

PROJECT MANUAL VOLUME TWO OSSINING UNION FREE SCHOOL DISTRICT 2024 BOND: PHASE 1- OHS LOCKER ROOM & CTE ADDITION

29 S Highland Avenue

Ossining, New York - 10562

DIVISIONS 21 THROUGH 34

CPL PROJECT NO.: R24.16761.00

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NEW YORK STATE EDUCATION DEPARTMENT PROJECT CONTROL NUMBER(S):

Ossining High School: 66-14-01-03-0-003-047

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

800-294-9000

www.cplteam.com

CONSTRUCTION MANAGER

Arris Contracting Company, Inc.

189 Smith Street Poughkeepsie, NY
12601

(914) 755-0494

FEberhard@arriscontracting.com

OWNER

Ossining Union Free School
District

400 Executive Boulevard
Ossining, NY 10562

(914) 941-7700

www.ossiningufsd.org



**SECTION 210500
COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Above ground piping.
- B. Escutcheons.
- C. Mechanical couplings.
- D. Pipe hangers and supports.
- E. Pipe sleeves.
- F. Pipe sleeve-seal systems.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - FIRESTOPPING.
- B. Section 211300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information. Indicate valve data and ratings.
- C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- D. For new and substantially modified sprinkler systems, drawings and hydraulic calculations are required to be submitted. Plans and calcs must be stamped by a Professional Engineer (PE) licensed in the State of the project or NICET level designer. Drawings and calculations must be submitted to the Local Building Department as part of the Project Building Permit.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Project Record Documents: Record actual locations of components and tag numbering.
- H. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section.
 - 1. Minimum three years experience.
- C. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers, with labeling in place.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.06 WARRANTY

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Sprinkler-based System:
 - 1. Comply with NFPA 13.
 - 2. See Section 211300.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.
- C. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.02 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A795 Schedule 10, ASTM A53 Schedule 40, ASTM A135/A135M Schedule 10, or ASTM A795 Schedule 40, black.
 - 1. Steel Fittings: ASME B16.5 steel flanges and fittings.
 - 2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
 - 3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
 - 4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
 - 5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

2.03 ESCUTCHEONS

- A. Manufacturers:
 - 1. Fire Protection Products, Inc.
 - 2. Tyco Fire Protection Products.
 - 3. Victaulic
 - 4. Viking Group Inc.h
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Material:
 - 1. Metals and Finish: Comply with ASME A112.18.1.
- C. Construction:
 - 1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
 - 2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.04 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
- B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.

2.05 MECHANICAL COUPLINGS

- A. Manufacturers:
 - 1. Anvil International.
 - 2. Shurjoint Piping Products, Inc.

3. Tyco Fire Protection Products.h
4. Victaulic Company; FireLock Style 009H.
- B. Rigid Mechanical Couplings for Grooved Joints:
 1. Dimensions and Testing: Comply with AWWA C606.
 2. Minimum Working Pressure: 300 psig.
 3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
 4. Housing Coating: Factory applied orange enamel.
 5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
 6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

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

3.02 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
 - B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
 - C. Install piping to conserve building space, to not interfere with use of space and other work.
 - D. Group piping whenever practical at common elevations.
 - E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
 - F. Fire suppression piping shall be independently supported and nothing else may touch or be supported by fire suppression piping and/or associated hangers/supports.
 - G. Pipe Hangers and Supports:
 1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 2. Place hangers within 12 inches of each horizontal elbow.
 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
 - I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
 - J. Structural Considerations:
 1. Do not penetrate building structural members unless indicated.
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- K. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- L. Escutcheons:
 - 1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
 - 2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
 - 3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.
- M. 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, unions, and couplings for servicing are consistently provided.
- N. Perform all pressure tests as required by NFPA 13.

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.
- C. See Section 017419 - Construction Waste Management and Disposal for additional requirements.

END OF SECTION

SECTION 210523

GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Ball valves with indicators.
- B. Iron butterfly valves with indicators.
- C. Check valves.
- D. Iron OS&Y gate valves.
- E. Trim and drain valves.

1.02 RELATED REQUIREMENTS

- A. Section 210553 - Identification for Fire Suppression Piping and Equipment.

1.03 REFERENCE STANDARDS

- A. UL 312 - Check Valves for Fire-Protection Service; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.05 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. Where listed products are specified, provide products listed, classified, and labeled by FM (AG) or UL (DIR) as suitable for the purpose indicated.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect valve ends and flange faces.
 - 3. Set valves open to minimize exposure of functional surfaces.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Valve-End Connections:
 - 1. Flanges on Iron Valves: ASME B16.1 or ASME B16.42.
 - 2. Threaded Ends: ASME B1.20.1.

- 3. Grooved Ends: AWWA C606.
- B. Comply with NFPA 13 for valves.
- C. Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.
- D. Valve Sizes: Same as upstream piping unless otherwise indicated.
- E. All valves on FP system shall be monitored by the building Fire Alarm system. Provide supervisory switches on all valve, except as allowed to be omitted by NFPA 13.

2.02 TWO PIECE BALL VALVES WITH INDICATORS

- A. UL 1091 and FM 1112 listed.
- B. Description:
 - 1. Minimum Pressure Rating: 175 psig.
 - 2. Body Design: Two piece.
 - 3. Body Material: Forged brass or bronze.
 - 4. Port Size: Full or standard.
 - 5. Seat: PTFE.
 - 6. Stem: Bronze or stainless steel.
 - 7. Ball: Chrome-plated brass.
 - 8. Actuator: Worm gear or traveling nut.
 - 9. Supervisory Switch: Internal or external.
 - 10. End Connections: Threaded or grooved.

2.03 IRON BUTTERFLY VALVES WITH INDICATORS

- A. UL 1091 and FM 1112 listed.
- B. Minimum Pressure Rating: 175 psig.
- C. Body Material: Cast or ductile iron.
- D. Seat: EPDM.
- E. Stem: Stainless steel.
- F. Disc: Ductile iron with EPDM coating.
- G. Actuator: Worm gear or traveling nut.
- H. Body Design: Grooved-end or wafer style.

2.04 SWING CHECK VALVES

- A. Manufacturers:
- B. UL 312 and FM 1210 listed.
- C. Minimum Pressure Rating: 175 psig.
- D. Body Material: Cast or ductile iron.
- E. Clapper: Bronze, EPDM-coated ductile iron, or stainless steel.
- F. Seat: Bronze or EPDM-coated bronze.
- G. End Connections: Flanged.

2.05 IRON OS&Y GATE VALVES

- A. UL 262 and FM 1120/1130 listed.
- B. Minimum Pressure Rating: 175 psig.
- C. Body and Bonnet Material: Cast or ductile iron.
- D. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
- E. Stem: Brass, bronze, or stainless steel.
- F. Packing: Non-asbestos PTFE.
- G. Supervisory Switch: External.

2.06 TRIM AND DRAIN VALVES

- A. Ball Valves:
 - 1. Description:
 - a. UL 258 or FM 1140 listed.
 - b. Pressure Rating: 175 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass or bronze.
 - e. Port Size: Full or standard.
 - f. Seat: PTFE.
 - g. Stem: Bronze or stainless steel.
 - h. Ball: Chrome-plated brass.
 - i. Actuator: Hand-lever.
 - j. End Connections: Threaded or grooved.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Confirm valve interior to be free of foreign matter and corrosion.
- B. Remove packing materials.
- C. Examine guides and seats by operating valves from the fully open position to the fully closed position.
- D. Examine valve threads and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage.
 - 1. Check bolting for proper size, length, and material.
 - 2. Verify gasket for size, defects, damage, and suitable material composition for service.
 - 3. Replace defective valves with new valves.

3.02 INSTALLATION

- A. Install valves in accessible locations to allow for operation, inspections, tests, and maintenance.
- B. Install listed valves in accordance with their listing.
- C. Install valves in accordance with manufacturer's instructions.
- D. Support valves independently of adjacent piping.
- E. Install valves in horizontal piping with stem at or above pipe center.
- F. Position valves to allow full actuator movement.

- G. Install OS&Y valves with full clearance for rising stem. Install surrounding components so they do not interfere with nor are they impacted by full extension of rising stem.
- H. Install supervised shutoff valves in supervised-open position.
- I. Connect all valve supervisory switches to building Fire Alarm panel. Coordinate with EC or Fire Alarm contract if applicable.
 - 1. Install permanent identification signs indicating portion of system controlled by each shutoff valve.
 - 2. Install threaded-end valves with unions upstream and downstream.
- J. Install valve tags. See Section 210553. Label valves in accordance with NFPA standard applying to the piping system in which valves are installed.

END OF SECTION

SECTION 210553
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Stencil paint.

1.03 REFERENCE STANDARDS

1.04 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.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Major Control Components: Nameplates.
- B. Piping: Tags.

2.02 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.

2.03 TAGS

- A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

2.04 PIPE MARKERS

- A. Color: Comply with ASME A13.1.
- B. 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.

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.
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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. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Use tags on piping 3/4 inch diameter and smaller.
- E. Pipe markers shall be installed 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 211300
FIRE-SUPPRESSION SPRINKLER SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wet-pipe sprinkler system.
- B. Dry-pipe sprinkler system.
- C. System design, installation, and certification.

1.02 REFERENCE STANDARDS

- A. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).
- B. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
- C. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.
- D. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Shop Drawings:
 - 1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
 - 2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
 - 3. Submit shop drawings, product data, and hydraulic calculations to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.
- D. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements for additional provisions.

2. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
3. Sprinkler Wrenches: For each sprinkler type.
- I. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.05 QUALITY ASSURANCE

- A. Maintain one copy of referenced design and installation standard on site.
- B. Comply with FM (AG) requirements.
- C. Designer Qualifications: Design system under direct supervision of a Professional experienced in design of this type of work and licensed in the State in which the Project is located. Provide PE or NICET stamp of designer on all plans.
- D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- E. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years experience and approved by manufacturer.
- F. Equipment and Components: Provide products that bear FM (AG) label or marking.
- G. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sprinklers, Valves, and Equipment:
 1. Anvil International.
 2. Tyco Fire Protection Products.
 3. Viking Corporation.
 4. Victaulic
 5. Reliable
 6. Substitutions: See Section 016000 - Product Requirements.

2.02 SPRINKLER SYSTEM

- A. Sprinkler System: Provide coverage for building areas noted.
- B. Occupancy: Light hazard; comply with NFPA 13. See drawings for design criteria.
- C. Water Supply: Determine volume and pressure from water flow test data. Contractor to perform new flow test prior to submitting hydraulic calculations.
- D. Interface system with building fire and smoke alarm system.
- E. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.
- F. Pipe Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 1. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 2. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 3. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.

2.03 SPRINKLERS

- A. Suspended Ceiling Type: Concealed pendant type with matching push on escutcheon plate. See drawings for sprinkler head description.
 - 1. Response Type: Quick.
 - 2. Coverage Type: Standard.
 - 3. Finish: Enamel, color White .
 - 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
 - 5. Manufacturers:
 - a. Tyco Fire Protection Products.
- B. Flexible Drop System: Stainless steel, multiple use, open gate type.
 - 1. Application: Use to properly locate sprinkler heads.
 - 2. Include all supports and bracing.
 - 3. Provide braided type tube as required for the application.
 - 4. Manufacturers:
 - a. FlexHead Industries, a brand of Anvil International.
 - b. Victaulic Company; Vic-Flex.

2.04 PIPING SPECIALTIES

- A. Test Connections:
 - 1. Inspector's Test Connection:
 - a. Route test connection to an janitor sink, accepting full flow without negative consequences.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with referenced NFPA design and installation standard.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Place pipe runs to minimize obstruction to other work.
- D. Place piping in concealed spaces above finished ceilings.
- E. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.
- F. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- G. Flush entire piping system of foreign matter.
- H. Hydrostatically test entire system.
- I. Require test be witnessed by Fire Marshal.

3.02 INTERFACE WITH OTHER PRODUCTS

- A. Ensure required devices are installed and connected as required to fire alarm system.

3.03 SCHEDULES

- A. System Hazard Areas:
 - 1. Offices and classrooms: Light Hazard.
 - 2. Mechanical, Storage, and kitchen rooms: Ordinary Hazard, Group 1.

END OF SECTION

**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. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections, including electrical disconnects.
 - 9. Painting and finishing.
 - 10. Concrete bases.
 - 11. 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, crawlspace, 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 deliver 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. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. 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 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150-psig (1035-kPa) minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 - 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.06 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.

2.07 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.

2.08 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 chrome-plated 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.

2.09 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.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. 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, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel 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 gypsum-board 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 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Provide required electrical disconnects for all equipment, sized and rated for each associated piece of equipment. Coordinate with electrical contract for power connection.

3.05 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.

3.06 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
 - 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Use 3000-psi (20.7-MPa, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Miscellaneous Cast-in-Place Concrete."

3.07 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.

3.08 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.

3.09 CAMERA INSPECTIONS OF UNDERGROUND SEWER/STORM PIPES

- A. Where camera inspections are called out on plans for a portion of existing underground piping, these requirements apply:
 - 1. Coordinate schedule for camera inspections with Owner to minimize disruption
 - 2. Coordinate schedule for camera inspections with Engineer of Record, to confirm if they want to be present during inspections.
 - 3. Assume all removal of cleanout covers or fixtures required for inspection is the responsibility of the contractor.

4. Narrate video material so it is obvious the date/time/location of each individual video.
5. Prepare a pdf or hard copy building plan identifying location of camera access and sections of piping surveyed. Also note major found information on this plan:
 - a. Size and material of pipe, general observed condition of pipe, major issues such as pipe belly/low points and/or breakage, Inverts.

3.10 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

**SECTION 220516
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Expansion joints and compensators.

1.02 RELATED REQUIREMENTS

- A. Section 221005 - Plumbing Piping.

1.03 REFERENCE STANDARDS

- A. EJMA (STDS) - EJMA Standards; Tenth Edition.
- B. FM (AG) - FM Approval Guide; Current Edition.
- C. UL (DIR) - Online Certifications Directory; Current Edition.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with UL (DIR) requirements.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturers:
 - 1. Mercer Rubber Company.
 - 2. The Metraflex Company.
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.
- D. Pressure Rating: 125 psi up to 3 inch.
- E. End Connections: Flanged.
- F. Size: Use pipe sized units.

2.03 ACCESSORIES

- A. Pipe Alignment Guides:
 - 1. Manufacturers:
 - a. Flex-Weld, Inc.
 - b. The Metraflex Company; PGQ Glide Riser Guide.
 - 2. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
- B. Swivel Joints:
 - 1. Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
-

- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION

**SECTION 220517
SLEEVES AND SLEEVE SEALS 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. Pipe sleeves.
- B. Stack-Sleeve fittings.
- C. Sleeve-Seal Fittings
- D. Grout

1.03 RELATED REQUIREMENTS

- A. Section 078400 - FIRESTOPPING.
- B. Section 099123 - Interior Painting: Preparation and painting of interior piping systems.
- C. Section 220523 - General-Duty Valves for Plumbing Piping.
- D. Section 220553 - Identification for Plumbing Piping and Equipment: Piping identification.
- E. Section 220719 - Plumbing Piping Insulation.

1.04 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).

1.05 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.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified this section.
 - 1. Minimum three years experience.
 - 2. Approved by manufacturer.
- C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.07 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.

1.08 WARRANTY

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

PART 2 PRODUCTS**2.01 PIPE SLEEVES**

- A. Manufacturers:
 - 1. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com/#sle.
 - 2. Smith, Jay R. Mfg. Co..
 - 3. Zurn Specification Drainage Operation; Zurn Plumbing Products Group..
 - 4. Presealed Systems.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
- C. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.Pipe
- D. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- E. Passing Through Below Grade Exterior Walls:
 - 1. Zinc coated or cast iron pipe.
 - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
 - 3. Provide product equal to Link-Seal by Garlock.
- F. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

2.02 STACK-SLEEVE FITTINGS

- A. Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping rings with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

- A. Manufactured plastic, sleeve-type, water stop assemblies made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

2.04 GROUT

- A. Standard: ASTM C 1107/C1107M Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28 day compressive strength.
- D. Packaging: Premix and factory packaged.

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. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- E. 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. Provide core through foundation wall sized as required by manufacturer of sleeve-seal system.
 - 4. Locate piping in center of sleeve or penetration.
 - 5. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 6. Tighten bolting for a water-tight seal.
 - 7. Install in accordance with manufacturer's recommendations.
- F. 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.
- C. See Section 017419 - Construction Waste Management and Disposal for additional requirements.

END OF SECTION

**SECTION 220519
METERS AND GAUGES 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. Water meters.
- B. Liquid-in-glass thermometers
- C. Thermowells
- D. Dial type pressure gages
- E. Gage Attachments
- F. Test Plugs.
- G. Pressure gauges.
- H. Thermometers.

1.03 RELATED REQUIREMENTS

- A. Section 221005 - Plumbing Piping

1.04 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 2025).
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- D. AWWA C702 - Cold-Water Meters -- Compound Type; 2024.
- E. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012, with Addendum (2018).
- F. NSF 61 - Drinking Water System Components - Health Effects; 2019.
- G. NSF 372 - Drinking Water System Components - Lead Content; 2024.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.
- C. Product Certificates: For each type of meter and gage, from manufacturer.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements. for additional provisions.

