 17. PS ANEXT (Power Sum Alien Near-End Crosstalk) sampled per section 3.2
- 18. Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk) sampled per section 3.2
- 19. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End) sampled per section 3.2
- 20. Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End) sampled per section 3.2
- B. All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described in Part 3. Any Permanent Link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation in accordance with Part 3.
- C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

PART 2 - PRODUCTS

2.01 BALANCED TWISTED-PAIR CABLE TESTERS

- A. The field-test instrument shall be within the calibration period recommended by the manufacturer, typically 12 months.
- B. Certification tester
 - 1. Accuracy
 - a) Level IIIe accuracy in accordance with ANSI/TIA-1152
 - b) Independent verification of accuracy
 - c) Acceptable manufacturers
 - 1) Fluke Networks
 - 2. Permanent Link Adapters
 - a) RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C
 - b) Twisted pair Category 5e, 6, 6A, 7 or 7_A cords are not permitted as their performance degrades with use and can cause false Return Loss failures
 - 3. Results Storage
 - a) Must be capable of storing > 10,000 results for all measurements found in 2.1.B.4 below
 - 4. Measurement capabilities
 - a) Wire Map
 - b) Length
 - c) Propagation Delay

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

271701

- d) Delay Skew
- e) DC Loop Resistance
- f) DC Resistance Unbalance
- g) Insertion Loss
- h) NEXT (Near-End Crosstalk)
- i) PS NEXT (Power Sum Near-End Crosstalk)
- j) ACR-N (Attenuation to Crosstalk Ratio Near-End)
- k) PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
- I) ACR-F (Attenuation to Crosstalk Ratio Far-End)
- m) PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
- n) Return Loss
- o) TCL (Transverse Conversion Loss)
- p) ELTCTL (Equal Level Transverse Conversion Transfer Loss)
- q) Time Domain Reflectometer
- r) Time Domain Xtalk Analyzer
- s) PS ANEXT (Power Sum Alien Near-End Crosstalk)
- t) Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk)
- u) PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
- v) Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

C. PC Software

- 1. Windows® based.
- 2. Must show when 3 dB and 4 dB rules are applied
- 3. Re-certification capability, where results must have their Cable IDs suffixed with (RC).
- 4. Built in PDF export no additional third party software permitted.
- 5. Built-in statistical analysis.

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

271701

2.02 IDENTIFICATION

A. Labels

- 1. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- 2. Shall be preprinted using a mechanical means of printing (e.g., laser printer).
- 3. Where used for cable marking, provide vinyl substrate with a white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow so that the labels are easily distinguishable.
- 4. Where insert type labels are used provide clear plastic cover over label.
- 5. Provide plastic warning tape 6 inches wide continuously printed and bright colored 18" above all direct buried services, underground conduits and duct-banks.
- 6. Acceptable Manufacturers:
 - a) Brady Corporation
 - b) Silver Fox
 - c) Brothers

2.03 ADMINISTRATION

- A. Administration of the documentation shall include test results of each Permanent Link.
- B. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
- C. The test result records saved within the field-test instrument shall be transferred into a Windows® based database utility that allows for the maintenance, inspection and archiving of these test records.
- D. Alien Crosstalk measurements shall be stored to a PC upon completion of the test.

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

271701

PART 3 – EXECUTION

- 3.01 GENERAL
 - A. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

3.02 BALANCED TWISTED PAIR CABLE TESTING

- A. Field-test instruments shall have the latest software and firmware installed.
- B. Permanent Link test results including the individual frequency measurements from the tester shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- C. Permanent Link testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.
- D. Alien Crosstalk testing shall be performed using a sampling plan. An acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in ISO 2859-1 for populations of up to 500,000 links shall be used. The following table represents this sampling level.

Installation size (No. of total links)	Sample size (No. of links to test)
3 – 33	100%
34 – 3,200	33
3,201 – 35,000	126
35,001 - 150,000	201
150,001 - 500,000	315

Disturbed (Victim) links chosen for Alien Crosstalk testing shall be an equal combination of short, medium and long links.

- E. Permanent Link adapters made from twisted pair Category 5e, 6, 6A, 7 or 7_A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
- F. The installer shall build a reference link. All components shall be anchored so it is not possible to disturb them. The technician is to conduct a Category 6A Permanent Link test each day to ensure no degradation of the tester or its Permanent Link adapters.
- G. Wire Map Measurement
 - 1. The wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors. For each of the 8 conductors in the cabling, the wire map indicates:
 - a) Continuity to the remote end
 - b) Shorts between any two or more conductors
 - c) Reversed pairs
 - d) Split pairs
 - e) Transposed pairs
 - f) Distance to open on shield