PART 2 PRODUCTS

2.01 WATER METERS

- A. Compound Water Meters:

1. Utility Connection Size: 3 inch flanged.
2. Maximum Unidirectional Water Flow Capacity: As indicated on drawings.
3. Lead-free bronze alloy case, polymer-based cap, and hermetically sealed register.
4. Pressure and Temperature: Up to 150 psi and 100 degrees F.
5. AWWA C702, with lead content below 0.25 percent when using non-lead-free materials on wetted surfaces according to NSF 61 and NSF 372.

2.02 LIQUID-IN-GLASS THERMOMETERS

- A. Standard: ASME B40.200.
- B. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
- C. Case Form: Adjustable angle unless otherwise indicated.
- D. Tube: Glass with magnifying lens and blue or red organic liquid (no mercury).
- E. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
- F. Window: Glass.
- G. Stem: Aluminum and of length to suit installation.
- H. Design for Thermowell Installation: Bare stem.
- I. Connector: 1-1/4 inches, with ASME B1.1 screw thread.
- J. Accuracy: Plus, or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.03 THERMOWELLS

- A. Standard: ASME B40.200.
- B. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
- C. Material for Use with Copper Tubing: CNR or CUNI.
- D. Type: Stepped shank unless straight or tapered shank is indicated.
- E. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
- F. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw thread.
- G. Bore: Diameter required to match thermometer bulb or stem.
- H. Insertion Length: Length required to match thermometer bulb or stem.
- I. Lagging Extension: Include on thermowells for insulated piping and tubing.
- J. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- K. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.04 PRESSURE GAUGES

- A. Manufacturers:
 1. Dwyer Instruments, Inc.
 2. Moeller Instrument Company, Inc.
 3. Omega Engineering a subsidiary of Spectris, Plc.
 4. Watts
- B. Bourdon Tube for Liquids and Gases:

-
1. Direct Mounted, Sealed Metal Case, Dial Type
 2. Dial Size and Cover: 4-1/2 inch diameter scale with polycarbonate window.
 3. Dial Text and Markings: Black color on white background with scaled kPa and psi units.
 4. Accuracy: ASME B40.100, adjustable commercial grade (D) with 5 percent of span.
 5. Process Connection: Lower-back, 1/4 inch NPT male except where noted.
 6. Listed for Potable water: NSF 61 and NSF 372 as applicable.

2.05 THERMOMETERS

- A. Manufacturers:
 1. Dwyer Instruments, Inc.
 2. Moeller Instrument Company, Inc.
 3. Watts Water Technologies, Inc.
 4. Weiss Instruments, LLC.
- B. General:
 1. Product Compliance: ASTM E1.
 2. Lens: Clear glass, except where stated.
 3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
 4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.
- C. Thermometers - Adjustable Angle: 7 inch v-shape aluminum case with clear glass window scale, 6 inch NPT stem, red or blue organic non-toxic liquid filled glass tube, and adjustable joint with positive locking device allowing 360 degrees in horizontal plane or 180 degrees in vertical plane adjustments.

2.06 GAGE ATTACHMENTS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install metering products in accordance with manufacturer's instructions for intended fluid type and service.
- B. Install water meters with inlet and outlet isolation valves in compliance with AWWA M6.
- C. Install pressure gauges as follows:
 1. At Pumps: Place single gauge before strainer, suction side and discharge side.
 2. Include gauge cock to isolate each gauge and extend nipples for insulation clearance.
 3. Adjust gauges to selected viewing angle, clean thoroughly, and calibrate to zero.
- D. Install thermometers as follows:
 1. Hot Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.
 2. Hot water Circulation pumps: Place downstream of pump.
 3. Mixing valves: Place on incoming hot water and cold water supply and downstream of mixing valve on tempered water supply.

4. Piping: Install thermometers in branch butt weld connection fitting or socket-weld thermowell. Enlarge pipes smaller than 2-1/2 inch to accommodate sockets. Ensure sockets are above insulation clearance.

- E. Locate PT (pressure-temperature) test plugs adjacent to control device sockets.

3.02 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Adjust faces of meters and gages to proper angle for best visibility

3.03 SCHEDULES

- A. Pressure Gauges, Location and Scale Range:
 1. Pumps, 0 to 100 psi.
 2. Expansion tanks, 0 to 100 psi.
 3. Pressure tanks, 0 to 100 psi.
 4. Domestic Cold Water 0 to 100 psi. Incoming water & Water Heater
 5. Domestic Hot Water 0 to 100 psi. Water Heater
 6. Domestic Hot Water Return 0 to 100 psi. Recirculating Pump
 7. Pressure reducing valves, 0 to 100 psi.
 8. Backflow preventers, 0 to 100 psi.
- B. Stem Type Thermometers, Location and Scale Range:
 1. Domestic Cold water 0 to 150 degrees F. Incoming Water & Water Heater
 2. Domestic Hot water supply and recirculation, 0 to 250 degrees F. Water Heater & Recirculating Pump.

END OF SECTION

**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. Butterfly valves.
- C. Check valves.
- D. Lubricated plug 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, with Errata (2023).
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- D. ASME B31.9 - Building Services Piping; 2025.
- E. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- F. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).
- G. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- H. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings; 2015 (Reapproved 2021).
- I. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- J. AWWA C606 - Grooved and Shouldered Joints; 2022.
- K. MSS SP-67 - Butterfly Valves; 2022.

- L. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
- M. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.
- N. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.
- O. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- P. NSF 61 - Drinking Water System Components - Health Effects; 2019.
- Q. NSF 372 - Drinking Water System Components - Lead Content; 2024.

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 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. Stem: Stainless steel, blowout proof.
 2. Ball: Stainless steel, vented.
 3. Manufacturers:
 - a. Apollo Valves.
 - b. Watts
 - c. Nibco - Equal to 585HP-66-LF

2.05 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Wafer Style:
1. Class 125, or Class 150 flanges.
 2. Comply with MSS SP-67, Type I.
 3. Lug Style, Service Pressure Ratings:
 - a. 250 psi for sizes 2 to 12 inch.
 - b. Vacuum down to 29.9 in-Hg.
 4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 5. Stem: One or two-piece stainless steel.
 6. Seat: EPDM.
 7. Disc: Aluminum-bronze.
 8. Finish: Epoxy coated.
 9. Operator: Gear operator with handwheel over direct-mount actuator base.

2.06 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 175 psi.
1. Comply with MSS SP-67, Type I.
 2. Body: Coated ductile iron.
 3. Stem: Two-piece stainless steel.
 4. Disc: Coated ductile iron.
 5. Disc Seal: EPDM.

2.07 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.
 - 6. Disc (Type 1): Bronze.

2.08 BRASS, HORIZONTAL SWING CHECK VALVES

- A. Class 125, Threaded or Soldered End Connections:

2.09 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.

2.10 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125 with Lever and Spring-Closure Control.
 - 1. Comply with MSS SP-71, Type I.
 - 2. Description:
 - a. CWP Rating: 200 psi.
 - b. Design: Clear or full waterway.
 - c. Body: ASTM A126, gray iron with bolted bonnet.
 - d. Ends: Flanged as indicated.
 - e. Trim: Bronze.
 - f. Gasket: Asbestos free.
 - g. Closer Control: Factory installed, exterior lever, and weight.

2.11 LUBRICATED PLUG VALVES

- A. Regular Gland with Flanged Ends:
 - 1. Comply with MSS SP-78, Type II.
 - 2. Body: ASTM A48/A48M or ASTM A126, cast iron with lubrication sealing system.
 - 3. Pattern: Regular or short.
 - 4. Plug: Cast iron or bronze with sealant groove.

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

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 B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- E. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

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.

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. 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.
- G. Secure fasteners according to manufacturer's recommended torque settings.
- H. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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

**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; 2023.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Schedules:
 - 1. Submit plumbing component identification schedule listing equipment, piping, and valves.
 - 2. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
 - 3. Valve Data Format: Include id-number, location, function, and model number.

PART 2 PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

- A. Pipe Markers: 3/4 inch diameter and higher.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc.
 - 2. Kolbi Pipe Marker Co
 - 3. Seton Identification Products.
- B. Description: Laminated piece with up to three lines of text.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.

2.03 TAGS

- A. Manufacturers:
 - 1. Brimar Industries, Inc.
 - 2. Kolbi Pipe Marker Co
-

- 3. Seton Identification Products.
- 4. Substitutions: See Section 016000 - Product Requirements.
- B. Flexible: Vinyl with engraved black letters on light contrasting background color with up to three lines of text. Minimum tag size 1-1/2 inch in diameter.
- C. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

- A. Manufacturers:
 - 1. Brimar Industries, Inc.
 - 2. Kolbi Pipe Marker Co.
 - 3. Seton Identification Products.
- B. Comply with ASME A13.1.
- C. Flexible Marker: Factory fabricated, semi-rigid, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid conveyed.
- D. Identification Scheme, ASME A13.1:
 - 1. Primary: External Pipe Diameter, Uninsulated or Insulated.
 - 2. Secondary: Color scheme per fluid service.
 - a. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive identification products.
- B. Prepare surfaces for stencil painting, see Section 099123.

3.02 INSTALLATION

- A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags in clear view and align with axis of piping
- C. Apply stencil painted identification in compliance with Section 099123 requirements. Identify unit with assigned id-number and area being served using pipe marking rules.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe marker 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. Install labels and/or tags on all pipes as follows:

END OF SECTION

**SECTION 220719
PLUMBING PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glass fiber insulation.
- B. Jacketing and accessories.
- C. Supplies and drains for hand
- D. Section includes insulating the following pipe systems
 - 1. Domestic Cold Water Piping
 - 2. Domestic 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; 2020.
- D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
- E. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2017, with Editorial Revision (2018).
- F. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2022.
- G. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).
- 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; 2024.
- 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 INSULATION

- A. Manufacturers:
 - 1. CertainTeed Corporation.
 - 2. Johns Manville Corporation.
 - 3. Knauf Insulation.
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ.
- 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 perm.

2.03 JACKETING AND ACCESSORIES

- A. PVC Plastic Jacket:
 - 1. 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, 0.010 inch.
 - e. Connections: Brush on welding adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- 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. 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. 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.

3.04 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
- D. Piping, Exposed:
 - 1. PVC: 20 mils thick.

Ossining Union Free School District

OUFSD_24BD_PH 1 - HS LKR RM & CTE Addition

R24.16761.00

Plumbing Piping Insulation

220719 - 4

END OF SECTION

CPL

**SECTION 221005
PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary waste piping, buried within 5 feet of building.
- B. Sanitary waste and vent piping, above grade.
- C. Sanitary Force Main piping, above Condensate grade.
- D. Chemical-resistant sanitary waste piping.
- E. Condensate piping
- F. Domestic water service, buried within 5 feet of building.
- G. Domestic water piping, above grade.
- H. Storm drainage piping, buried within 5 feet of building.
- I. Storm drainage piping, above grade.
- J. Natural gas piping, buried within 5 feet of building.
- K. Natural gas piping, above grade.
- L. Pipe flanges, unions, and couplings.

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 220529 - Hangers and Supports for Plumbing Piping and Equipment.
- E. Section 220553 - Identification for Plumbing Piping and Equipment.
- F. Section 220719 - Plumbing Piping Insulation.
- G. Section 312316 - Excavation.
- H. 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; 2018.
- 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; 2025.
- H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- 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; 2025.
- K. ASTM B32 - Standard Specification for Solder Metal; 2020.
- L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
- 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 Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.
- P. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- 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 D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2024.
- T. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- U. ASTM F437 - Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2024.
- V. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40; 2023.
- W. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2024.
- X. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80; 2023.
- Y. ASTM F442/F442M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR); 2023.
- Z. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2022.
- AA. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2024.
- BB. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems; 2024.
- CC. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- DD. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.
- EE. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.
- FF. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).
- GG. AWWA C651 - Disinfecting Water Mains; 2023.
- HH. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.

- II. 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.
- JJ. NSF 61 - Drinking Water System Components - Health Effects; 2019.
- KK. NSF 372 - Drinking Water System Components - Lead Content; 2024.
- LL. PPI TR-4 - PPI HSB Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe; 2021.
- MM. 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.
- C. All Cast Iron Soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International.
 - 1. Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer or manufacturer's register trademark

2.02 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

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

2.03 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, solvent.
 - 2. Joints: ASTM B32, alloy Sn50 solder.
- C. Copper Tube: ASTM B88 (ASTM B88M), Type K (A).
 - 1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, solvent.
 - 2. Joints: ASTM B32, alloy Sn50 solder.

2.04 SANITARY FORCE MAIN PIPING, ABOVE GRADE

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A).
 - 1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, solvent.
 - 2. Joints: ASTM B32, alloy Sn50 solder.

2.05 CHEMICAL-RESISTANT SANITARY WASTE PIPING

- A. CPVC Pipe: ASTM D2846/D2846M, ASTM F441/F441M, ASTM F2618, or ASTM F442/F442M.
 - 1. Manufacturers:
 - a. IPEX USA, LLC; Xirtec CPVC Schedule 40: www.ipexna.com/#sle.
 - b. Charlotte Pipe - ChemDrain.
 - 2. Pipe shall be manufactured from CPVC type IV Grade 1 compounds with minimum cell class of 23447.
 - 3. Fittings: CPVC; ASTM D2846/D2846M, ASTM F437, ASTM F438, or ASTM F439.
 - 4. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement.
 - a. Use one step solvent cement specially formulated for CPVC Chemical Waste Application that has a VOC content of ~500 g/L or less.

2.06 CONDENSATE PIPING

- A. Copper Tube: ASTM B306, DWV.
 - 1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, solvent.
 - 2. Joints: ASTM B32, alloy Sn50 solder.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B).
 - 1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, solvent.
 - 2. Joints: ASTM B32, alloy Sn50 solder.

2.07 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Ductile Iron Pipe: AWWA C151/A21.51.
 - 1. Cement Mortar lining AWWA C104.
 - 2. Fittings: AWWA C110/A21.10. Ductile iron, Class 52 thickness. Cement lined.
 - 3. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.

2.08 DOMESTIC WATER PIPING, BURIED WITHIN BUILDING (I.E. TO ISLAND SINK)

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Coil length required for underslab, no joints.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.
 - a. No joints below slab. Route within PVC conduit, with joints just above slab.
- B. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
 - 1. Manufacturers:

- a. Uponor, Inc.
- 2. PPI TR-4 Pressure Design Basis:
 - a. 160 psig at maximum 73 degrees F.
- 3. Joints: Mechanical compression fittings.
 - a. No joints below slab. Route within PVC conduit, with joints just above slab

2.09 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.

2.10 STORM DRAINAGE PIPING, BURIED WITHIN 5 FEET OF BUILDING

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

2.11 STORM DRAINAGE PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.12 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M, Grade B, Type F, Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: ASME B31.1, welded.
 - 3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.13 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.
- B. Gas Turret (GT-1)
 - 1. Laboratory turret with polished chrome plated brass body and handle, serrated tip outlet 3/8" NPT female inlet. Certified to ANSI Z21.15a / CSA 9.1a. Meets ADA ANSI/ICC A117.1 requirements.
- C. Gas Turret (GT-2)
 - 1. Laboratory turret with polished chrome plated brass body, (2) serrated tip outlets at 180 degrees and 3/8" NPT female inlet. Certified to ANSI Z21.15a / CSA 9.1a. Meets ADA ANSI/ICC A117.1 requirements.
- D. Emergency Gas Shutoff (GS-1)
 - 1. Products in this section: All Products and Devices for a complete Laboratory Safety Device System with all components designed to operate together as a system. The system shall and be UL listed and labelled and be as listed in the Equipment Schedule of this Section.

2. Merlin utility controller: At each science classroom and elsewhere as shown on Drawings, provide a Utility Controller with fascia panel mounted switches to activate remote solenoids and relays to control natural gas outlets or other indicated services or devices. Utility Controller shall be certified to Underwriter's Laboratory UL61010-1 3rd Edition Standards. Controller shall provide line voltage signals for output circuits. Controller shall provide inputs for remote EPO's and Gas Sensors. The Controller shall be equipped with an Authority Key Lock that restricts activation and de-activation of output signals to the instructor or educator. Controller shall be provided with a fascia mounted recessed EPO button. Basis of design AGS Merlin 1000Si.
3. Gas Solenoid Valve: At each science classroom and where shown on Drawings, Provide a Gas Solenoid Valve: UL Listed 429, CSA Certified, FM 400 liquid or gas safety shut-off valve. Aluminium body two-way normally closed valve rated for natural gas (methane) and LPG (liquid petroleum gas). Size to be same as pipe size indicated on plans, 120 volt ac single phase actuator, 15 watts, and 5 PSI maximum operating pressure capacity. Manufacturer: American Gas Safety (AGS) series AGSGSV**** or equivalent.
4. Remote panic button: Where shown on Drawings and where classroom size and configuration restricts clear path from work areas to Utility Controller, provide a wall mounted Remote Panic Button. Button shall be red mushroom twist re-set type recessed in a yellow polycarbonate enclosure with a clear lift up protective shield. Button shall be UL listed and provide clear label text "Emergency Power Off". Assembly shall be located as shown on Drawings and as stipulated in Equipment Schedule. Integrate assembly with volt free dry contact input on Controller. Basis of design AGS EGOTW.
5. Fuel Gas Sensor: Where shown on Drawings and in Equipment Schedule, furnish and install a NG (Methane) Gas Sensor to detect natural gas within the classroom. Detector to provide clear digital traffic light reading of %LEL value. Detector shall provide a local visual and audible alarm. Integrate Fuel Gas Sensor with low voltage input on Controller. Sensor quantity and location as per drawings and manufacturer's instructions. Basis of design AGS NGiS.

2.14 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
 - 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. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls. Diagonal runs are prohibited unless specifically indicated otherwise on plans.
- D. Install free of sags and bends.
- E. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- F. Group piping whenever practical at common elevations.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 220516.
- H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- I. Provide access where valves and fittings are not exposed.
 - 1. Coordinate size and location of access doors with Section 083100.
- J. Establish elevations of buried piping outside the building to ensure not less than 5 ft of cover for pipes that require freeze protection.
- K. Install sanitary, vent and storm piping at slopes as indicated, but not less than as required by code. Minimum 1/8"/foot on mains and 1/4" per foot on branch piping.
- L. Install vent and gas piping penetrating roofed areas to maintain integrity of roof assembly and to comply with manufacturer warranty.
- M. Vent through roof termination shall extend at least 18" above roof.
- N. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
 - 1. See Section 099113 for painting of exterior plumbing systems and components.
- O. Excavate in accordance with Section 312316.
- P. Backfill in accordance with Section 312323.
- Q. Install valves with stems upright or horizontal, not inverted. See Section 220523.
- R. Install water piping to ASME B31.9.
- S. 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.
- T. Sleeve pipes passing through partitions, walls, and floors.
- U. 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.
- V. 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.
- W. 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. Test Sanitary waste and vent piping according to procedures of AHJ or in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test.
 2. Leave piping uncovered and unconcealed new, altered, extended or replaced waste and vent piping until it has been tested, inspected and approved.
 3. Rough-in Plumbing test Procedure:

- a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
- C. 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.
- D. 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.
- E. 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 biological examination shows contamination.
 - 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 221006
PLUMBING PIPING SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Drains. Roof and Floor
- B. Cleanouts.
- C. Hose bibbs.
- D. Hydrants.
- E. Backflow preventers.
- F. Double check valve assemblies.
- G. Water hammer arrestors.
- H. Mixing valves.
- I. Floor drain trap seals.
- J. Exterior penetration accessories.

1.02 REFERENCE STANDARDS

- A. ASME A112.6.3 - Floor Drains; 2022.
- B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2022.
- C. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.
- D. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent; 2021.
- E. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies; 2021.
- F. ASSE 1015 - Performance Requirements for Double Check Backflow Prevention Assemblies; 2021.
- G. ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems; 2023.
- H. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2023.
- I. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
- J. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- K. DIN 19580 - Drainage Channels for Vehicular and Pedestrian Areas - Durability, Mass Per Unit Area and Evaluation of Conformity; 2010.
- L. NSF 61 - Drinking Water System Components - Health Effects; 2019.
- M. NSF 372 - Drinking Water System Components - Lead Content; 2024.
- N. PDI-WH 201 - Water Hammer Arresters; 2017.

1.03 SUBMITTALS

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

- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- D. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- F. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements for additional provisions.
 - 2. Extra Loose Keys for Outside Hose Bibbs: One.

1.04 QUALITY ASSURANCE

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

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS

- A. Roof Drains (RD-1) Primary & Secondary Overflow:
 - 1. Assembly: ASME A112.6.4.
 - 2. Body: Powder-coated cast iron with sump.
 - 3. Strainer: Removable cast iron dome with vandal proof screws.
 - 4. Accessories: Coordinate with roofing type.
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Roof sump receiver.
 - d. Waterproofing flange.
 - e. Adjustable extension sleeve for roof insulation.
 - 5. Manufacturers:
 - a. Jay R. Smith Manufacturing Company 1015 Series
 - b. Josam
 - c. MIFAB, Inc.p
 - d. Zurn Industries, LLC; FROET 100C.
 - e. Watts
- B. Downspout Nozzles - For Secondary RD daylight termination (DN-1):
 - 1. Stainless Steel with hinged cover and perforated flap
 - 2. Size to match associated secondary storm outlet.
 - 3. Equal to JR Smith Figure 1775
- C. Floor Drains:
 - 1. Manufacturers:

- a. Jay R. Smith Manufacturing Company.
 - b. Josam
 - c. MIFAB, Inc.p
 - d. Zurn Industries, LLC.
 - e. Watts
- D. Floor Drain - Finished area/Toilet room/Shower (FD-1):
- 1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.
 - 2. Include deep seal p-trap and mechanical trap guard.
 - 3. Equal to JR Smith Figure 2051
- E. Floor Drain - mechanical/boiler area (FD-2):
- 1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, medium duty adjustable round nickel bronze strainer with removable perforated sediment bucket.
 - 2. Equal to JR Smith Figure 2220
 - 3. Include optional 4 funnel as required for indirect waste.
 - 4. Include deep seal p-trap and mechanical trap guard.

2.03 CLEANOUTS

- A. Manufacturers:
- 1. Jay R. Smith Manufacturing Company.
 - 2. Josam Company.
 - 3. MIFAB, Inc; C1100-R.
 - 4. Zurn Industries, LLC.
 - 5. Watts
- B. Cleanouts at Interior Finished Floor Areas FCO:
- 1. Galvanized cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored Nickel Bronze cover in service areas and hard surface finished floors and round gasketed depressed cover to accept floor finish in carpeted floor areas.
- C. Cleanouts at Interior Finished Wall Areas WCO:
- 1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
- D. Cleanouts at Interior Unfinished Accessible Areas CO: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.04 HYDRANTS

- A. Manufacturers:
- 1. Jay R. Smith Manufacturing Company.
 - 2. Zurn Industries, LLC.
 - 3. Watts
- B. Wall Hydrants - Mild Climate **HB-1**:
- 1. ASSE 1019; mild climate with chrome-plated wall plate hose thread spout, lockshield and removable key, and integral vacuum breaker.
 - 2. Equal to Watts #HY-450

C. Wall Hydrants - non-freeze **NFHB**:

1. ASSE 1019; freeze resistant, self-draining type with chrome-plated wall plate hose thread spout, lockshield and removable key, and integral vacuum breaker.
2. Equal to Watts #HY-725

2.05 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventer Assembly: RPZ-1

1. ASSE 1013; cast bronze body and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure, and non-threaded vent outlet.
2. Size: 3 inch assembly with threaded gate valves.

2.06 DOUBLE CHECK-VALVE ASSEMBLIES

A. Double Check Valve Assembly: DCV-1

1. ASSE 1012; cast bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.
2. Size: 6 inch assembly with threaded full port ball valves.

B. Double Check Valve Assembly: DCV-2

1. ANSI/NSF standard 18, Manual food and beverage dispensing equipment, ASSE 1032 Approved dual check valve, 316 stainless steel body and all rubber components comply with FDA regulations. All materials in contact with potable water are in compliance with the safe drinking water act, public law 93-523, National interim primary drinking water regulations.
2. Size: 3/8 inch assembly with threaded full port ball valves.
3. Maximum Working Parameters: 200 psi at 110 degrees F.

2.07 WATER HAMMER ARRESTORS

A. Water Hammer Arrestors:

1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.08 MIXING VALVES

A. Thermostatic Master Mixing Valves:

1. Manufacturers:
 - a. Leonard Valve Company.
 - b. Watts Water Technologies; POWERS
2. Valve: ASSE 1017, bronze or brass body; thermostatic element; corrosion- and lime-resistant internal components; integral locking temperature adjustment.
3. Capacity: 38 gpm at 20 psi differential.
4. Mixed-Water Temperature Setting: 115 degrees F.
5. Finish: Rough bronze.
6. Accessories:
 - a. Strainer stop checks on inlets.
 - b. Shut-off valve on outlet.
 - c. Stem thermometer on outlet.

2.09 FLOOR DRAIN TRAP SEALS

- A. Manufacturers:
 - 1. Green Drains; GD4.
 - 2. MIFAB, Inc; MI-GARD.
- B. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

2.10 EXTERIOR PENETRATION ACCESSORIES

- A. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for piping, cables, and roofing system to be installed; designed to accommodate existing penetrations where applicable.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install floor drains at low point in floor. Coordinate final "flush to finished floor" drain cover elevation with GC flooring installer. If entire floor is not pitched to floor drain, create 2' diameter low point at drain, pitched ~1/8"/foot.
- C. All floor and trench drains shall be installed with a deep seal p-trap and mechanical trap guard, unless other-wise specified on plans.
- D. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- E. Install floor cleanouts at elevation to accommodate finished floor.
- F. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
- G. Pipe relief from backflow preventer to nearest drain.
- H. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks, washing machine outlets, or any fast closing fixtures/valves.

END OF SECTION

**SECTION 221329
SANITARY SEWERAGE PUMPS**

TTPART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submersible sewage pumps.
- B. Sewage pump basins and pits.

1.02 RELATED REQUIREMENTS

- A. Section 220513 - Common Motor Requirements for Plumbing Equipment.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015 (Reaffirmed 2020).
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; 2014 (Reaffirmed 2020).
- C. ICC (IPC) - International Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NEMA MG 00001 - Motors and Generators; 2024.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide certified pump chart or curve with duty point marked over.
- C. Shop Drawings: Include dimensions and performance data.
- D. Certificate: Certify that products of this section meet or exceed specified requirements.
- E. Executed warranty.

1.05 QUALITY ASSURANCE

- A. Certifications: UL (DIR) listed, classified, and suitable for purpose specified and indicated.
- B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.07 WARRANTY

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

PART 2 PRODUCTS

2.01 SUBMERSIBLE SEWAGE PUMPS

- A. Manufacturers:
 - 1. Crane Pumps and Systems.
 - 2. Gorman-Rupp Pumps, a subsidiary of Gorman-Rupp Company.

3. Grundfos Pumps Corporation; SL Series.h
 4. PROFLO.
 5. Superior Pump.
 6. Weil Pump Company, Inc.
 7. Zoeller Company.
- B. Description: Submersible centrifugal pump made of rugged stainless steel and cast-iron housing and base with oil-filled motor chamber, ball bearings, and mechanical seal.
- C. Casing:
1. Capable of withstanding pressures 50 percent greater than maximum operating pressure.
 2. Volute: Consisting of smooth passages providing unobstructed flow through pump.
 3. Exposed Nuts and Bolts: Stainless steel construction.
 4. Finish: Protect casing exterior surfaces in contact with sewage using sewage-resistant coal tar epoxy coating.
- D. Pump Shaft: Fabricate of high-grade alloy steel of adequate strength and size, with application-appropriate safety factor to transmit full driver horsepower. Include shaft key so that impeller cannot be loosened by either reverse or forward torque.
- E. Wear Rings: Renewable; provided on casing and impeller with wearing surfaces normal to axis of rotation. Material suitable for ease of maintenance and secured to prevent rotation.
- F. Bearings:
1. Provide roller type capable to handle multi-directional thrust loads.
 2. Do not use pumps dependent on thrust and hydraulic balance.
 3. Bearing Life: L-10, 50,000 hours minimum, complying with ABMA STD 9 or ABMA STD 11.
- G. Seals:
1. Provide tandem mechanical shaft seal system running in oil bath.
- H. Motor:
1. Base-mounted, enclosed, lubricated oil-free, thermal-overload protected, continuous-duty, permanent split capacitor with oil-resistant, three-prong connector, 6-foot power cord.
 2. Watertight with Class F insulation, NEMA B design, complying with NEMA MG 00001.
 3. Provide oil filled, air filled with water jacket, or air filled with cooling fins that encircle stator housing.
- I. Power Cable:
1. Enters through heavy-duty entry assembly provided with internal grommet assembly to prevent leakage.
 2. Separate motor and cable entry junction by terminal board or stator lead sealing gland that prevents foreign material from gaining access to motor interior through top of pump.
 3. Standard construction for submersible pump applications; do not use materials consisting of silicones.
- J. Controls: Integral, chemically-resistant, vertical plated-steel rod float switch. Cycle pump ON/OFF between 2.5- and 9-inch heights from bottom of pump.
- K. Solids Handling Capacity: Pass lint and other small solids up to 1/2 inch in size.
- L. Discharge Pipe Size: 2 inches, NPT, female.
- M. Maximum Water-Based Effluent Temperature: 120 degrees F.
- N. Accessories: Provide reverse flow assembly and high-level audio/visual alarm system.
-

2.02 SEWAGE BASINS AND PITS

- A. Simplex Basin:
 - 1. Manufacturers:
 - a. Liberty Pumps Inc.
 - b. Plumbstar USA.
 - c. Topp Industries, Inc.
 - d. Zoeller Company.
 - 2. Simplex Basin Diameter and Height: 18 by 30 inches.
 - 3. Molded-Finish Requirements: Hard bottom, watertight, gastight, and radon-tight molding.
 - 4. Basin Material: Polyethylene structural-foam, heavy-duty injection-molded.
 - 5. Below Ground Pipe Inlet: Molded or predrilled with seal, 3 inches.
 - 6. Maximum Waste Effluent Temperature: Match or exceed maximum pump service temperature.
 - 7. Basin Cover: 1-1/4-inch discharge, 1-1/2-inch vent, and cord grommet openings with hubs.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products with related fittings and accessories according to manufacturer instructions.
- B. Provide accessories required to complete installation in accordance with ICC (IPC).

3.02 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Tests: Conduct tests to demonstrate satisfactory functional operation and efficiency.

3.03 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

3.04 PROTECTION

- A. Protect installed products from damage due from subsequent construction operations.
- B. Repair or replace products damaged before Date of Substantial Completion.

END OF SECTION

**SECTION 221429
SUMP PUMPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submersible sump pumps.
- B. Sump basins and pits.

1.02 REFERENCE STANDARDS

- A. ICC (IPC) - International Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide certified pump chart or curve with duty point marked over.
- C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- D. Executed warranty.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with three years minimum of documented experience.
- B. Certifications: UL (DIR) listed, classified, and suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for pumps and related components. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 SUBMERSIBLE ELEVATOR SUMP PUMPS - REFER TO SCHEDULE ON PLANS

- A. Manufacturers:
 - 1. Grundfos Pumps Corporation.
 - 2. Liberty Pumps - equal to ELV-series with OilTector.
 - 3. Stancor.
 - 4. Zoeller Company.
- B. General: Cast iron housing and base with oil-filled motor chamber, ball bearings, and mechanical seal.
- C. Impeller: Thermoplastic; open nonclog, stainless steel shaft.

- D. Motor: Base mount, enclosed, lubricated oil-free, thermal-overload protected, continuous duty, permanent split capacitor with oil-resistant, three-prong connector, 10 foot power cord.
- E. Oil Detection Controls: NEMA 4X panel, Integral, chemically-resistant, vertical plated-steel rod float switch. Cycle pump Off/On between _____ inch heights from bottom of pump. Provide oil detection monitor, to automatically shut pump off if oil is detected and alarm locally.
- F. Solids Handling Capacity: Pass lint and other small solids up to 1/2 inch in size.
- G. Discharge Pipe Size: 1-1/2 inch, NPT, female.
- H. Accessories: Provide full flow swing-type discharge check valve.
- I. Minimum sump pit size: 18"dia x 30" deep

2.02 SUMP BASINS AND PITS - REFER TO SCHEDULE ON PLANS

- A. Sump Basin:
 - 1. Manufacturers:
 - a. Topp Industries, Inc.
 - b. Zoeller Company.
 - 2. Below Ground Pipe Inlet: Molded or predrilled with seal, 4 inch.
 - 3. Basin Dimensions: 18 inch diameter, 30 inch deep.
 - 4. Basin Material: Polyethylene, heavy duty injection molded.
 - 5. Molded-Finish Requirements: Hard bottom, watertight, gas-tight and radon-tight molding.
 - 6. Maximum Effluent Temperature: Match or exceed maximum pump service temperature.
 - 7. Basin Riser Extension: Diameter matched, 6 inch with hardware.
 - 8. Basin Cover:
 - a. Material: One-piece flat lid made of polyethylene with seal gasket.
 - b. Openings: 1-1/2 inch discharge, 3-inch vent, and cord grommet with hubs.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products with related fittings and accessories according to manufacturer instructions.
- B. Observe and provide incidentals required to complete installation in compliance with ICC (IPC).
- C. Coordinate elevator sump pump location with elevator equipment and controls. Coordinate elevator sump alarm panel location with electrical contractor and elevator inspector.

3.02 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Operational Tests: Conduct operating tests to demonstrate satisfactory, functional, and operating efficiency.

3.03 CLEANING

- A. See Section 017419 - Construction Waste Management and Disposal for additional requirements.

3.04 PROTECTION

- A. Protect installed products from damage from subsequent construction operations.

END OF SECTION

**SECTION 224000
PLUMBING FIXTURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush valve water closets.
- B. Wall hung urinals.
- C. Lavatories.
- D. Wall-hung, solid surface, multistation lavatory units.
- E. Sinks.
- F. Under-lavatory pipe supply covers.
- G. Shower receptors.
- H. Bottle filling drinking fountains.
- I. Bi-level, electric water coolers.