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

- g) Any other miss-wiring
- 2. The correct connectivity of telecommunications outlets/connectors is defined in ANSI/TIA-568-C.2. Two color schemes are permitted. The user shall define which scheme is to be used. The field tester shall document which color scheme was used.
- H. Length Measurement
 - 1. The length of each balanced twisted pair shall be recorded.
 - 2. Since physical length is determined from electrical length, the physical length of the link calculated using the pair with the shortest electrical delay shall be reported and used for making the pass or fail determination.
 - 3. The pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in ANSI/TIA-568-C.2 plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a Permanent Link, the length measurement can be 325 ft. (99 m) before a fail is reported.
- I. Propagation Delay measurement
 - 1. Is the time it takes for a signal to reach the end of the link.
 - 2. The measurement shall be made at 10 MHz per ANSI/TIA-1152.
 - 3. The propagation delay of each balanced twisted pair shall be recorded.
 - 4. Is not to exceed 498 ns per ANSI/TIA-568-C.2 Section 6.3.18.
- J. Delay Skew measurement
 - 1. Is the difference in propagation delay @ 10 MHz between the shortest delay and the delays of the other wire pairs.
 - 2. The delay skew of each balanced twisted pair shall be recorded.
 - 3. Is not to exceed 44 ns per ANSI/TIA-568-C.2 Section 6.3.19.
- K. DC Resistance
 - 1. Often reported as Resistance, is the loop resistance of both conductors in the pair.
 - 2. Is not specified in ANSI/TIA-1152, but shall be recorded for all four pairs.
- L. DC Resistance Unbalance
 - 1. Often reported as Resistance Unbalance, is the difference in resistance of the two wires within the pair.
 - 2. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be recorded for all four pairs.
- M. Insertion Loss
 - 1. Is the loss of signal strength over the cabling (in dB).
 - 2. The frequency resolution shall be:
 - a) 1 31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

- 3. Worst case shall be reported for all four pairs in one direction only.
- Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk
 (*).
- 5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.7.
- N. NEXT (Near-End Crosstalk)
 - 1. Is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
 - 2. The frequency resolution shall be:
 - a) 1 31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. Shall be measured in both directions. (12 pair to pair possible combinations)
 - 4. Both worst case and worst margins shall be reported.
 - 5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.8.
 - Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk
 (*).
 - 7. The Time Domain Xtalk data shall be stored for any marginal or failing NEXT results.
- O. PS NEXT (Power Sum Near-End Crosstalk)
 - 1. Is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. Shall be measured in both directions. (8 pair possible combinations)
 - 4. Both worst case and worst margins shall be reported.
 - 5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.9.
 - Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk
 (*).
 - 7. The Time Domain Xtalk data shall be stored for any marginal or failing PS NEXT results.
- P. ACR-N (Attenuation Crosstalk Ratio Near-End)
 - 1. Is a calculation of NEXT minus Insertion Loss of the disturbed pair in dB.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

- b) 31.25 100 MHz: 250 kHz
- c) 100 250 MHz: 500 kHz
- d) 250 500 MHz: 1000 kHz
- 3. Shall be calculated in both directions.
- 4. Is not specified in ANSI/TIA-1152, but shall be recorded for all 12 possible combinations.
- Q. PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-End)
 - 1. Is a calculation of PS NEXT minus Insertion Loss of the disturbed pair in dB.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. Shall be calculated in both directions.
 - 4. Is not specified in ANSI/TIA-1152, but shall be recorded for all 8 possible combinations.
- R. ACR-F (Attenuation Crosstalk Ratio Far-End)
 - 1. Is a calculation of FEXT minus Insertion Loss of the disturbed pair in dB.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. Shall be measured in both directions. (24 pair to pair possible combinations)
 - 4. Both worst case and worst margins shall be reported.
 - 5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.11.
 - Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
- S. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - 1. Is a calculation of PS FEXT minus Insertion Loss of the disturbed pair in dB.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. Shall be measured in both directions. (8 pair possible combinations)

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

- 4. Both worst case and worst margins shall be reported.
- 5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.13.
- Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk
 (*).
- T. Return Loss
 - 1. Is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. Shall be measured in both directions. (8 pair possible combinations)
 - 4. Both worst case and worst margins shall be reported.
 - 5. Shall be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
 - 6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.6.
 - Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
 - 8. The Time Domain Reflectometer data shall be stored for any marginal or failing Return Loss results.
- U. TCL (Transverse Conversion Loss)
 - 1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
 - 2. The frequency resolution shall be:
 - a) 1 31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. Shall be measured in both directions.
 - 4. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be recorded for all 8 possible combinations.
- V. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - 1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

- c) 100 250 MHz: 500 kHz
- d) 250 500 MHz: 1000 kHz
- 3. Shall be measured in both directions.
- 4. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be recorded for all 8 possible combinations.
- W. PS ANEXT (Power Sum Alien Near-End Crosstalk)
 - 1. Takes into account the combined alien crosstalk (statistical) on a receive pair from all external nearend disturbers operating simultaneously.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. The disturbed (victim) link shall have links to the left and right of it and if present, links above and below it.
 - 4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
 - 5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
 - 6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.21.
- X. Average PS ANEXT (Power Sum Alien Near-End Crosstalk)
 - 1. Is calculated by averaging the individual PSANEXT loss values, in dB, for all four pairs in the disturbed (victim) link.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.22.
- Y. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
 - AFEXT loss is the coupling of crosstalk at the far-end from external link pairs into a disturbed (victim) pair of the 4-pair link under test. PS AACR-F is the calculated power sum from all external pairs into the disturbed (victim) pair.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz

1.