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.
- D. Section 221006 - Plumbing Piping Specialties.
- E. Section 223000 - Plumbing Equipment.
- F. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2008 (Reaffirmed 2013).
- C. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
- D. ASME A112.18.1 - Plumbing Supply Fittings; 2024.
- E. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures; 2011 (Reaffirmed 2022).
- F. ASME A112.19.1 - Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures; 2024.
- G. ASME A112.19.2 - Ceramic Plumbing Fixtures; 2024.
- H. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2022.
- I. ASME A112.19.1 - Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures; 2024.
- J. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2022.
- K. ASME A112.19.15 - Bathtubs/Whirlpool Bathtubs with Pressure Sealed Doors; 2012 (Reaffirmed 2022).
- L. ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers; 2020.

- M. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2020.
- N. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping; 2021.
- O. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- P. NSF 61 - Drinking Water System Components - Health Effects; 2019.
- Q. NSF 372 - Drinking Water System Components - Lead Content; 2024.
- R. 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

2.04 FLUSH VALVE CHINA WATER CLOSETS, WALL HUNG - WITH SENSOR OPERATED FLUSH VALVES

- A. Water Closet (**WC-1**): Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action, Accessible, hard wired sensor operated flush valve.
1. Bowl: ASME A112.19.2; with elongated rim.
 2. Flush Valve: Exposed (top spud).
 3. Flush Operation: Sensor operated, hard wired.
 4. Accessible installation.
 5. Trapway Outlet: 4 inch.
 6. Color: White.
 7. Basis of Design American Standard - AFWall 2257.101
- B. Water Closet (**WC-2**): Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action, hard wired sensor operated flush valve.
1. Bowl: ASME A112.19.2; with elongated rim.
 2. Flush Valve: Exposed (top spud).
 3. Flush Operation: Sensor operated, hard wired.
 4. Standard height installation.
 5. Trapway Outlet: 4 inch.
 6. Color: White.
 7. Basis of Design American Standard - AFWall 2257.101
- C. Flush Valves:
1. Valve Supply Size: 1 inch.
 2. Valve Outlet Size: 1-1/2 inches.
 3. Sensor-Operated: Hard Wired with transformer.
 4. Type: ASME A112.19.5; chloramine-resistant clog-resistant dual-seat diaphragm valve complete with vacuum breaker, stops and accessories.
 5. Mechanism: Solenoid-operated electronic motor-actuated operator with low-voltage powered infrared sensor, and true mechanical override button.
 6. Supplied Volume Capacity: 1.28 gal per flush.
 7. Exposed Type: Chrome-plated, escutcheon, integral screwdriver stop.
 8. Basis of Design - Sloan Valve - Sloan 111.ESS-1.28-TMO-HW
- D. Seats:
1. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.
- E. Water Closet Carriers:
1. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.05 WALL HUNG CHINA URINALS

- A. Urinal (**UR-1**) Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier, Accessible.
1. Flush Volume: 0.125 gallons, maximum.
 2. Flush Valve: Exposed (top spud).
 3. Flush Operation: Sensor operated, hard wired.

4. Trapway Outlet: Integral.
5. Basis of Design: American Standard - Washbrook - 6501.010
- B. Flush Valves:
 1. Sensor-Operated Type: Solenoid operator, battery powered, infrared sensor with mechanical over-ride or over-ride push button.
 2. Sensor-Operated:
 - a. Type: ASME A112.19.5; chloramine-resistant, clog-resistant dual-seat diaphragm valve with vacuum breaker, stops and accessories.
 - b. Mechanism: Solenoid-operated operator with low-voltage powered infrared sensor, and true mechanical override button.
 - c. Supplied Volume Capacity: .125 gal per flush.
 3. Exposed Type: Chrome-plated, escutcheon, integral screwdriver stop.
 4. Basis of Design: Sloan Valve - Sloan 186-ESS-0.125-TMO-HW
- C. Urinal Carriers:
 1. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.06 SINKS COUNTER MOUNTED

- A. Single Compartment Bowl (**SK-1**), stainless steel, accessible, undercounter mounted
 1. ASME A112.19.3; 18-1/2inches x 21-1/2inches outside, 4-7/8inches deep, 16inches x 19inches inside dimensions 18 gauge, .0478 inch thick, Type 304 stainless steel, undercoated.
 2. Basis of Design: Just Sinks USADA-1821-A50-J
 3. Drain: 3-1/2 inch crumb cup and tailpiece.
 4. Supplies:
 - a. Chrome plated brass compression stop with inlet connection matching water supply piping type and size.
 - b. Loose key stop
 - c. Risers braided or corrugated stainless steel flexible hose.
 5. Mounted under counter with sealant and clips
 6. Coordinate hole punching with faucet
- B. Faucet: ASME A112.18.1; chrome plated combination supply fitting, Gooseneck with wrist blade handles, water economy aerator with maximum flow of 2.2 gallons per minute, indexed handles.
 1. Gooseneck, 8" swivel/rigid
 2. 4" Wrist blade handles
 3. Deck mounted, 8" fixed centers
 4. 2.2 GPM flow
 5. Basis of design: T&S Brass - B-1120-135X-WH4

2.07 SINKS - FREE STANDING

- A. Owner provided lab sink basin (SK-2, SK-3 and SK-4)
 - B. Single Hole Deck Mount Mixing Faucet (SF-2), Quarter-Turn Eterna Cartridges w/ Spring Checks, 4" Wrist Action Handles, Swivel/Rigid Vacuum Breaker Nozzle, Serrated Tip Outlet w/ 0.5 GPM Flow Control & 18" Flexible Stainless Steel supply Hoses w/ 1/2" NPSM Male Inlets.
 - C. NSF 61 - Section 9
 - D. ANSI A117.1 (ADA)
-

2.08 UNDER-LAVATORY/SINK PIPE SUPPLY COVERS

- A. Manufacturers:
 - 1. Plumberex Specialty Products, Inc.
 - 2. Truebro
 - 3. Oatey
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Basis of Design: Plumberex Specialty Products, Inc..
- C. 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 ASTM C1822 Type III for covers on accessible lavatory piping.
 - b. Comply with ASME A112.18.9 for covers on accessible lavatory piping.
 - c. 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.

2.09 BOTTLE FILLING DRINKING FOUNTAINS

- A. Manufacturers:
 - 1. Elkay Manufacturing Company
 - 2. Murdock Manufacturing, Inc
 - 3. Substitutions: See Section 016000 - Product Requirements.
- B. See Plumbing Schedule for Model Information

2.10 BI-LEVEL, ELECTRIC WATER COOLERS - ADA (EWC-1)

- A. See Plumbing Schedule for Model Information
- B. Water Cooler: Bi-level, electric, mechanically refrigerated; surface mounted, ADA compliant; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.
 - 1. Capacity: 8 gph of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
 - 2. Provide with integral water filter.
 - 3. Electrical: 115 VAC, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.
- C. Bottle Filler: Materials to match fountain.

2.11 MOP SINKS (MR-1)

- A. See Plumbing Schedule for Model Information
- B. Terrazzo Mop Sink Manufacturers:
 - 1. Acorn Engineering Company
 - 2. Fiat Products; equal to TSB-100
 - 3. Just Manufacturing Company
 - 4. Zurn Industries, Inc
- C. Material: Precast terrazzo composed of marble chips cast in Portland cement.

- D. Type: Neo-corner, with stainless rim guard
- E. Grid strainer: Stainless steel; integral; removable.
- F. Dimensions: 24"x24" unless otherwise indicated on drawings.
- G. Accessories:
 - 1. 5 feet of 1/2 inch diameter plain end reinforced plastic hose.
 - 2. Service Sink Faucet with vacuum breaker, pail hook, 3/4" hose thread, wall brace, 8" center with lever handles.
 - a. Equal to Chiago Faucet 897 series
 - 3. Hose clamp hanger.
 - 4. Mop hanger.
 - 5. Provide with additional cold water connection through backflow prevention device for dedicated supply to owner provided chemical dispensing system.

2.12 HOSE BIB BOXES

- A. Material: 316 stainless steel.
- B. Finish: Satin.
- C. Mount in wall fully recessed.
- D. Provide with NPT PVC ball valves and fittings.
- E. Provide with internal hose drain bracket and waste outlet.

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 224500
EMERGENCY PLUMBING FIXTURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Emergency shower.
- B. Eyewash equipment.
- C. Self-contained eyewash equipment.
- D. Personal eyewash equipment.
- E. Eye/face wash equipment.
- F. Safety stations (combination emergency fixture units).
- G. Emergency-fixture water-tempering valves.

1.02 REFERENCE STANDARDS

- A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2014.

PART 2 PRODUCTS

2.01 EMERGENCY SHOWER

- A. ANSI Z358.1, wall-mounted, drench type.
- B. Pipe and Fittings Material: Epoxy coated galvanized steel
- C. Shower Head:
 - 1. Type: Self-cleaning, non-clogging, 8 inches in diameter.
- D. Valve: Full flow, self closing, quick to open using assembly-fitted manual arm-rod based hand operator.

2.02 EYEWASH EQUIPMENT

- A. See Plumbing Schedule for Model Information
- B. ANSI Z358.1, wall-mounted bowl with dual eye-spray head assembly.
- C. Pipe and Fittings Material: Epoxy coated galvanized steel.
- D. Valve: Full flow, self close, quick to open using wide-handle manual hand operator.
- E. Drain: Built-into the bowl assembly with 1-1/4 inch female outlet.

2.03 SAFETY STATIONS (COMBINATION EMERGENCY FIXTURE UNITS)

- A. Water Discharge Flow Rates:
 - 1. Shower Head: Minimum, 20 gpm .
 - 2. Eye wash Spray Heads: 1.6 gpm.
- B. Pipe and Fittings Material: Powder coated galvanized steel.
- C. Shower Head:
 - 1. Self-cleaning, non-clogging, 10 inches in diameter with escutcheon.
 - 2. Flow Pattern: Minimum, 20 inches at 60 inches above floor end.
- D. Valves: Full flow, self closing, quick to open within one second using dedicated manual panic bar operator for shower and dedicated manual panic bar handle for eye wash.

2.04 EMERGENCY-FIXTURE WATER-TEMPERING VALVES

- A. Tepad Water Temperature: Set to 85 degrees F.
- B. Capacity: Sized for 50 gpm at 30 psi supply pressure.
- C. Valve Assembly: Thermostatic mixing (blending) type made of lead-free cast brass body with integral built-in cold water bypass (fail safe), color marked dual-scale outlet temperature gauge, integral inlet check valve, integral inlet strainer, locking-type regulator, and mounting bracket.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that fixtures and accessories are of the correct type and size prior to installation.
- B. Verify that deck, wall and floor finishes are prepared and ready for fixture installation.

3.02 INSTALLATION

- A. Install fixtures and fittings in accordance with the manufacturer's instructions.
- B. Adjust water flow rates to comply with manufacturer's rating of the fixture.
- C. Place remote-activated thermostatically actuated bleed valve behind wall or buried below frost line.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Operational Tests: Upon completion and sterilization of plumbing systems, conduct operating tests to demonstrate satisfactory, functional, and operating efficiency.

3.04 CLEANING

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

3.05 PROTECTION

- A. Protect installed products from damage due to subsequent construction operations.
- B. Repair or replace products damaged 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. They shall call attention to any changes or additions which, in their opinion, are necessary to make possible the fulfillment of any guarantee called for by these specifications; failing which, it shall be deemed that they have accepted full responsibility for all such guarantees.
- E. The contractor shall put their work in place as fast as is reasonably possible. They shall, at all times, keep a competent foreperson 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. They 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. They 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 1.04 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 their 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 their 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 they submit 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 cost 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 their 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 their 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 feet 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 blue-line 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 warranties may be indicated in other sections. In all cases, the more stringent guarantee or warranty 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 230000**THIS PAGE INTENTIONALLY LEFT BLANK****END OF SECTION**

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.
 - 8. Emergency Pushbutton Operator Station.

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)

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):
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1. Allen-Bradley Co. Bulletin 736.
2. General Electric Co. CR-230.
3. Square D Co. Class 8640.
4. Cutler-Hammer. ECA45.

2.04 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.

2.05 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

3.08 EMERGENCY PUSHBUTTON OPERATOR STATION

- A. Provide Emergency Pushbutton Operator Station at each boiler room exit to de-energize the primary control circuit and to close the main fuel valves to stop the flow of fuel to the burner during an emergency.
- B. Review plans for locations.
- C. Provide all conduit and wiring for interlock of each boiler.

END OF SECTION

**SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

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 00001 - Motors and Generators; 2024.
- 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.

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 00001 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 00001 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 00001.
- 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. Hydronic Fan Coil Unit:
 - 1) Operating Mode: Constant cfm.
 - 2) Input: Motor manufacturer to coordinate control requirements with the control board of the fan coil unit and/or specified sequence of operation.
 - 3) Shaft Extension: Single.
 - 4) Options: User-interface.
 - c. 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.

- d. 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.
- e. 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.

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

**SECTION 230516
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Pipe loops, offsets, and swing joints.

1.02 REFERENCE STANDARDS

- A. EJMA (STDS) - EJMA Standards; Tenth Edition.
- B. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- C. Design Data: Indicate selection calculations.
- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
- E. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
- 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 Packing for Packed Expansion Joints: One set for each joint.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with UL (DIR) requirements.

2.02 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Inner Hose: Stainless Steel.
- B. Exterior Sleeve: Single braided, stainless steel.
- C. Pressure Rating: 125 psi up to 12 inch.
- D. Maximum Service Temperature: 450 degrees F.
- E. End Connections: Flanged.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.

2.03 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Inner Hose: Bronze.
- B. Exterior Sleeve: Braided bronze.

- C. Pressure Rating: 125 psi up to 2 inch.
- D. Maximum Service Temperature: 450 degrees F.
- E. End Connections: Flanged.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.
- H. Application: Copper piping.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.
- G. Substitute grooved piping for vibration isolated equipment instead of flexible connectors. Grooved piping need not be anchored.

END OF SECTION

**SECTION 230517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**

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.

1.03 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.
- 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.
- 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 Valve Stem Packings: Two for each type and size of valve.

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

**SECTION 230519
METERS AND GAUGES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Positive displacement meters.
- B. Flow meters.
- C. Electromagnetic flow meters.
- D. Pressure gauges and pressure gauge taps.
- E. Thermometers and thermometer wells.
- F. Static pressure gauges.
- G. Filter gauges.

1.02 RELATED REQUIREMENTS

- A. Section 230923 - Direct-Digital Control System for HVAC.
- B. Section 230943 - Pneumatic Control System for HVAC.
- C. Section 230993 - Sequence of Operations for HVAC Controls.
- D. Section 232113 - Hydronic Piping.
- E. Section 232213 - Steam and Condensate Heating Piping.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- B. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
- C. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2025).
- D. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2024.
- F. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012, with Addendum (2018).
- G. Modbus (PS) - The Modbus Organization Communications Protocol.; Latest Update.
- H. 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.
- C. Project Record Documents: Record actual locations of components and instrumentation.
- D. Operation and Maintenance Data:
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Gauge Oil for Inclined Manometers: One bottle.
3. Extra Pressure Gauges: One of each type and size.

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. 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 and KPa.

2.02 PRESSURE GAUGE TAPPINGS

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

2.03 STEM TYPE THERMOMETERS

- A. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
 1. Size: 9 inch scale.
 2. Window: Clear Lexan.
 3. Accuracy: 2 percent, per ASTM E77.
 4. Calibration: Degrees F.
- 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 DIAL THERMOMETERS

- A. Thermometers - Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
 1. Size: 5 inch diameter dial.
 2. Lens: Clear glass.
 3. Accuracy: 1 percent.

4. Calibration: Degrees F.
- B. Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 1. Size: 3 inch diameter dial.
 2. Lens: Clear glass.
 3. Accuracy: 1 percent.
 4. Calibration: Degrees F.
- C. Thermometers: Dial type vapor or liquid actuated; ASTM E1; stainless steel case, with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer, glass lens.
 1. Size: 4-1/2 inch diameter dial.
 2. Lens: Clear glass.
 3. Length of Capillary: Minimum 5 feet.
 4. Accuracy: 2 percent.
 5. Calibration: Degrees F.

2.05 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.

2.06 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.
- B. 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 Nordel core for temperatures up to 350 degrees F.
- C. 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 Viton core for temperatures up to 400 degrees F.
- D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauges, one gauge adapters with 1/8 inch probes, two 1 inch dial thermometers.

2.07 STATIC PRESSURE GAUGES

- A. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- B. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- C. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.

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- C. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
 - D. 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.
 - 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 thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 230943. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
 - H. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
 - I. Coil and conceal excess capillary on remote element instruments.
 - 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 thermometers and thermometer sockets.