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

- d) 250 500 MHz: 1000 kHz
- 3. The disturbed (victim) link shall have links to the left and right of it and if present, links above and below it.
- 4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
- 5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
- 6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.25.
- Z. Average PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
 - Is calculated by averaging the individual PS AACR-F values, in dB, for all four pairs in the disturbed (victim) link.
 - 2. The frequency resolution shall be:
 - a) 1-31.25 MHz: 150 kHz
 - b) 31.25 100 MHz: 250 kHz
 - c) 100 250 MHz: 500 kHz
 - d) 250 500 MHz: 1000 kHz
 - 3. The disturbed (victim) link shall have links to the left and right of it and if present, links above and below it.
 - 4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
 - 5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
 - 6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.26.

3.03 ADMINISTRATION

- A. Test results documentation
 - Test results saved within the field-test instrument shall be transferred into a Windows[™]-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
 - 2. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
 - 3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD or DVD prior to Owner acceptance of the building. This CD or DVD shall include the software tools required to view, inspect, and print any selection of the test reports.
 - 4. Circuit IDs reported by the test instrument should match the specified label ID
 - 5. For Permanent Link testing, the detailed test results documentation data is to be provided in an electronic database for each tested balance twisted-pair and shall contain the following information

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

- a) The overall Pass/Fail evaluation of the link-under-test
- b) The date and time the test results were saved in the memory of the tester
- c) The identification of the customer site as specified by the end-user
- d) The name of the test limit selected to execute the stored test results
- e) The name of the personnel performing the test
- f) The version of the test software and the version of the test limit database held within the test instrument
- g) The manufacturer, model and serial number of the field-test instrument
- h) The adapters used
- i) The factory calibration date
- j) Wire Map
- k) Propagation Delay values, for all four pairs
- I) Delay Skew values, for all four pairs
- m) DC Resistance values, for all four pairs
- n) DC Resistance Unbalance, values for all four pairs
- o) Insertion Loss, worst case values for all four pairs
- p) NEXT, worst case margin and worst case values, both directions
- q) PS NEXT, worst case margin and worst case values, both directions
- r) ACR-F, worst case margin and worst case values, both directions
- s) PS ACR-F, worst case margin and worst case values, both directions
- t) Return Loss, worst case margin and worst case values, both directions
- u) TCL, worst case values both directions
- v) ELTCTL, worst case values, both directions.
- w) Time Domain Crosstalk data if the link is marginal or fails
- x) Time Domain Reflectometer data if the link is marginal or fails
- 6. For Alien Crosstalk testing, the detailed test results documentation data is to be provided in an electronic database for each tested balance twisted-pair and shall contain the following information
 - a) The overall Pass/Fail evaluation of the link-under-test
 - b) The date and time the measurements were made
 - c) The identification of the customer site as specified by the end-user
 - d) The name of the test limit selected to execute the stored test results
 - e) The name of the personnel performing the test
 - f) The version of the test software
 - g) PS ANEXT, worst case margin for all four pairs
 - h) Average PS ANEXT, worst case margin

TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE

271701

- i) PS AACR-F, worst case margin for all four pairs
- j) Average PS AACR-F, worst case margin
- B. Record copy and as-built drawings
 - Provide record copy drawings periodically through out the project as requested by the Construction Manager or Owner, and at end of the project on a CD or DVD. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:
 - a) Field directed changes to pull schedule.
 - b) Horizontal cable routing changes.
 - c) Associated detail drawings.

END OF SECTION
SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

275010

SECTION 27 50 10

SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The drawings and general provisions of the Contract Documents apply to this Section.

1.02 SUMMARY

- A. The Tappan Zee High School had a new Rauland Sound System and Lockdown System with Electronic Displays installed in the Summer of 2023. This system will remain in place and there will be minor modifications of the cabling and associated end devices to accommodate the new Renovations.
- B. The District's maintenance Contractor of the new Sound & Lockdown System is:
 - 1. OSI Metro, 258 Route 117 Bedford Hills, NY 10507 Contact Person: Rob Rutigliano 914-241-0057 <u>Rrutigliano@osmetro.com</u>
- C. This project includes but is not limited to the following:
 - 1. Removal and reinstallation of Sound and Lockdown System equipment with associated cabling.
 - 2. Installation of new of Sound and Lockdown System equipment with associated cabling.
 - 3. System programming to align with new renovations and use of various spaces in the facility.