3.02 SCHEDULE

- A. Positive Displacement Meters, Location:
 - 1. Expansion tank make-up.
 - B. Flow Meters, Location:
 - 1. Heating water system.
 - C. Pressure Gauges, Location and Scale Range:
 - 1. Pumps, 0 to 100 psi.
 - 2. Expansion tanks, 0 to 100 psi.
 - 3. Backflow preventers, 0 to 100 psi.
 - D. Pressure Gauge Tappings, Location:
 - 1. Control valves 3/4 inch & larger - inlets and outlets.
 - 2. Major coils - inlets and outlets.
 - 3. Boiler - inlets and outlets.
 - E. Stem Type Thermometers, Location and Scale Range:
 - 1. Headers to central equipment, 0 to 280 degrees F.
 - 2. Boilers - inlets and outlets, 0 to 280 degrees F.
 - 3. After major coils, 0 to 280 degrees F.
 - F. Thermometer Sockets, Location:
 - 1. Control valves 1 inch & larger - inlets and outlets.
 - 2. Reheat coils - inlets and outlets.
 - 3. Cabinet heaters - inlets and outlets.
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- 4. Unit heaters - inlets and outlets.
- G. Dial Thermometers, Location and Scale Range:
 - 1. Each supply air zone, 0 to 280 degrees F.
 - 2. Outside air, 0 to 280 degrees F.
 - 3. Return air, 0 to 280 degrees F.
 - 4. Mixed air, 0 to 280 degrees F.
- H. Static Pressure and Filter Gauges, Location and Scale Range:
 - 1. Supply fan discharge, 0 to 4 inches W.C..

END OF SECTION

**SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Applications.
- B. Angle valves.
- C. Globe valves.
- D. Ball valves.
- E. Check valves.
- F. Gate valves.
- G. Chainwheels.

1.02 RELATED REQUIREMENTS

- A. Section 230553 - Identification for HVAC Piping and Equipment.
- B. Section 230719 - HVAC Piping Insulation.
- 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; 2017.
- D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022, with Errata (2023).
- 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; 2025.
- H. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

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- 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; 2024.
 - 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-68 - High Pressure Butterfly Valves with Offset Design; 2021.
 - O. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.
 - P. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
 - Q. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.
 - R. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
 - S. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.
 - T. 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:
 - 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.

- 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

2.01 APPLICATIONS

- A. See drawings for specific valve locations.
- B. Provide the following valves for the applications if not indicated on drawings:
 - 1. Throttling (Hydronic): Ball and Globe.
 - 2. Isolation (Shutoff): Gate and Ball.
 - 3. Swing Check (Pump Outlet):
 - a. 2 NPS and Smaller: Bronze with bronze disc.
 - b. 2-1/2 NPS and Larger: Iron with lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat.
- C. 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).
- D. Heating Hot Water Valves:
 - 1. 2 NPS and Smaller, Bronze Valves:
 - a. Threaded ends.
 - b. Angle: Bronze disc, Class 125.
 - c. Ball: Full port, two piece, stainless steel trim.
 - d. Swing Check: Bronze disc, Class 125.
 - e. Gate: NRS, Class 125.
 - f. Globe: Bronze disc, Class 125.
 - 2. 2-1/2 NPS and Larger, Iron Valves:
 - a. 2-1/2 NPS to 4 NPS: Threaded ends.
 - b. Ball: 2-1/2 NPS to 10 NPS, Class 150.
 - c. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, aluminum-bronze disc, EPDM seat, 200 CWP.
 - d. Single-Flange Butterfly: 14 NPS to 24 NPS, aluminum-bronze disc, EPDM seat, 150 CWP.
 - e. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 175 CWP.
 - f. Butterfly: High performance, single flange, Class 150.
 - g. Swing Check: Metal seats, Class 125.
 - h. Swing Check: 2-1/2 NPS to 12 NPS, lever and spring closure control, Class 125.
 - i. Grooved-End Swing Check: 3 NPS to 12 NPS, 300 CWP.
 - j. Gate: NRS, Class 125.
 - k. Globe: 2-1/2 NPS to 12 NPS, Class 125.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

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- 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. 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, ANGLE VALVES

- A. Class 125: CWP Rating: 200 psig: and Class 150: CWP Rating: 300 psig:.
 - 1. Comply with MSS SP-80, Type 1.
 - 2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
 - 3. Ends: Threaded.
 - 4. Stem: Bronze.
 - 5. Disc: Bronze, PTFE, or TFE.
 - 6. Packing: Asbestos free.
 - 7. Handwheel: Bronze or aluminum.

2.04 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.

2.05 IRON, GLOBE VALVES

- A. Class 125: CWP Rating: 200 psig: and Class 250: CWP Rating: 500 psig:.
 - 1. Comply with MSS SP-85, Type I.
 - 2. Body: Gray iron; ASTM A126, with bolted bonnet.
 - 3. Ends: Flanged.
 - 4. Trim: Bronze.
 - 5. Packing and Gasket: Asbestos free.
 - 6. Operator: Handwheel or chainwheel.

2.06 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.

2.07 IRON, BALL VALVES

- A. Split Body, Full Port:
 - 1. Comply with MSS SP-72.
 - 2. CWP Rating: 200 psig.
 - 3. Body: ASTM A126, gray iron.
 - 4. Ends: Flanged.
 - 5. Seats: PTFE.
 - 6. Stem: Stainless steel.
 - 7. Ball: Stainless steel.

2.08 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.

2.09 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.

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3. Body Material: Bronze, ASTM B62.
 4. Ends: Threaded.
 5. Disc: Bronze.

2.10 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. Disc: PTFE or TFE.
 7. Gasket: Asbestos free.

2.11 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.

2.12 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.

2.13 IRON, GATE VALVES

- A. NRS or OS&Y:
 1. Comply with MSS SP-70, Type I.
 2. Class 125: 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
 3. Class 125: 14 NPS to 24 NPS, CWP Rating: 150 psig.
 4. Class 250: 2-1/2 NPS to 12 NPS, CWP Rating: 500 psig.
 5. Class 250: 14 NPS to 24 NPS, CWP Rating: 300 psig.
 6. Body Material: Gray iron with bolted bonnet.
 7. Ends: Flanged.
 8. Trim: Bronze.
 9. Disc: Solid wedge.
 10. Packing and Gasket: Asbestos free.

2.14 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
-

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball, butterfly, and plug valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

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 and center-guided into horizontal or vertical position, between flanges.
- E. Provide chainwheels on operators for valves 4 NPS and larger where located 96 NPS or more above finished floor, terminating 60 NPS above finished floor.

END OF SECTION

**SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

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; 2014.
- 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; 2023.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- 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; 2025.
- 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.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - 2. Provide factory-fabricated continuous-slot metal channel (strut) and associated fittings, 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.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 5. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 - 6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
- D. 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. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
 - c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- E. Thermal Insulated Pipe Supports:
 - 1. Manufacturers:
 - a. Buckaroos, Inc: www.buckaroos.com/#sle.
 - b. KB Enterprises: www.snappitz.com/#sle.
 - 2. General Construction and 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. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid phenolic foam insulation surrounded by a 360 degree, PVC jacketing.
 - 3. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.

- b. Minimum Service Temperature: Minus 40 degrees F.
 - c. Maximum Service Temperature: 180 degrees F.
 - d. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - e. Thickness: 60 mil.
 - f. Connections: Brush on welding adhesive.
 - 4. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.
 - 5. Products:
 - a. Buckaroos, Inc; CoolDry: www.buckaroos.com/#sle.
 - F. Pipe Supports:
 - 1. Liquid Temperatures Up To 122 degrees F:
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
 - b. Support From Below: MSS SP-58 Types 35 through 38.
 - 2. Operating Temperatures from 122 to 446 degrees F:
 - a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.
 - b. Roller Support: MSS SP-58 Types 41 or 43 through 46, with appropriate saddle of MSS SP-58 Type 39 for insulated pipe.
 - c. Sliding Support: MSS SP-58 Types 35 through 38.
 - G. Pipe Stanchions: For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
 - 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.phpspd.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.
 - 6. 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:
 - 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 - BSD 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

**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. 2025 New York State Building Code (Section 1609).
- C. 2025 New York State 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 7-2.

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. 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 2025 New York State Building Code (Section 1609) and American Society of Civil Engineers ASCE/SEI 7-22. The following criteria are applicable to this project:
 1. Nominal Design Wind Speed (V) (Per ASCE 7-22): 115 mph.
 2. Risk Category (Per ASCE 7-22): II
 3. Exposure Category (Per ASCE 7-22): C
 4. Height and Exposure Adjustment Coefficient (Per ASCE 7-22): 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.
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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.

END OF SECTION

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.
- B. 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.

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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

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- 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.

END OF SECTION

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic and refrigerating systems.
- C. Field quality-control testing of Laboratory fume hoods.
- D. Measurement of final operating condition of HVAC systems.
- E. 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, with Errata (2022).
- 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. Preface: An explanation of the intended use of the control system.
 - b. 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.
 - c. 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.
 - d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Final test report forms to be used.
 - f. Expected problems and solutions, etc.
 - g. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Quality-control Testing of Laboratory Fume Hoods:

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1. Product Data sheets for all equipment proposed for use in on-site as-installed testing.
 2. Sample Test Report.
 3. List of laboratory fume hoods to be tested. Submit a minimum of one week prior to commencement of testing.
 4. Test data demonstrating that each type of fume hood provided for the project has been successfully tested in the factory as per requirements of Section 115313.
- E. 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:
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- 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. Proper strainer baskets are clean and in place.
 - 14. 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.

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- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
 - D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
 - E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
 - F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
 - G. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 FUME HOOD TESTING (ON SITE)

- A. General: Test fume hoods as installed to assess airflow velocity, airflow visualization, and level of containment. Perform tests with static mode (set sash position) conditions. Conduct testing as outlined below for 100% of the hoods provided in the Project.
- B. Testing to be performed by firm certified by National Environmental Balancing Bureau - NEBB (FHT).
- C. Preparation: Visit the project site to confirm that construction activities related to the fume hood system(s) and equipment are complete. Review design documents and Contractor's submittals. Verify that mechanical ventilation systems serving the space are functioning and operating in the normal mode. Notify Owner in writing, if conditions exist which preclude proper fume hood testing. Starting of testing constitutes acceptance of site conditions.
- D. Testing Requirements:
 - 1. Perform the following tests, in order:
 - a. Airflow Velocity Test.
 - b. Airflow Visualization Test.
 - c. Tracer Gas Containment Test.
 - 2. Airflow Velocity Test: Comply with Section 9 of NEBB (FHT) Fume Hood Testing Standard - current edition.
 - 3. Airflow Visualization Test: Comply with Section 10 of NEBB (FHT) Fume Hood Testing Standard - current edition.
 - 4. Tracer Gas Containment Test:
 - a. Comply with Section 11 of NEBB Fume Hood Testing Standard - current edition.
 - 5. Reporting Requirements: Comply with Section 5 of NEBB (FHT) Fume Hood Testing Standard - current edition. Organize and include, at a minimum, the following information:
 - a. Report Title.
 - b. Report Certification.
 - c. Table of Contents.
 - d. Report Summary/ Remarks.
 - e. Appropriate Forms.
 - f. Instrument Calibration.
 - g. List of Abbreviations Used.
 - h. A room layout drawing for each tested item. Identify: walls; doors; fume hood(s); other present environmental enclosures (e.g. biological safety cabinet(s), laminar flow hood(s), canopy hood(s), etc.); location and airflow pattern of all air supply, return, and exhaust grilles, registers and diffusers.

3.07 AIR SYSTEM PROCEDURE

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- 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. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
 - G. 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.
 - H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
 - I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
 - J. Where modulating dampers are provided, take measurements and balance at extreme conditions.

3.08 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.

3.09 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.

3.10 SCOPE

- A. Test, adjust, and balance the following:
 - 1. HVAC Pumps.
 - 2. Packaged Steel Fire Tube Boilers.
 - 3. Air Cooled Refrigerant Condensers.
 - 4. Packaged Roof Top Heating/Cooling Units.
 - 5. Unit Air Conditioners.
 - 6. Air Coils.
 - 7. Terminal Heat Transfer Units.

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8. Air Handling Units.
 9. Fans.
 10. Air Inlets and Outlets.

3.11 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.
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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. Entering DB air temperature, design and actual.
 6. Leaving DB air temperature, design and actual.
 7. 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. Entering air WB temperature, design and actual.
 8. Leaving air DB temperature, design and actual.
 9. Leaving air WB temperature, design and actual.
 10. Water flow, design and actual.
 11. Water pressure drop, design and actual.
 12. Entering water temperature, design and actual.
 13. Leaving water temperature, design and actual.
 14. Saturated suction temperature, design and actual.
 15. 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.
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12. Air pressure drop, design and actual.
- H. 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.
- I. 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.
- J. 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.
- K. Duct Traverses:
1. System zone/branch.
 2. Duct size.
 3. Area.
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4. Design velocity.
 5. Design air flow.
 6. Test velocity.
 7. Test air flow.
 8. Duct static pressure.
 9. Air temperature.
- L. Duct Leak Tests:
1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.
 5. Maximum allowable leakage duct capacity times leak factor.
 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 7. Test static pressure.
 8. Test orifice differential pressure.
 9. Leakage.
- M. Air Monitoring Stations:
1. Identification/location.
 2. System.
 3. Size.
 4. Area.
 5. Design velocity.
 6. Design air flow.
 7. Test velocity.
 8. Test air flow.
- N. 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.
- O. Terminal Unit Data:
1. Manufacturer.
 2. Type, constant, variable, single, dual duct.
 3. Identification/number.
 4. Location.
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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.
- P. 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.

END OF SECTION

**SECTION 230713
DUCT INSULATION**

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.
- 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; 2017.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2020.
- 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; 2025.
- 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; 2024.
- 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; 2020.
- 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 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 Polymeric; 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.

2.05 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 connections
 - a. 2" Duct Liner
 2. Concealed supply/return ducts 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.
- F. 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.
 2. First 10ft from unit return connections.
 - a. 1" Duct Liner

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OUFSD_24BD_PH 1 - HS LKR RM & CTE Addition
Duct Insulation 230713 - 6

END OF SECTION

CPL

**SECTION 230719
HVAC PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.
- D. Engineered wall outlet seals and refrigerant piping insulation protection.

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 C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2020.
- H. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
- I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).
- J. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.
- K. ASTM D610 - Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces; 2008 (Reapproved 2019).
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- M. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- N. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).

- O. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2016).
- P. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.
- Q. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- R. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials; 2013 (Reapproved 2021).
- S. 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 perm-inches.
- 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 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.

2.04 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.

2.05 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

- A. Basis of Design: Airex Manufacturing, Inc; www.airexmfg.com/#sle.
 - 1. Pipe Penetration Wall Seal: Airex Titan Outlet.
 - 2. Refrigeration Pipe Insulation Protection System: Airex E-Flex Guard.
 - 3. Pipe Penetration Wall Seal and Insulation Protection System: Airex Pro-System Kit.
- B. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
 - 1. Outlet Cover Color: Gray.
 - 2. Water Penetration: Comply with ASTM E331.
 - 3. Air Leakage: Comply with ASTM E283.
 - 4. Air Permeance: Comply with ASTM E2178.
- C. Insulation Protection System: Refrigerant piping insulation PVC protective cover.
 - 1. PVC Insulation Cover Color: Black with full-length velcro fastener.
 - 2. Weatherization and Ultraviolet Exposure Protection: Comply with ASTM G153.
 - 3. Water/Vapor Permeability: Comply with ASTM E96/E96M.
 - 4. Anti-Fungal and Anti-Microbial Resistance: Comply with ASTM G21.
 - 5. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

2.06 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.
- 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.
- C. Outdoor Systems:
 - 1. Refrigerant Suction, Liquid and Hot Gas:
 - a. All Sizes: 2 inch thick Flexible Elastomeric Cellular with Vapor Barrier and Aluminum Jacket.

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. Variable frequency drives.
 - 7. Special Ventilation:
 - a. Fume hoods.
 - 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 REFERENCE STANDARDS

- A. ASHRAE Guideline 1.1 - Application of the Commissioning Process to New HVAC&R Systems; 2025.

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. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- C. 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).
 - D. 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.
 - E. 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.
 - F. 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.
 - 1. Include cost of sheaves and belts that may be required for testing, adjusting, and balancing.
- F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- G. Provide temperature and pressure taps in accordance with Contract Documents.
 - 1. Provide a pressure/temperature plug at each water sensor that is an input point to the control system.

3.02 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. Coil Valve Leak Check:
1. Method 1 - Water Temperature With 2-Way Valve:
 - a. Calibrate water temperature sensors on each side of coil to be within 0.2 degree F of each other.
 - b. Turn off air handler fans, close outside air dampers. Keep pump running. Make sure appropriate coil dampers are open.
 - c. Normally closed valves will close.
 - d. Override normally open valves to the closed position.
 - e. After 10 minutes observe water delta T across coil. If it is greater than 2 degrees F (, leakage is probably occurring.
 - f. Reset valve stroke to close tighter.
 - g. Repeat test until compliance is achieved.
- F. 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.
- G. 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.
 - 14. Trend logging and graphing features that are specified.

- 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's 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:
- E. TAB Review: Instruct Owner's personnel for minimum 8 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 8 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 8 hours of on-site, hands-on 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 4 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

**SECTION 230913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

PART 1 GENERAL

ALL CONTROLS SHALL BE COMPATIBLE WITH THE EXISTING ACL/ANDOVER BUILDING MANAGEMENT SYSTEM.

2.01 SECTION INCLUDES

- A. Air Supply System:
 - 1. Compressor and receivers.
 - 2. Pressure regulators.
 - 3. Particle filters.
 - 4. Pressure relief valves.
 - 5. Control and instrumentation tubing.
 - 6. Refrigerated air dryers.
- B. Control panels.
- C. Control Valves:
 - 1. Ball valves and actuators.
 - 2. Globe pattern.
 - 3. Electronic operators.
 - 4. Radiation valves.
- D. Dampers.
- E. Damper Operators:
 - 1. Electric operators.
 - 2. Inlet vane operators.
- F. Humidistats:
 - 1. Limit duct humidistats.
- G. 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.
- H. Thermostats:
 - 1. Electric room thermostats.
 - 2. Low-limit temperature cutout switch (freezestat)
 - 3. Line voltage thermostats.
 - 4. Room thermostat accessories.
 - 5. Outdoor reset thermostats.
 - 6. Immersion thermostats.
 - 7. Airstream thermostats.
 - 8. Electric low limit duct thermostats.
 - 9. Electric high limit duct thermostats.
- I. Transmitters:

1. Pressure transmitters.
 2. Air pressure transmitters.
 3. Water pressure transmitters (liquid differential pressure transmitters).
 4. Temperature transmitters.
 5. Humidity transmitters.
- J. Level Switches:
1. Float Sensors:
 - a. Boiler water level control.

2.02 RELATED REQUIREMENTS

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

2.03 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. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2018.
- E. ASTM B32 - Standard Specification for Solder Metal; 2020.
- F. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- G. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- H. ASTM B819 - Standard Specification for Seamless Copper Tube for Medical Gas Systems; 2019.
- I. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics; 2021.
- J. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- K. NEMA BS 31032 - Residential Controls—Electrical Wall-Mounted Room Thermostats; 2025.
- L. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

2.04 ADMINISTRATIVE REQUIREMENTS

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

2.05 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. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Thermostats and Other Exposed Sensors: One of each type.

2.06 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.

2.07 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

3.01 EQUIPMENT - GENERAL

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

3.02 AIR SUPPLY SYSTEM

- A. Compressor and Receivers:
 - 1. Simplex belt driven air compressor and tank unit with belt guard, silencers, flexible connections, air filter, automatic and manual drain assemblies, oil and particle filter for minimum 0.5 micron particles, pressure reducing valves, and pressure relief valves.
 - 2. Size compressor and storage tank to limit compressor starts to maximum 10 per hour and 50 percent running time.
 - 3. Pressure Control: Zinc or aluminum castings, rated for service with elastomeric diaphragm, adjustable electric contacts.
 - a. Set to start and stop compressor at 50 and 60 psig.
- B. Pressure Regulators:
 - 1. Zinc or aluminum castings, rated for service with elastomeric diaphragm, balanced construction to automatically prevent pressure build up, and producing flat, reduced pressure curve for system capacity demand.
- C. Particle Filters:

1. Zinc or aluminum castings with filtration efficiency at rated air flow of 97 percent, rated for service with threaded connections, quick-disconnect service devices, aluminum bowl or plastic bowl with metal guard equipped with manual drain cock, to separate liquid and solid particles.
- D. Pressure Relief Valves:
 1. ASME Code Rated and labeled for high pressure side and sized for installed capacity of pressure regulators at low pressure. Set at maximum 20 percent above low pressure.
- E. Control and Instrumentation Tubing:
 1. Copper Tube: ASTM B819 Type K, or ASTM B88 (ASTM B88M) Type K (A), seamless, H or O temper (drawn or annealed).
 - a. Fittings: ASME B16.22, wrought copper.
 - b. Joints: Solder, lead free, ASTM B32 HB alloy (95-5 tin-antimony), or tin and silver.
 2. Polyethylene Tubing: Black, flame retardant, virgin polyethylene, resistant to environmental stress-cracking when tested in accordance with ASTM D1693.
 - a. Fittings: UL labeled, rod or forged brass rated to 200 psig at 100 degrees F.
 - b. Joints: Compression or barbed type.
- F. Refrigerated Air Dryers:
 1. General Assembly: Self-contained, commercial quality, refrigerated, compressed air dryer complete with heat exchangers, moisture separator, and internal wiring and piping. Provide air inlet and outlet connections connected through manual by-pass valve.
 2. Heat Exchangers: Air to refrigerant coils. Provide centrifugal type moisture separator located at discharge of compressed air complete with automatic trap assembly. Provide automatic control system to bypass refrigeration system on low or no load conditions.
 3. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of 0 degrees F at 20 psig. House in steel cabinet with access door and panel.
 4. Accessories: Air inlet temperature gauge, air inlet pressure gauge, on/off switch, high temperature light, power on light, refrigerant gauge on back, air outlet temperature gauge, air outlet pressure gauge, contacts for remote indication of power status, and high temperature alarm.

3.03 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 EN 10250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.

3.04 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.
 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.
 - 3. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of stainless steel.
 - c. Size for 3 psig maximum pressure drop at design flow rate.
 - d. two-way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two-way valve operators to close valves against pump shut off head.
 - 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. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
-

2. Rate for service pressure of 125 psig at 250 degrees F.
3. Size for 3 psig maximum pressure drop at design flow rate.
4. two-way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two-way valve operators to close valves against pump shut off head.
5. Operators (2 Position): Synchronous motor with enclosed gear train, dual return springs, valve position indicator; 24 v DC, 0.4 amp. Valves shall spring return to normal position for temperature protection.
6. 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.

3.05 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.

3.06 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.
- C. Inlet Vane Operators:
 1. High pressure with pilot positioners and sufficient force to move vanes when fan is started with vanes in closed position. Return vane operator to closed position on fan shutdown.

3.07 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.

3.08 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. Sensing Range:
 - 1) Provide limited range sensors if required to sense the range expected for a respective point.
 - 2) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
 - 3) Use temperature transmitters in conjunction with RTD's when RTD's are incompatible with DDC controller direct temperature input.
 - e. Wire Resistance:
 - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
 - f. Room Sensors: Locking cover.
 - g. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - h. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
 - i. Room Temperature Sensors:
 - 1) Construct for surface or wall box mounting.
 - 2) Provide the following:
 - (a) Setpoint reset slide switch with an adjustable temperature range.
 - (b) Individual heating/cooling setpoint slide switches.
 - (c) Momentary override request push button for activation of after-hours operation.
 - (d) Analog thermometer.
 - j. Room Temperature Sensors with Integral Digital Display:

- 1) Construct for wall box.
 - 2) Provide a four button keypad with the following capabilities:
 - (a) Indication of space and outdoor temperatures.
 - (b) Display and control fan operation status.
 - (c) Manual occupancy override and indication of occupancy status.
 - (d) Controller mode status.
 - (e) Password enabled setpoint and override modes.
 - k. 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.
 - l. Insertion Elements:
 - 1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
 - 2) 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:
 - 1) HS Element: Digitally profiled thin-film capacitive.
 - 2) Accuracy 1 percent at 10 to 80 percent relative humidity at 77 degrees F, multi-point calibration, NIST traceable.
 - (a) Plus/minus 1 percent at 20 to 40 percent RH in mA output mode; (multi-point calibration, NIST traceable).
 - 3) 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: $(0.0013 \times \%RH \times (T_{\text{degreeC}} - 25))$.
 - 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.
 - l. 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:

3.09 THERMOSTATS

- A. Electric Room Thermostats:
1. Type: NEMA BS 31032, 24 volts, with setback/setup temperature control.
 2. Service: Cooling and heating.
 3. Covers: Locking with set point adjustment, with thermometer.
- B. Low-Limit Temperature Cutout Switch (low-limit thermostat or freezestat):
1. Configuration: Digital module tied to sensor-assembly.
 2. Sensing Length: 4 feet.
 3. Setpoint Adjust: Slider.
 4. Switch Type: SPDT, snap-action, form C in dust-protected enclosure.
 5. Sensing Range: 15 to 55 degrees F.
 6. Mounting: Locate on cooling coil intake side.
 7. Field Interface: Connect load line-voltage to stater.
 8. Electrical Rating: Pilot duty, 125 VA at 125 to 600 VAC.
- C. Immersion Thermostats:
1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- D. Airstream Thermostats:
1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 2. Averaging service remote bulb element: 7.5 feet.
- E. Electric Low 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 below setpoint,

2. Bulb length: Minimum 20 feet.
 3. Provide one thermostat for every 20 sq ft of coil surface.
- 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,

3.10 TRANSMITTERS

- A. Pressure Transmitters:
1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.
- B. Air Pressure Transmitters:
1. General: Provide dry media differential pressure transducers to monitor duct and room pressure.
 - a. Media Compatibility: Dry air.
 - b. Input Power: Class 2; 12 to 30 VDC; 2-wire: 20 mA max.
 - c. Output: Field selectable, 2-wire, loop-powered 4 to 20 mA (DC only, clipped and capped).
 - d. Pressure Ranges: 4 and 7, field selectable.
 - e. Response Time:
 - 1) Standard: T95 in 20 seconds.
 - 2) Fast: T95 in 2 seconds.
 - 3) Switch selectable.
 - f. Mode: Switch selectable, unidirectional.
 - g. Display:
 - 1) Signed 3-1/2 digit LCD, indicates pressure.
 - 2) Over-range indicator.
 - h. Proof Pressure (pressure differential): 3 psid.
 - i. Burst Pressure (pressure differential): 5 psid.
 - j. Accuracy: Plus/minus 1 percent f.s. (full scale) of selected range (combined linearity & hysteresis).
 - k. Temperature Effect (per transmitter size):
 - 1) 1 inch w.c.: 2.0 percent per degree C.
 - 2) 10 inch w.c.: 0.01 percent per degree C.; (Relative to 25 degrees C) 32 degrees F to 122 degrees F.
 - l. Zero Drift (1-year) (per transmitter size):
 - 1) 1 inch w.c.: 2 percent maximum.
 - 2) 10 inch: 0.05 percent maximum.
 - m. Zero adjust: Pushbutton auto-zero and digital input (2-pos terminal block).
 - n. Operating Environment:
 - 1) 32 degrees F to 140 degrees F.
 - 2) 0 to 90 percent RH noncondensing.
 - o. Fittings:
 - 1) 0.24 inches outer diameter.
 - 2) UL 94 V-O fire retardant ABS.
- C. Water Pressure Transmitters (Liquid Differential Pressure Transmitters):
1. General: Provide wet media differential pressure transducers with 6 ft (1.83 m) armored cable, to allow remote pressure sensing capability using existing plumbing runs.

- a. Input Power: Class 2; 15 to 30 VDC, 24VAC nominal, 50/60 Hz.
 - b. Maximum Current Draw:
 - 1) DC: 125 mA.
 - 2) AC: 280 mA.
 - c. Output: 3-wire transmitter; user-selectable, 4 to 20 mA (0 to 5V/0 to 10V).
 - d. Sensor:
 - 1) Media Compatibility: 17 to 4 PH stainless steel.
 - 2) Status Indication: Dual color LED.
 - 3) Proof Pressure: 2x max. F.S. range.
 - 4) Burst Pressure: 5x max. F.S. range.
 - 5) Accuracy at 77 degrees F for less than or equal 20 ft:
 - (a) Ranges A and B: Plus/minus 1 percent F.S. typical.
 - (b) Range C: Plus/minus 1.5 percent F.S. typical.
 - (c) Range D: Plus/minus 2 percent F.S. typical.
 - 6) Surge Damping: Electronic; 1 second averaging.
 - 7) Long Term Stability: Plus/minus 0.25 percent.
 - 8) Zero Offset (Bidirectional and Port Swap Modes Only): 0.5 percent.
 - e. Reverser:
 - 1) Zero Adjust: Push button auto-zero and digital input (2-position terminal block).
 - 2) Fittings:
 - (a) 27 NPT female thread, stainless steel 17 to 4 PH.
 - (b) Overall Thread Length: 0.5946 inches complying with ASME B1.20.1.
 - f. Pressure Ranges:
 - 1) 0 psi to 50 psi (Gauge): 5 psid/10 psid/25 psid/50 psid (pressure differential).
 - 2) 0 psi to 100 psi (Gauge): 10 psid/20 psid/50 psid/100 psid (pressure differential).
 - 3) 0 psi to 250 psi (Gauge): 25 psid/50 psid/125 psid/250 psid (pressure differential).
 - g. Operating Conditions:
 - 1) Temperature Compensated Range:
 - (a) 32 degrees F.
 - (b) TC Zero less than 1.5 percent of product F.S. (full scale) per sensor.
 - (c) TC Span less than 1.5 percent of product F.S. (full scale) per sensor.
 - 2) Sensor Operating Range: Minus 4 degrees F to 185 degrees F.
 - 3) Operating Environment: 14 degrees F to 122 degrees F; 10 to 90 percent RH noncondensing.
 - h. Enclosure: NEMA EN 10250, Type 4.
- D. Temperature Transmitters:
- 1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degrees F span and plus or minus 1 percent for 50 degrees F span, with 50 degrees F. temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.

3.11 LEVEL SWITCHES

- A. Float Sensors:
 - 1. Boiler Water Level Control:
 - a. Wetted Materials:

- 1) Body: Cast iron.
- 2) Float: 304 stainless steel.
- 3) Trim and Packing Gland: Brass.
- 4) Packing: Carbon.
- 5) Body Gasket: Carbon.
- b. Temperature Limit:
 - 1) Ambient Temperature: 212 degrees F.
 - 2) Process Temperature: 365 degrees F.
- c. Pressure Limit: 150 psi.
- d. Enclosure Rating: General purpose.
- e. Switch Type: Snap action.
- f. Electrical Rating:
 - 1) Snap Switch: 15 A at 120/240/480 VAC.
 - 2) Mercury Switch: 4 A at 120 VAC/DC.
- g. Electrical Connection: Screw terminal.
- h. Conduit Connection: 7/8 inch hole for 1/2 inch conduit.
- i. Process Connection: 1 inch female NPT.
- j. Mounting Orientation: Vertical.
- k. Deadband: Approximately 1-1/2 inch.
- l. Specific Gravity: Minimum 0.88.
- m. Manual reset.
- n. Weight: 20 lbs.
- o. Agency Approvals (Except snap switch): CSA.

PART 3 EXECUTION

4.01 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.

4.02 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 thermostats in aspirating boxes in front entrances and gymnasiums.

- G. Provide guards on thermostats in entrances and public areas.
- H. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- I. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors.
- J. Provide isolation (two position) dampers of parallel blade construction.
- K. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- L. 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.
- M. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- N. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

4.03 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

**SECTION 230923
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. System description.
- B. Operator interface.
- C. Controllers.
- D. Power supplies and line filtering.
- E. System software.
- F. Controller software.
- G. HVAC control programs.

1.02 RELATED REQUIREMENTS

- A. Section 230913 - Instrumentation and Control Devices for HVAC.
- B. Section 230993 - Sequence of Operations for HVAC Controls.
- C. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- B. CTA-709.1 - Control Network Protocol Specification; 2019.
- C. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2019h, with Editorial Revision (2022).
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for each system component and software module.
- C. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. List connected data points, including connected control unit and input device.
 - 3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 - 4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 5. Indicate description and sequence of operation of operating, user, and application software.

- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- E. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Designer Qualifications: Perform design of system using manufacturer's software under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.08 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 230913.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

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- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.02 OPERATOR INTERFACE

- A. PC Based Work Station:
1. Resides on high speed network with building controllers.
 2. Connected to server for full access to all system information.
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C. BACnet protocol to comply with ASHRAE Std 135.
- D. LonTalk protocol to comply with CTA-709.1.
- E. Hardware:

2.03 CONTROLLERS

- A. Building Controllers:
1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
 2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

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5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B. Application Specific Controllers:
1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
- C. Input/Output Interface:
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
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- b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
 - 4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
 - 5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
 - 6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
 - 7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
 - 8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
 - 9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.04 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies:
 - 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 - 2. Limit connected loads to 80 percent of rated capacity.
 - 3. Match DC power supply to current output and voltage requirements.
 - 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
 - 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 - 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 - 7. Operational Ambient Conditions: 32 to 120 degrees F.

8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.
- B. Power Line Filtering:
 1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
 2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.05 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.06 SYSTEM SOFTWARE

- A. Operating System:
 1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 - b. Acceptable Operating Systems: Microsoft Windows 11.
 2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:
 - (a) Analog and binary values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.
 3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.

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- c. Capture or convert graphics from AutoCAD.
 - 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - 1) Boilers.
 - 2) Air Handlers.
 - 3) Terminal HVAC Units.
 - b. Ancillary Equipment:
 - 1) Fans.
 - 2) Pumps.
 - 3) Coils.
 - 4) Valves.
 - 5) Piping.
 - 6) Dampers.
 - 7) Ductwork.
 - B. Workstation System Applications:
 - 1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
 - 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
 - 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
 - 4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
 - 5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. All system security data stored in encrypted format.
 - 6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
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- 3) Modems.
 - 4) Network connections.
 - 5) Building management panels.
 - 6) Controllers.
 - b. Device failure is annunciated to the operator.
 - 7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
 - 8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
 - 9. Configurable Alarm Reactions by Workstation and Time of Day:
 - a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
 - 10. Custom Trend Logs:
 - a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
 - 11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
 - 12. Object, Property Status and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
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- 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
13. Reports and Logs:
 - a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Archivable to hard disk.
 - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s).
 14. Reports:
 - a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - (a) Alarm History.
 - (b) System messages.
 - (c) System events.
 - (d) Trends.
 - b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
 - c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
 - d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - (a) Monthly showing daily natural gas consumption for each meter.
 - (b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:
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- (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

C. Workstation Applications Editors:

1. Provide editing software for each system application at PC workstation.
2. Downloaded application is executed at controller panel.
3. Full screen editor for each application allows operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
4. Scheduling:
 - a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
5. Custom Application Programming:
 - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.07 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 1. User access secured via user passwords and user names.