1.03 SUBMITTALS

- A. Product data for each component.
- B. Shop Drawings: Prior to proceeding with the work: Provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection, and a complete schedule of all equipment and materials with associated manufacturers cuts sheets which are to be used.
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances.
 - 2. Drawings and lists indicating proposed nameplate nomenclature and arrangements for control panels and plug panels prior to fabrication reflecting equipment used.
 - 3. Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, Systems Contractor's name in the title block.

SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

275010

- 4. Details and descriptions of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.
- C. FCC Approval: The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Systems, which are not FCC approved or utilize an intermediary device for connection, will not be considered. Provide the FCC registration number of the system being proposed as part of the submittal process.
- D. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.
- E. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
- F. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.
- G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
- H. Maintenance Data: For equipment to be included in maintenance manuals specified in Division
 - 1. Record of Owners equipment-programming option decisions.
 - 2. All instructions necessary for proper operation and manufacturer's instructions.
 - 3. "Proof of Performance" information.
 - 4. Manufacturer's maintenance information.
 - 5. Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.
- Record Drawings: Prior to final acceptance, provide two complete sets of drawings indicating all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions. These Record Drawings will be used during "Final Acceptance Testing".
- J. System Training: Submit the following information describing the training programs and system trainers.
 - 1. Include with the submittal a preliminary staff development training program in outline form for review and approval by the owner's representative.
 - Include with the submittal a current copy of the trainer's certification from the manufacturer that certifies and identifies the trainer(s) who are eligible to provide training and support for the project.
 - 3. Include with the submittal a current copy of trainer's need's assessment form which will be reviewed with the owner's designated representative for the system's preliminary system programming and configuration.
 - 4. Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.
- K. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required **five-year** equipment warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary.

SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

275010

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following with in thirty (30) days after notification to proceed:
- B. Provide a list of installations that the Installer has specifically installed for verification by the Owner. The Installer, not its employees, must meet these qualifications.
- C. The Installer shall demonstrate to the satisfaction of the Owner or his representative that he has:
 - 1. Adequate plant and equipment to pursue the work properly and expeditiously.
 - 2. Adequate staff and technical experience to implement the work.
 - 3. Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.
- D. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of a "Installer" who does meet the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/ Engineer. The "Installer" shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer
- E. Each major component of equipment shall have the manufacturers name, address and model number on a plate securely affixed in a conspicuous place. NEMA code ratings, UL Label, or other data that is die-stamped into the surface of the equipment shall be easily visible.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- G. Comply with NFPA 70
- H. Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools.
- I. Comply with UL 60950.

1.05 IN-SERVICE TRAINING

- A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions
- B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.
- C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

275010

1.06 WARRANTY

- A. Provide a manufacturer's five-year warranty of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic equipment, as well as speakers. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one-year warranty shall be provided for labor.
- B. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard in quality.
- C. During the first year of warranty, which includes material & labor, the Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.
- D. Make available a service contract offering continuing factory authorized service of the system after the initial one-year material & labor warranty period.

1.07 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide the following system:
 - 1. Telecenter "U" (Universe) manufactured by Rauland-Borg Corp.

PART 2 PRODUCTS

- A. Surface Speaker / Electronic Display Housing & Baffle
 - 1. Surface mounted housing: Rauland ACC3011SBB
 - 2. Speaker / Display Baffle: Rauland ACC3011S with Rauland US0880 8 inch speaker and 2 patch cables. Rauland IP Classroom Module TCC2011A shall be provided separately.
- B. IP ceiling mounted speaker assemblies
 - 1. Ceiling speaker assemblies shall consist of an 8 in. round coaxial speaker with integral RJ-45 Network Jack (Rauland ACC1480) and IP Classroom Module (Rauland TCC2011A) an insulated metal backbox, and a metal ceiling tile support bridge. The ceiling speaker shall incorporate the following components, functions, and features:
 - 2. Frequency range shall be 65Hz to 17kHz.
 - 3. Power rating shall be 8 watts RMS.
 - 4. Sensitivity shall be 93 dB @ 4 ft. with 1-watt input.
 - 5. Magnet shall be 5.0 oz. ceramic.
 - 6. Voice coil impedance shall be 8 ohms.
 - 7. Transformer taps for 25/70 v. shall be 5/16, 5/8, $1\frac{1}{4}$, $2\frac{1}{2}$, and 5 watts.
 - 8. Metal insulated backbox shall be a model ACC1101 by Rauland-Borg Corp.
 - 9. Ceiling tile support bridge shall be a model ACC1104 by Rauland-Borg Corp.

SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

275010

- C. Analog ceiling mounted speaker assemblies
 - 1. Ceiling speaker assemblies shall consist of an 8 in. round coaxial speaker with integral 25volt transformer, an insulated metal backbox, and a metal ceiling tile support bridge. The ceiling speaker shall incorporate the following components, functions, and features:
 - 2. Speaker shall be 8 in. round coaxial design pre-assembled with integral 25/70-volt transformer and white circular grille.
 - 3. Frequency range shall be 65Hz to 17kHz.
 - 4. Power rating shall be 8 watts RMS.
 - 5. Sensitivity shall be 93 dB @ 4 ft. with 1-watt input.
 - 6. Magnet shall be 5.0 oz. ceramic.
 - 7. Voice coil impedance shall be 8 ohms.
 - 8. Transformer taps for 25/70 v. shall be 5/16, 5/8, 1 ¼, 2 ½, and 5 watts.
 - 9. Speaker assembly shall be a model ACC1401 by Rauland-Borg Corp.
 - 10. Metal insulated backbox shall be a model ACC1101 by Rauland-Borg Corp.
 - 11. Ceiling tile support bridge shall be a model ACC1104 by Rauland-Borg Corp.
- D. Analog wall mounted speaker assemblies
 - 1. Wall mounted speaker assemblies shall consist of an 8 in. diameter speaker housed in a prefabricated metal housing with a metal grille. The speaker shall be provided from the factory with a 25/70V transformer and the entire assembly shall come from the manufacturer pre-assembled.
 - 2. Speaker Type: 8 inch (20.3 cm) Permanent Magnet, with "Whizzer" cone for extended high-frequency response.
 - 3. Power Rating: 8 watts RMS
 - 4. Sensitivity: 93 dB @ 1 meter with 1 Watt input
 - 5. Frequency Response: 65 to 17,000 Hertz
 - 6. Magnet: 5 oz. (141.7 g) ceramic
 - 7. Voice Coil Impedance: 8 ohms
 - 8. Voice Coil Diameter: 0.75 inches (1.9 cm)
 - 9. Transformer: 25V/70V
 - 10. Taps at 5/16, 5/8, 11/4, 21/2, and 5 Watts
 - 11. Baffle Size: Square 111/2" (29.2 cm)
 - 12. Housing and Baffle Finish: Textured Off-White Epoxy Semi-Gloss
 - 13. Dimensions: 115/8 in. wide, 51/2 in. deep at top, 31/8 in. deep at bottom, 113/8 in. high
 - 14. Weight: 4 lbs., 2 oz.

SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

275010

- 15. Wall mount Speaker Assemblies shall be a model ACC1208 by Rauland-Borg.
- E. Paging Horn Speaker Assemblies
 - 1. Paging horns shall be a wide-angle paging projector consisting of an integrated driver assembly combined with a double re-entrant, non-resonant heavy-duty ABS resin horn.
 - 2. Paging horns shall contain a built-in, weatherproofed 25- and 70-volt line matching transformer and shall be provided with a screwdriver adjustable impedance wattage switch.
 - 3. Power taps shall be available as follows: 1.8, 3.7, 7.5, and 15 watts on 25-volt lines.
 - 4. The loudspeaker driver assembly shall have a heavy-duty magnet, and a self-aligning, field replaceable diaphragm.
 - 5. Power handling capacity shall be 30 watts at full range and produce 107dB at 1 meter on axis with 1-watt input.
 - 6. Frequency response shall be 225 to 14,000 Hz.
 - 7. Dispersion shall be no less than 120° horizontal and no greater than 60° vertical.
 - 8. The assembly shall include a die-cast universal mounting bracket permitting single locking pin adjustment on vertical or horizontal planes.
 - 9. Termination to the device shall be by means of screw terminals, protected by an environmental cover, and having an integral cable strain relief.
 - 10. The unit shall be totally weatherproof, with horn and reflex cone construction of heavy-duty high-impact ABS resin.
 - 11. The driver and transformer housing and mounting bracket shall be weatherproof heavy diecast aluminum. All exposed parts and hardware shall be entirely impervious to weather.
 - 12. Finish shall be gray.
 - 13. Dimensions shall not exceed 14-1/4" wide, 6" high, 13-11/16" deep.
 - 14. Paging horn speaker assemblies shall be a model 3603 by Rauland-Borg.
 - 15. Provide Rauland Model A30G weather tight adaptor for exterior horns.
- F. IP Classroom Module: Model TCC2011A
- G. Electronic Displays:
 - 1. Rauland TCC3100S Message Board.
 - 2. Mounting Accessories for installation in Rauland ACC3011S Baffle and associated Rauland ACC3011SBB Backbox.
 - 3. Mounting Accessories and back box for surface wall mounting.
- H. Large Electronic Displays:
 - 1. Rauland TCC3012L Large Message Board.
 - 2. Mounting Accessories and back box for surface wall mounting.

SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

275010

3. Provide a custom wire guard with 9 gauge wire material as manufactured by STI. <u>https://www.sti-usa.com/custom-wire-cages/</u>

2.02 BLUE LOCKDOWN STROBES

- A. Amber Lenses have been tested to meet UL 1971 light distribution
- B. Choice of strobe lens colors amber, blue, red (some models or by special order)
- C. Field selectable candela settings of 15/30/75/95cd or high intensity models with 115/177cd settings
- D. Indoor 24VDC models with UL "Regulated Voltage" at 16-33 VDC using filtered DC or unfiltered FWR input voltage
- E. Multitone appliance
- F. Strobes can be synchronized with Wheelock's DSM sync modules or SAFEPATHTM4 power supplies
- G. Combination speaker/strobes available for voice messages with visual alerting
- H. Mount to standard electrical boxes
- I. High quality designs from the leader in fire notification alarms
- J. Exterior shall be weather proof and include surface mount box
- K. Design Make: Interior: Wheelock -RSSB-24MCC-NW, Exterior Wheelock -MTWPB-2475W-NW
- L. Provide wire guards in gymnasiums.

2.08 CAT 6 PATCH CABLES

- 1. Provide all patch cables as required at the network rack and the end devices to interconnect equipment with Cat 6 horizontal wiring and end equipment devices.
- 2. Provide Cat 6 Patch Cables, 28 Gauge, Legrand 576-RD40-00X (purple).
- 3. Provide quantity and lengths as required by the project. Refer to the Drawings. Field investigate project requirement prior to ordering.

PART 3 PART 3 – EXECUTION

3.01 GENERAL

A. EXAMINATION: Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- 1. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.
- 2. Furnish and install all material, devices, components and equipment for a complete operational system.

SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

275010

- 3. Impedance and Level Matching: Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.
- 4. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
- 5. All housings are to be located as indicated.
- 6. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.
- 7. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
- 8. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12 inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.
- 9. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.
- 10. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

3.03 GROUNDING

- 1. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
- 2. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.
- 3. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

3.04 FIELD QUALITY CONTROL

- 1. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- 2. Inspection: Make observations to verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.
- 3. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM

275010

3.05 FINAL ACCEPTANCE TESTING

- 1. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.
- 2. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.
- 3. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.06 COMMISSIONING

- A. The contractor shall train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. This training will be in accordance with the training as outlined in Section 1.6, paragraphs 3, 5 & 6 of these specifications. In addition to the Training Materials provided, the contractor will also furnish Operators Manuals and Users Guides at the time of this training.
- B. Schedule training with Owner through the owner's representative, with at least seven days advance notice.

3.07 OCCUPANCY ADJUSTMENTS

A. The contractor shall provide Occupancy Adjustments in accordance with Section 1.6, paragraph 9 of these specifications. A response scenario amenable to both the owner and the contractor will be established and followed for the first year of service.

3.08 CLEANING AND PROTECTION

A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner's representative.

END OF SECTION

This page intentionally left blank

INTRUSION DETECTION SYSTEM

281600

SECTION 28 16 00 INTRUSION DETECTION 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 an Intrusion Detection System consisting of electric door monitoring hardware, motion sensing devices, system controllers, monitor/control stations or keypads, and associated equipment.
- B. The existing intrusion detection system at South Orangetown High School will be modified to accommodate the renovations to the school. This includes but is not limited to control panels, motion detectors, and associated wiring. Existing alarm points, such as door contacts, shall be maintained.
- C. Some of the existing motion detectors will be removed in their entirety along with their associated wiring. Other existing motion detectors are newer and will be removed and re-installed after the spaces are renovated and will utilize the existing wiring. All wiring will need to be extended as required for the new locations of the motion detectors. Refer to the Drawings for more detail.
- D. Existing Motion Detectors will need to be installed as shown on the drawings. Provide the associated wiring and terminate on the existing intrusion detection panel and /or wiring buss.
- E. Contractor shall survey all facilities and document existing system prior to demolition and provide complete inventory of intrusion detection devices.
- F. Related Sections:
 - 1. SECTION 27 05 11 Requirements for Communications Systems
 - 2. SECTION 27 05 28 Interior Pathways

1.3 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. PIR: Passive infrared.
- C. RFI: Radio-frequency interference.
- D. UPS: Uninterruptible power supply.

281600

- E. Control Unit: System component that monitors inputs and controls outputs through various circuits.
- F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
- G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
- H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
- I. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
- J. Zone. A defined area within a protected premise. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
 - 1. Include manufacturer's technical data for all material and equipment at the system and sub system level to be provided as part of the system.
 - 2. Provide complete manufacturer's data for each item listed in PART 2 below.
- B. Shop Drawings:
 - 1. Indicate all system device locations on architectural floor plans. No other system(s) shall be included on these plans.
 - 2. Include full schematic wiring information on these drawings for all devices modified or added to the existing system. Wiring information shall include cable type, conductor routings, quantities, and connection details at device
 - 3. Include a complete one-line, block diagram.
 - 4. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 5. Cable Administration Drawings: As specified in "Identification" Article.
- C. Contract Close-Out Submittals:

INTRUSION DETECTION SYSTEM

281600

- 1. 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.
- 2. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the Access Control System to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the Access Control System. Copies of the final as-built drawings shall be provided to the end user hard copy and electronic format.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications
 - 1. System Vendor shall be certified by existing intrusion detection system Manufacturer and shall be an established organization with referenced and documented experience delivering and maintaining Security Management Systems of equal or higher sophistication and complexity as compared to the system detailed in this specification.
- B. Bidder Qualifications: The Bidder shall be regularly engaged in the installation and maintenance of specified systems and shall meet the following qualifications at the time of the bid:
 - 1. Hold a valid Security system installers license by the State of New York.
 - 2. District's current Intrusion Detection System Maintenance Vendor is:

Sean Werlau Open Systems Metro 914-241-0057 swerlau@osmetro.com

- 3. To the fullest extent possible, provide products of the same kind, from a single source, and from the same manufacturer.
- C. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.
- D. The Contractor and the System Vendor are jointly responsible to remedy defects due to faulty workmanship and materials that appear within one year from the date of acceptance in accordance with the General Conditions, unless Specifications specify a different duration
- E. The system shall include all wiring, installation, supervision, calibration, adjustments, and checkout necessary for a complete and fully operational system.
- F. The System contractor shall have single source responsibility of the complete installation and proper operation of the system as specified and shall include debugging and proper calibration and commissioning of each component in the entire system.

INTRUSION DETECTION SYSTEM

14457.20

281600

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of the system that fail, or do not function in substantial accordance to the published specification, within the specified warranty period.
 - 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONTROL PANEL (existing)

A. The District has older ADT Focus 200 Intrusion Detection Panels. These panels will continue to be utilized to support all intrusion detection system devices.

2.2 MOTION DETECTORS (existing)

A. Existing motion detectors shall be removed and stored for re-installation in renovated spaces. Label all existing motion detectors as they need to be re-installed in the exact same space.

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 intrusion detection.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with UL 681 and NFPA 731.
- B. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.
 - 1. Connect new equipment to existing control panel in existing part of the building.

INTRUSION DETECTION SYSTEM

2. Expand, modify, and supplement existing control and monitoring] equipment as necessary to extend existing functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

3.3 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceways according to SECTION 27 05 28 Interior Pathways, except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Division 26 Section "Identification for Electrical Systems."
- B. Install instructions frame in a location visible from master control unit.

3.5 GROUNDING

- A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.
- B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.
- D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 TESTING

- A. Existing system testing:
 - 1. Contractor shall test each existing system in presence of Owner's Representative and issue a report to the Owner and Architect listing conditions found prior to any removals, relocations, or additions.

INTRUSION DETECTION SYSTEM

281600

- B. After installation, align, adjust, and perform testing on modified portion of the system to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
 - 1. After testing is complete, provide a letter certifying that installation of the modified components is complete and fully operable; include names and titles of witnesses to tests.

END OF SECTION

14457.20

SECURITY & TECHNOLOGY EQUIPMENT

283550

SECTION 28 35 50

SECURITY & TECHNOLOGY EQUIPMENT

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION

- A. Electrical Contractor shall coordinate with the Owner when removing and re-installing Wireless Access Points (WAPs) and Mounting Brackets in locations shown on the drawings. This shall include recording of WAP MAC Addresses and device location, installation of patch cables at the wireless access point locations.
- B. Electrical Contractor shall coordinate with the Owner for the modifications of the existing and new telecommunication racks to minimize network disruptions. Any network shutdown shall be coordinated with the Owner.
- C. Electrical Contractor shall coordinate with the Owner when removing and re-installing IP cameras and mounting brackets in locations shown on the drawings. This shall include recording of IP Camera MAC Addresses and device location, installation of patch cables at the camera locations. Coordinate with Owner for final re-aiming of cameras.
- D. The Owner is responsible for removing and re-installing Flat Panels and associated mounting brackets in locations shown on the drawings. EC shall coordinate with Owner and the GC when installing Power and communications cabling and associated raceways to the new flat panel locations.
- E. Telecommunications equipment shall be grounded and bonded in accordance with ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications and Article 800, 2002 National Electric Code.
- E All materials furnished and all work performed shall comply with all State, County and Local Codes.
- G. All equipment and work shall comply with FCC regulations.

PART 2 PRODUCTS

2.01 HDMI JACK INSERTS AT FLAT PANELS

- A. Legrand On-Q 4K HDMI Coupler Keystone Insert, Black
- B. Part No. WP124KBK.
- C. 4K @ 60Hz, 18Gbps Rated

SECURITY & TECHNOLOGY EQUIPMENT

283550

2.02 HDMI CABLE FOR FLAT PANELS

- A. Mono Price Product # 12735 High Speed HDMI Cable
- B. Lengths from 25Ft to 100Ft. Field verify all lengths prior to ordering.
- C. 4K @ 60Hz, 18Gbps Rated
- D. CL2 fire safety rating
- E. Confirm cable type with Owner prior to ordering cable.