2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
3. User Log On/Log Off attempts are recorded.
4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
 1. Binary object is set to alarm based on the operator specified state.
 2. Analog object to have high/low alarm limits.
 3. All alarming is capable of being automatically and manually disabled.
 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- G. Sequencing: Application software based upon specified sequences of operation in Section 230993.
- H. PID Control Characteristics:
 1. Direct or reverse action.
 2. Anti-windup.
 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 4. User selectable controlled variable, set-point, and PED gains.
- I. Staggered Start Application:
 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 2. Order of equipment startup is user selectable.
- J. Energy Calculations:
 1. Accumulated instantaneous power or flow rates are converted to energy use data.
 2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- K. Anti-Short Cycling:
 1. All binary output objects protected from short-cycling.
 2. Allows minimum on-time and off-time to be selected.
- L. On-Off Control with Differential:
 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

M. Run-Time Totalization:

1. Totalize run-times for all binary input objects.
2. Provides operator with capability to assign high run-time alarm.

2.08 HVAC CONTROL PROGRAMS**A. General:**

1. Support Inch-pounds and SI (metric) units of measurement.
2. Identify each HVAC Control system.

B. Optimal Run Time:

1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
 4. Use outside air temperature to determine early shut down with ventilation override.
 5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
 6. Operator commands:
 - a. Define term schedule.
 - b. Add/delete fan status point.
 - c. Add/delete outside air temperature point.
 - d. Add/delete mass temperature point.
 - e. Define heating/cooling parameters.
 - f. Define mass sensor heating/cooling parameters.
 - g. Lock/unlock program.
 - h. Request optimal run time control summary.
 - i. Request optimal run time mass temperature summary.
 - j. Request HVAC point summary.
 - k. Request HVAC saving profile summary.
 7. Control Summary:
 - a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Optimal run time system normal start times.
 - h. Occupancy and vacancy times.
 - i. Optimal run time system heating/cooling mode parameters.
 8. Mass temperature summary:
 - a. Mass temperature point type and ID.
 - b. Desired and current mass temperature values.
 - c. Calculated warm-up/cool-down time for each mass temperature.
 - d. Heating/cooling season limits.
 - e. Break point temperature for cooling mode analysis.
 9. HVAC point summary:
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- a. Control system identifier and status.
 - b. Point ID and status.
 - c. Outside air temperature point ID and status.
 - d. Mass temperature point ID and point.
 - e. Calculated optimal start and stop times.
 - f. Period start.
- C. Supply Air Reset:
- 1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
 - 2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
 - a. Raising cooling temperatures to highest possible value.
 - b. Reducing heating temperatures to lowest possible level.
 - 3. Operator commands:
 - a. Add/delete fan status point.
 - b. Lock/unlock program.
 - c. Request HVAC point summary.
 - d. Add/Delete discharge controller point.
 - e. Define discharge controller parameters.
 - f. Add/delete air flow rate.
 - g. Define space load and load parameters.
 - h. Request space load summary.
 - 4. Control summary:
 - a. HVAC control system status (begin/end).
 - b. Supply air reset system status.
 - c. Optimal run time system status.
 - d. Heating and cooling loop.
 - e. High/low limits.
 - f. Deadband.
 - g. Response timer.
 - h. Reset times.
 - 5. Space load summary:
 - a. HVAC system status.
 - b. Optimal run time status.
 - c. Heating/cooling loop status.
 - d. Space load point ID.
 - e. Current space load point value.
 - f. Control heat/cool limited.
 - g. Gain factor.
 - h. Calculated reset values.
 - i. Fan status point ID and status.
 - j. Control discharge temperature point ID and status.
 - k. Space load point ID and status.
 - l. Air flow rate point ID and status.
- D. Enthalpy Switchover:
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1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
2. Operator commands:
 - a. Add/delete fan status point.
 - b. Add/delete outside air temperature point.
 - c. Add/delete discharge controller point.
 - d. Define discharge controller parameters.
 - e. Add/delete return air temperature point.
 - f. Add/delete outside air dew point/humidity point.
 - g. Add/delete return air dew point/humidity point.
 - h. Add/delete damper switch.
 - i. Add/delete minimum outside air.
 - j. Add/delete atmospheric pressure.
 - k. Add/delete heating override switch.
 - l. Add/delete evaporative cooling switch.
 - m. Add/delete air flow rate.
 - n. Define enthalpy deadband.
 - o. Lock/unlock program.
 - p. Request control summary.
 - q. Request HVAC point summary.
3. Control summary:
 - a. HVAC control system begin/end status.
 - b. Enthalpy switchover optimal system status.
 - c. Optimal return time system status.
 - d. Current outside air enthalpy.
 - e. Calculated mixed air enthalpy.
 - f. Calculated cooling coil enthalpy using outside air.
 - g. Calculated cooling coil enthalpy using mixed air.
 - h. Calculated enthalpy difference.
 - i. Enthalpy switchover deadband.
 - j. Status of damper mode switch.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 230993.
- C. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.

- D. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.
- C. Provide basic operator training for 2 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.04 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Owner.

3.05 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
- C. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- D. Provide complete service of systems, including call backs. Make minimum of 2 complete normal inspections of approximately 8 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

END OF SECTION

**SECTION 230934
VARIABLE-FREQUENCY MOTOR CONTROLLERS**

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.
- B. Section 230553 - Identification for HVAC Piping and Equipment: 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 EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- D. NEMA IA 10039 - Control Circuit and Pilot Devices; 2025.
- E. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.
- F. NEMA IS 10033 - Industrial Control and Systems: Adjustable-Speed Drives; 2026.
- G. NEMA IS 10034 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems; 2022 (Reapproved 2025).
- H. NEMA IS 10035 - Application Guide for AC Adjustable Speed Drive Systems; 2021 (Reaffirmed 2025).
- 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 00001 - Motors and Generators; 2024.
- 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 dimensioned plan and elevation views of controllers and adjacent equipment with required clearances indicated.
 2. Include wiring diagrams showing factory and field connections.
 3. Identify mounting conditions required for equipment seismic qualification.
- D. Derating Calculations: Indicate ratings adjusted for applicable service conditions.
- E. Manufacturer qualification statement.
- 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. 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.
- H. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- I. Maintenance contracts.
- J. 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 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 IS 10033, NEMA IS 10034, 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 IS 10035, NEMA MG 00001 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 00001 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 low-speed 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.
 - h. Automatic response to loss of speed reference; selectable to run motor at last known speed, run motor at designated speed, or stop motor.
 - i. PID Control: Provide integral PID controller employing feedback for closed-loop control where indicated or required.
 - 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.

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- 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.
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- 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 IA 10030.
 - 2. NEMA EN 10250 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.

2.02 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.
- 8. 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.

2.03 ACCESSORIES

- A. Auxiliary Contacts:
 - 1. Comply with NEMA IA 10039.
 - 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 IA 10039; 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 IA 10039.
 - 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.

2.04 SOURCE QUALITY CONTROL

- A. See Section 014000 - BSD 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 IS 10034 and manufacturer's instructions.

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- 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 - BSD 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. Instructor: Manufacturer's authorized representative.
 - 4. 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.
- B. Provide to Owner a proposal as alternate to base bid, a separate maintenance contract for service and maintenance of controllers for two years from date of Substantial Completion; Include complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with detailed schedule.
- C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
- D. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 4 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION

**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. Radiant heating piping system.
- E. Equipment drains and overflows.
- F. Pipe hangers and supports.
- G. Unions, flanges, mechanical couplings, and dielectric connections.
- H. Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
 - 4. Pressure independent temperature control valves and balancing valves.
- I. Flow controls.

1.02 RELATED REQUIREMENTS

- A. Section 230516 - Expansion Fittings and Loops for HVAC Piping.
- B. 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; 2018.
- E. ASME B31.9 - Building Services Piping; 2025.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- 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; 2025.
- J. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- 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 D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- O. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2018, with Editorial Revision (2024).
- P. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2020.
- Q. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2023.
- R. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2020.
- S. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).
- T. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
- U. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2019).
- V. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- W. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020.
- X. AWWA C606 - Grooved and Shouldered Joints; 2022.
- Y. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

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.
 - 3. Indicate valve data and ratings.
 - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Valve Repacking Kits: One for each type and size of valve.

1.05 QUALITY ASSURANCE

- A. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- B. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. 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 shut-off, 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 RADIANT HEATING PIPING

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A) annealed.
1. Fittings: ASME B16.22, wrought copper.
 2. Joints: Braze, AWS A5.8M/A5.8 BCuP copper/silver alloy.

2.04 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.
 2. 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; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- C. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
1. Fittings: ASTM D2466 or D2467, PVC.
 2. Joints: Solvent welded in accordance with ASTM D2855.

2.05 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. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 9. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
 10. Vertical Support: Steel riser clamp.

11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 12. 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.
 13. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 14. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 15. 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.

2.06 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.

2.07 BALL VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.
 - 4. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
 - 5. Victaulic Company: www.victaulic.com/#sle.
 - 6. Viega LLC: www.viega.us/#sle.
 - 7. Substitutions: See Section 016000 - Product Requirements.
- B. Up To and Including 2 Inches:
 - 1. Bronze one piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle with balancing stops, threaded ends with union.
- C. Over 2 Inches:
 - 1. Ductile iron body, chrome plated stainless steel ball, teflon or Virgin TFE seat and stuffing box seals, lever handle or gear operated, flanged ends, rated to 800 psi.

2.08 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.
 - 4. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
 - 5. Victaulic Company: www.victaulic.com/#sle.
 - 6. Substitutions: See Section 016000 - Product Requirements.
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.
- C. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
- D. Stem: Stainless steel with stem offset from the centerline to provide full 360-degree circumferential setting.
- E. Operator: 10 position lever handle.

2.09 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.

4. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
 5. Victaulic Company: www.victaulic.com/#sle.
 6. Substitutions: See Section 016000 - Product Requirements.
- B. Up To and Including 2 Inches:
1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, threaded ends.
- C. Over 2 Inches:
1. Iron body, bronze trim, stainless steel, bronze, or bronze faced rotating swing disc, renewable disc and seat, flanged or grooved ends.

2.10 SPRING LOADED CHECK VALVES

- A. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

2.11 FLOW CONTROLS

- A. Manufacturers:
1. Griswold Controls: www.griswoldcontrols.com/#sle.
 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
 3. Taco, Inc: www.taco-hvac.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

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. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9 requirements.
- C. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- D. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- E. Install piping to conserve building space and to avoid interference with use of space.
- F. Group piping whenever practical at common elevations.

- G. Sleeve pipe passing through partitions, walls, and floors.
- H. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- I. Slope piping and arrange to drain at low points.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 230516.
- K. 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.
- L. 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.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 230719.
- N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- O. 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.
 - 4. 2-1/2 Inches: Maximum span, 9 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.

END OF SECTION

**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. Combination flow controls.
- J. Flow meters.
- K. Radiator valves.
- L. Relief valves.
- M. Pressure reducing 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; 2025, with Errata .

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.
- D. Maintenance Contract.

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. 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.
- B. 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.
- C. 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. Dip Tube Fitting (Where Not Provided By Boiler Manufacturer):
 - 1. For 125 psi operating pressure; to prevent free air collected in boiler from rising into system.
- B. In-line Air Separators:
 - 1. Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi operating pressure.
- C. 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. Accommodate the Following:
 - a. Angular Rotation: 15 degrees.
 - b. Force developed by 1.5 times specified maximum allowable operating pressure.
 3. End Connections: Same as specified for pipe jointing.
 4. Provide pump connector with integral vanes to reduce turbulent flow.
 5. 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 COMBINATION FLOW CONTROLS

- A. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
- B. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.
- C. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.

2.09 FLOW METERS

- A. Orifice principle by-pass circuit with direct reading gauge, soldered or flanged piping connections for 125 psi working pressure, with shut off valves, and drain and vent connections.
- B. Direct reading with insert pitot tube, threaded coupling, for 150 psi working pressure, maximum 240 degrees F, 5 percent accuracy.
- C. Cast iron, wafer type, orifice insert flow meter for 250 psi working pressure, with read-out valves equipped with integral check valves with gasketed caps.
- D. Calibrated, plug type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate, and indicating pointer.
- E. Portable meter consisting of case containing one, 3 percent accuracy pressure gauge with 0-60 feet pressure range for 500 psi maximum working pressure, color-coded hoses for low and high-pressure connections, and connectors suitable for connection to read-out valves.

2.10 RADIATOR VALVES

- A. Angle or straight pattern, rising stem, inside screw globe valve for 125 psi working pressure, with bronze body and integral union for screwed connections, renewable composition disc, plastic wheel handle for shut-off service, and lockshield key cap and set screw memory bonnet for balancing service.

2.11 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.

2.12 PRESSURE REDUCING 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.
 - 4. Taco, Inc: www.taco-hvac.com/#sle.
- B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 232113.
- C. Materials of Construction:

1. Valve Body: Constructed of bronze, cast iron, brass, or iron.
2. Internal Components: Construct of stainless steel or brass and composition material.
- D. Connections:
 1. NPT threaded: 0.50 inch or 0.75 inch.
 2. Soldered: 0.50 inch.
- E. Provide integral check valve and strainer.
- F. Maximum Inlet Pressure: 100 psi.
- G. Maximum Fluid Temperature: 180 degrees F.
- H. Operating Pressure Range: Between 10 psi and 25 psi.

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. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- F. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- G. Provide valved drain and hose connection on strainer blowdown connection.
- H. Provide pump suction fitting on suction side of base-mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- I. Support pump fittings with floor-mounted pipe and flange supports.
- J. Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.
- K. Provide radiator balancing valves on water outlet from terminal heating units such as radiation, unit heaters, and fan coil units.
- L. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- M. 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.
- N. Pipe relief valve outlet to nearest floor drain.
- O. Where one line vents several relief valves, make cross-sectional area equal to sum of individual vent areas.

3.02 MAINTENANCE

- A. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of glycol system for one year from date of Substantial Completion at no extra charge to Owner.

- D. Perform monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Report findings in detail in writing, including analysis and amounts of glycol or water added.
- E. Explain corrective actions to Owner's maintenance personnel in person.

END OF SECTION

**SECTION 232123
HYDRONIC PUMPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line circulators.
- B. Base-mounted pumps.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - CAST-IN-PLACE CONCRETE.
- B. Section 230513 - Common Motor Requirements for HVAC Equipment.
- C. Section 230716 - HVAC Equipment Insulation.
- D. Section 230719 - HVAC Piping Insulation.
- E. Section 232113 - Hydronic Piping.
- F. 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.
- C. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Cartridges for Side-Stream Filters: One set for each filter.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

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. Minimum Quality Standard: UL 778.

- C. Base Mounted Pumps: Aligned by qualified millwright.
- D. 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.
- G. Drive: Flexible coupling.

2.04 BASE-MOUNTED PUMPS

- A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi maximum working pressure.
- B. Casing: Cast iron, or ductile iron with suction and discharge gauge ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, fully enclosed, keyed to shaft.
- D. Bearings: Oil lubricated roller or ball bearings.
- E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- G. Drive: Flexible coupling with coupling guard.
- H. Baseplate: Cast iron or fabricated steel with integral drain rim.

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 air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals, piped to and discharging into floor drains.
- G. Check, align, and certify alignment of base-mounted pumps prior to start-up.

- H. Install close-coupled and base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 033000.
- I. Lubricate pumps before start-up.

END OF SECTION

**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. Check valves.
- G. Pressure regulators.
- H. Pressure relief valves.
- I. Filter-driers.
- J. Solenoid valves.
- K. Expansion valves.
- L. Receivers.
- M. Flexible connections.
- N. Engineered wall seals and insulation protection.
- O. Exterior penetration accessories.

1.02 RELATED REQUIREMENTS

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

1.03 REFERENCE STANDARDS

- A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers; 2005.
- B. AHRI 710 (I-P) - Performance Rating of Liquid-Line Driers; 2009.
- C. AHRI 711 (SI) - Performance Rating of Liquid-Line Driers; 2009.
- D. AHRI 730 (I-P) - Flow Capacity Rating of Suction Line Filters and Suction Line Filter Driers; 2013 (Reapproved 2014).
- E. AHRI 760 (I-P) - Performance Rating of Solenoid Valves for Use with Volatile Refrigerants; 2014.
- F. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2022, with Errata (2023).
- G. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2022, with Errata (2023).
- H. 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.
- I. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2018.