2.03 USB EXTENSION CABLING (CAT 6)

A. New Flat Panel installations will have a USB Extension between the Teacher's Stations and the flat panel. This will be accomplished by installing a Cat 6 cable and associated Cat 6 Data Jacks. The Owner will then purchase a Cat 6 to USB Converter to be used at the Teacher's Station and the flat panel.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Equipment, mounting brackets and patch cables must be installed in accordance with the manufacturer's specifications and industry best practices. Submit for Owner review and approval an installation work plan and schedule. Coordinate with the owner.
- B. Removal and disposal of all packaging and unused installation materials.

3.02 PRESENCE AT CUTOVER

- A. At all times during installation of new systems, maintain existing (prior to cutover) services. Any necessary disruptions to service must be clearly communicated in advance and approved by the Owner.
 - B. Once the IP Cameras are installed and operating minor adjustments may be required to the installation. Provide 4 hours of labor to modify camera installations to improve system performance. Document all time associated with this task on a per school basis.

END OF SECTION

SECTION 284601 FIRE ALARM SYSTEM (EXISTING SYSTEM)

PART 1 - GENERAL

1.01 SCOPE & RELATED DOCUMENTS

- A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations in connection with the modifications and additions to the existing Fire Alarm System(s) as shown on the drawings and as herein specified.
- B. The requirements of the conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.
- C. The complete installation is to conform to the applicable sections of NFPA-72, NFPA-71, Local Code Requirements and National Electrical Code with particular attention to Article 760.
- D. Additionally, the entire installed system and all integrated system operations shall be within the guidelines of the SBCCI Standard Building Code.
- E. The work covered by this section of the specifications is to be coordinated with the related work as specified elsewhere under the project specifications.
- F. The contractor shall provide all required modifications and additions to the existing Fire Alarm System for the removal, relocation of existing devices and addition of new devices. This shall include all additional wiring, devices, modifications to the existing control panel, additional components and modules, addressable cards, testing, troubleshooting and instructions to the owner.

1.02 QUALITY ASSURANCE

- A. Each and all items of the Fire Alarm System shall be listed compatible with the existing system under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. All control equipment is to be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable
- B. All items shall match and be of the same manufacturer as the existing system.
- C. The equipment and installation supervision furnished under this specification is to be provided by a manufacturer who has been engaged in production of this type (software driven) of equipment for at least ten (10) years, and has a fully-equipped service organization within thirty-five (35) miles of the installation.
- D. All control equipment must have transient protection devices to comply with UL864 requirements.
- E. In addition to the UL-UOJZ requirement mentioned above, the system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760-23.
- F. Supplier shall provide documentation that fire alarm technicians are NICET LEVEL 2 certified (minimum of four).
- G. Suppliers' service organization must have been established in the local area for a minimum of ten (10) years with ten (10) years experience on specific equipment brand supplied.

1.03 SUBMITTALS

- A. Submit shop drawings for each piece of equipment specified including complete wiring and connection diagrams.
- B. All submittals shall be submitted in a single complete brochure, which shall be in the form of a soft cover binder with each group separated be an identified index tab.
- C. Submittals that fail to comply with the above requirements will automatically be rejected.

- D. It is the Contractor's responsibility to provide submittals in an organized and timely manner in order so as not to delay the project schedule and hamper the work of other trades.
- E. Submit certificate of Fire Alarm System operating tests.

PART 2 PRODUCTS

2.01 PERIPHERAL DEVICES

- A. The Contractor shall furnish and install addressable devices that are compatible with the existing Cerberus Pyrotronics fire alarm System
- B. Devices Required but not limited to:
 - 1. Manual Pull Stations
 - 2. Smoke Detectors
 - 3. Duct Smoke Detectors
 - 4. Combination Speaker/Strobe Stations
 - 5. Visual Alarm (Strobe) Stations
 - 6. Auxiliary contacts on devices where indicated on drawings.
 - 7. Magnetic fire door holds
 - 8. Power Supplies
 - 9. Addressable Relay modules

2.02 MAGNETIC DOOR HOLDERS

- A. Description: Units shall be listed to UL 228. Units shall be equipped for wall or floor mounting as indicated on plans and are complete with matching door plate and extension arms as required. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source from fire alarm panel. Magnets must develop a minimum of 25 lbs. holding force for any of these voltages.
- B. Material and Finish: Match door hardware. All final hardware material and finishes must be coordinate with the GC.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide and install all devices in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC Article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC-Article 760 A and B. Upon completion, the contractor shall so certify in writing to the owner and general contractor.
 - 1. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.
- B. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- C. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.
- D. The manufacturer's authorized representative shall provide on-site supervision of installation.

3.02 TESTING

A. The completed fire alarm system shall be fully tested in accordance with NFPA-72H by the contractor in the presence of the owner's representative and the Local Fire Marshal. Upon completion of a successful test, the contractor shall so certify in writing to the owner and general contractor.

3.03 WARRANTY

A. The contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test or from the date of first beneficial use.

B. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72H guidelines.

END OF SECTION

This page intentionally left blank