- J. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2024.
- K. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.
- L. ASME B31.9 - Building Services Piping; 2025.
- M. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- N. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- O. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2023.
- P. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- Q. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- R. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials; 2013 (Reapproved 2021).
- S. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- T. IAPMO (UMC) - 2024 Uniform Mechanical Code; 2024.
- U. ICC (IMC) - International Mechanical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- V. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.
- W. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.
- X. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

1.04 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.
- D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of leak test, acid test.
- F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- G. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Filter-Dryer Cartridges: One of each type and size.
 - 3. Refrigeration Oil Test Kits: One, each containing everything required to conduct one test.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.
- B. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.06 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 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure integrity of system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
- C. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
 - 2. If receiver is provided, install in liquid line leaving receiver.
 - 3. Use line size on leaving side of liquid solenoid valves.
- D. Valves:
 - 1. Use service valves on suction and discharge of compressors.
 - 2. Use gauge taps at compressor inlet and outlet.
 - 3. Use gauge taps at hot gas bypass regulators, inlet and outlet.
 - 4. Use check valves on compressor discharge.
 - 5. Use check valves on condenser liquid lines on multiple condenser systems.
- E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
- F. Strainers:
 - 1. Use line size strainer upstream of each automatic valve.
 - 2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
 - 3. On steel piping systems, use strainer in suction line.
 - 4. Use shut-off valve on each side of strainer.
- G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.
- H. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
- I. Solenoid Valves:
 - 1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.

2. Use in liquid line of single or multiple evaporator systems.
 3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
- J. Receivers:
1. Use on systems with long piping runs.
- K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

2.02 REGULATORY REQUIREMENTS

- A. Comply with ASME B31.9 for installation of piping system.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- C. Welders Certification: In accordance with ASME BPVC-IX.
- D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.03 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.
 3. Push-to-Connect Fittings: Complying with UL 207.
 4. Mechanical Press Fittings: UL 207 listed, ICC (IMC) and IAPMO (UMC) approved, with HNBR seals.
- B. Copper Tube to 7/8-inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.
1. Fittings: ASME B16.26 cast copper.
 2. Joints: Flared.
 3. Push-to-Connect Fittings: Complying with UL 207.
 4. Mechanical Press Sealed Fittings: UL 207 listed, ICC (IMC) and IAPMO (UMC) approved, with HNBR seals.
- C. 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.

2.04 REFRIGERANT

- A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 700.

2.05 MOISTURE AND LIQUID INDICATORS

- A. Indicators: Single port type, UL listed, with copper or brass body, flared or soldered 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.

2.06 VALVES

- A. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, soldered or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- B. Packed Angle Valves:
 - 1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, soldered or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- C. Ball Valves:
 - 1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.
- D. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or soldered ends, for maximum pressure of 500 psi.

2.07 STRAINERS

- A. Straight Line or Angle Line Type:
 - 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.08 CHECK VALVES

- A. Globe Type:
 - 1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 425 psi.
- B. Straight Through Type:
 - 1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.09 PRESSURE REGULATORS

- A. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi range, for maximum working pressure of 450 psi.

2.10 PRESSURE RELIEF VALVES

- A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi.

2.11 FILTER-DRIERS

- A. Performance:

1. Flow Capacity - Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710.
 2. Flow Capacity - Suction Line: As indicated in schedule, minimum, rated in accordance with AHRI 730 (I-P).
 3. Water Capacity: As indicated in schedule, rated in accordance with AHRI 710 (I-P) (AHRI 711 (SI)).
 4. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
 5. 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.

2.12 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, soldered, 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.

2.13 EXPANSION VALVES

- A. Angle or Straight Through Type: AHRI 760 (I-P); design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with nonreplaceable capillary tube and remote sensing bulb and remote bulb well.
- B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.14 RECEIVERS

- A. Internal Diameter 6 inch and Smaller:
1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

2.15 FLEXIBLE CONNECTORS

- A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

2.16 ENGINEERED WALL SEALS AND PIPING PROTECTION

- A. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
 - a. Elastomeric Sleeve Diameter: 1-11/16 inch.
 2. Outlet Cover Color: Gray.
- B. PVC Refrigerant Piping Covers:
1. PVC Insulation Cover Color: White enclosure with color matched fittings.

2. Weatherization and Ultraviolet Exposure Protection: Comply with ASTM G153.
3. Water/Vapor Permeability: Comply with ASTM E96/E96M.
4. Flame Spread and Smoke Development Rating of 25/450: Comply with ASTM E84.
5. Adhesive free.

2.17 EXTERIOR PENETRATION ACCESSORIES

- A. 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.
- B. 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.

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. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- I. Provide clearance for installation of insulation and access to valves and fittings.
- J. Flood piping system with nitrogen when brazing.
- K. Insulate piping and equipment.
- L. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- M. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- N. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- O. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- P. Provide PVC refrigerant pipe covers where piping is installed in accessible locations indoors.
- Q. Provide PVC refrigerant pipe covers where piping is installed along walls outdoors.
- R. Fully charge completed system with refrigerant after testing.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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.
 - 7. 3-1/8 inch OD: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 8. 3-5/8 inch OD: Maximum span, 11 feet; minimum rod size, 1/2 inch.

END OF SECTION

**SECTION 232500
HVAC WATER TREATMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A. Section 016000 - Product Requirements: Owner furnished treatment equipment.
- B. Section 232114 - Hydronic Specialties.

1.03 REFERENCE STANDARDS

- A. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 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.
- C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- E. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Sufficient chemicals for treatment and testing during required maintenance period.

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. Company shall have local representatives with water analysis laboratories and full time service personnel.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage 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.

2.02 MATERIALS

- A. Closed System Treatment (Water):
 - 1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 - 2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 - 3. Conductivity enhancers; phosphates or phosphonates.

2.03 BY-PASS (POT) FEEDER

- A. 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. Concentration:
 - 1. As recommended by manufacturer.
- B. 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.

3.05 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
 - 1. Provide minimum of two hours of instruction for two people.
 - 2. Have operation and maintenance data prepared and available for review during training.
 - 3. Conduct training using actual equipment after treated system has been put into full operation.

3.06 MAINTENANCE

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

- B. Provide a separate maintenance contract for specified maintenance service.
- C. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.
- D. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of Owner.
- E. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.
- F. Provide monthly technical service visits to perform field inspections and make water analysis on-site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- G. Provide laboratory and technical assistance services during this maintenance period.
- H. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

END OF SECTION

**SECTION 233100
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ductwork.
- B. Casings and plenums.
- C. Laboratory exhaust ductwork.

1.02 RELATED REQUIREMENTS

- A. Section 230593 - Testing, Adjusting, and Balancing for HVAC.
- B. Section 230713 - Duct Insulation: 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. ASHRAE Std 126 - Method of Testing HVAC Air Ducts; 2020.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- 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; 2018.
- J. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2021.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- L. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines; 2001.
- M. 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 _____ 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. Fume Hood Exhaust: 1/2 inch wg pressure class, galvanized steel.
- H. Outside Air Intake: 1/2 inch wg pressure class, galvanized steel.
- I. Combustion Air: 1/2 inch wg pressure class, galvanized steel.
- J. 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).
- G. Fume Hood Exhaust Ducts: Minimum 18 gauge, 0.0500 inch thick, single wall, Type 304 stainless steel.
 1. Fabricate in accordance with ductwork manufacturer's instructions, test duct system to sustain positive and negative pressures in compliance with ASHRAE Std 126.
 2. Single-wall, factory built chimney liner system.
 3. Designed, fabricated, and installed liquidtight preventing exhaust leakage into building.

4. Operating Range: 10 inch wg.
5. Seal joints during installation with factory supplied flanges and airtight gasketing.
6. Provide with factory installed and pressure tested access doors.

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.
- L. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

END OF SECTION

**SECTION 233300
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Combination fire and smoke dampers.
- D. Combination fire and smoke dampers - corridor dampers.
- E. Duct access doors.
- F. Duct test holes.
- G. Fire dampers.
- H. Flexible duct connectors.
- I. 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; 2018.
- B. NFPA 92 - Standard for Smoke Control Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- 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. Manufacturer's Installation Instructions: Provide instructions for fire dampers.
- D. 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 BACKDRAFT DAMPERS - METAL

- A. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

2.03 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.

2.04 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.

2.05 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.

2.06 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.

2.07 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.

2.08 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.

2.09 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:
 - 1. Material: Same gauge as duct to 24 inches size in either direction, and two gauges heavier for sizes over 24 inches.
 - 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 - 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- 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 backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

- C. 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.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. 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.
- F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- G. Demonstrate re-setting of fire dampers to Owner's representative.
- H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- J. 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.
- K. Use splitter dampers only where indicated.
- L. 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.

END OF SECTION

SECTION 233423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof exhausters.
- B. Laboratory-fume exhaust fans.

1.02 RELATED REQUIREMENTS

- A. Section 233100 - HVAC Ducts and Casings.
- B. Section 233300 - Air Duct Accessories: Backdraft dampers.
- C. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- B. AMCA 99 - Standards Handbook; 2016.
- C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005 (Reaffirmed 2012).
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016.
- E. AMCA 211 - Certified Ratings Program Product Rating Manual for Fan Air Performance; 13th Edition, Revised 2017.
- F. AMCA 260 - Laboratory Methods of Testing Induced Flow Fans for Rating; 2013.
- G. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
- H. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2014.
- I. AMCA 311 - Certified Ratings Program Product Rating Manual for Fan Sound Performance; 2016.
- J. ANSI Z9.5 - Laboratory Ventilation; 2012.
- K. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- L. NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals; 2019.
- M. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.
- N. NFPA 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids; 2020.
- O. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate fan roof curbs and service utilities installation according to fan size.
- B. Sequencing: Ensure that utility connections are completed in an orderly and expeditious manner.

1.05 SUBMITTALS

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

- B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Fan Belts: One set for each individual fan.

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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carnes, a division of Carnes Company Inc: www.carnes.com/#sle.
- B. Greenheck Fan Corporation: www.greenheck.com/#sle.
- C. Loren Cook Company: www.lorencook.com/#sle.
- D. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
- E. Twin City Fan & Blower: www.tcf.com/#sle.
- F. Substitutions: See Section 016000 - Product Requirements.

2.02 POWER VENTILATORS - GENERAL

- A. Manufacturers:
 - 1. Greenheck Fan Corporation: www.greenheck.com/#sle.
- B. Static and Dynamically Balanced: Comply with AMCA 204.
- C. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.
- D. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.
- E. Fabrication: Comply with AMCA 99.
- F. UL Compliance: UL 705, listed, labeled, designed, manufactured, and tested.
- G. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 ROOF EXHAUSTERS

- A. Manufacturers:
 - 1. Carnes, a division of Carnes Company Inc: www.carnes.com/#sle.
 - 2. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - 3. Twin City Fan & Blower; BCRD: www.tcf.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

- C. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
- D. Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
- E. Backdraft Damper: Aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- F. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.04 LABORATORY FUME-EXHAUST FANS

- A. General Requirements:
 - 1. Fan Type: Base-mounted, constant stack-velocity discharge laboratory exhaust.
 - 2. Minimum air discharge velocity of 3,000 fpm in compliance with ANSI Z9.5.
 - 3. Provide fan-assembly manufactured to sustain structural integrity without external guy-wires or supplemental supports at wind speeds up to 125 mph.
 - 4. Fan performance tested in accordance with AMCA 210, AMCA 260, and AMCA 300.
 - 5. Fan performance ratings certified in accordance with AMCA 211 and AMCA 311.
 - 6. Explosion Resistant Construction: Provide fan classified as Spark B with motor and drive-assembly outside of contaminated airstream in compliance with AMCA 99.
 - 7. Comply with NFPA 90A and NFPA 91 requirements for chemical laboratory applications per NFPA 45.
- B. Application:
 - 1. Dedicated Fume Hood Exhaust:
 - a. Fan Type: Belt-driven, single-speed motor with epoxy-based protective coating.
 - b. Exhaust Capacity: Select fan to handle full exhaust airflow rate, system static pressure loss with 15 percent load-capacity factor, and minimum discharge plume height of 10 feet above roof level.
- C. Fan Section Requirements:
 - 1. Impeller:
 - a. Non-overloading, backward-inclined centrifugal.
 - b. Material: Aluminum.
 - 2. Fan Shaft:
 - a. Ground and polished steel with anticorrosive coating.
 - b. First critical speed at least 25 percent over maximum cataloged operating speed.
 - c. Enclosed over OSHA recommended safety-yellow painted guards.
 - 3. Bearings:
 - a. 100 percent factory tested surface-mounted bearings outside of the airstream.
 - b. Operate during a minimum L10 service life in excess of 100,000 hours at maximum cataloged operating speed.
 - 4. Belt-drive Assembly:
 - a. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
 - b. Belts: Static-free and oil resistant.
 - c. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

- d. Motor pulley adjustable for final system balancing, readily accessible for maintenance.
- 5. Housing:
 - a. Construct of heavy gauge aluminum with standard factory finish.
 - b. Mounting Base:
 - c. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
 - d. Provide breather tube for fresh air motor cooling and wiring.
 - e. Minimum Assembly Height: 120 inches above the roof surface.
- 6. Isolation Damper:
 - a. With parallel blade damper, constructed of matching materials and finish.
 - b. Provided by manufacturer, bolted to access drawer or panel for easy removal from contaminated airstream.
 - c. With two-position damper actuator:
 - 1) Provided by manufacturer.
 - 2) Operate interlocked with fan starter.
 - 3) With integral auxiliary switches to monitor blade position status.
 - 4) Rated for NEMA EN 10250, Type 4 (IP66) environment within protective weather-housing out of contaminated airstream, connected through linkages.
- 7. Fan Discharge Outlet-Nozzle:
 - a. High Plume: Conical shaped nozzle manufactured to facilitate attaining a required air-discharge velocity of constantly to lightly reduced exhaust flows.
- 8. Fan Inlet Flow Sensor: Provide factory-mounted pitot tube-based differential pressure sensor probe ready for connection into differential pressure-based flow transmitter.
 - a. Transmitter Housing: Provide NEMA EN 10250, Type 4 enclosure.
- D. Disconnect Switch:
 - 1. Factory-mounted in NEMA EN 10250, Type 3R box wired in compliance with Section 260583.
 - 2. Switchbox Finish: Manufacturer's standard unless otherwise indicated.
- E. Roof Curbs:
 - 1. 18 inch high flanged, self-flashing of matching material and finish with continuously welded seams.
 - 2. Provide integral formed steel support framework with curb cap guides.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
- D. Provide sheaves required for final air balance.
- E. Install backdraft dampers on inlet to roof and wall exhausters.

END OF SECTION

**SECTION 233700
AIR OUTLETS AND INLETS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diffusers:
- B. Rectangular ceiling diffusers.
- C. Round ceiling diffusers.
- D. Registers/grilles:
 - 1. Ceiling-mounted, exhaust and return register/grilles.
 - 2. Ceiling-mounted, supply register/grilles.
- E. Duct-mounted supply and return registers/louvers.
- F. Wall and ceiling gypsum board access panels.
- G. Louvers:
 - 1. Combination louvers.

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); 2021.

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.
- E. Substitutions: See Section 016000 - Product Requirements.

2.02 ROUND CEILING DIFFUSERS

- A. Type: Round, adjustable pattern, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sectorizing baffles where indicated. Diffuser collar shall project not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.
- B. Fabrication: Steel with baked enamel finish.
- C. Color: As indicated.
- D. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 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. Fabrication: Steel with baked enamel finish.
- D. Color: As indicated.

2.04 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. Material: 22 gauge, 0.0299 inch.
- C. Color: As indicated on drawings.

2.05 CEILING SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C. Construction: Made of aluminum extrusions with factory enamel finish.
- D. Construction: Made of stainless steel.
- E. Color: As indicated.

2.06 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.
- F. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.07 LOUVERS

- A. Type: 4 inch deep frame with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over intake or exhaust end.
- B. Fabrication: 16 gauge, 0.0598 inch (1.52 mm) thick galvanized steel thick galvanized steel welded assembly, with factory prime coat finish.
- C. Color: To be selected by Architect from manufacturer's standard range.
- D. Mounting: Furnish with interior flat flange for installation.

2.08 COMBINATION LOUVERS

- A. Damper-combined, drainable louver:
- B. Size: As indicated on the drawings.
- C. Material: Extruded galvanized steel.
- D. Paint Finish and Color: To be selected by Architect from manufacturer's standard range.
- E. Rust Inhibitor Coating: Standard.
- F. Sleeve or Flange: Factory-mounted standard.
- G. Duct Transition Fitting: Square.
- H. Linkage: Concealed in frame.
- I. Custom Features: Include architectural finish.
- J. Insulation: Water-resistant sound absorbing material.
- K. Mounting: Furnish with interior flat flange for installation.

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.

END OF SECTION

**SECTION 235100
BREECHINGS, CHIMNEYS, AND STACKS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Field fabricated breechings.
- B. Manufactured breechings.
- C. Draft regulators.
- D. Single wall metal stacks.
- E. Double wall metal stacks.
- F. Special gas venting.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - FIRESTOPPING.
- B. Section 230716 - HVAC Equipment Insulation.
- C. Section 251400 - Integrated Automation Local Control Units.
- D. Section 251500 - Integrated Automation Software.
- E. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ANSI Z223.1 - National Fuel Gas Code; 2024.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- C. NFPA 31 - Standard for the Installation of Oil-Burning Equipment; 2024.
- D. NFPA 54 - National Fuel Gas Code; 2024.
- E. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment; 2024.
- F. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; 2024.
- G. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- H. UL 1738 - Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV; 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. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.06 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.
- D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.
- E. Manufacturer's Certificate: Certify that refractory lined metal stacks meet or exceed specified requirements.
- F. Designer's qualification statement.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.

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 in which the Project is located.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Breechings, Chimneys, and Stacks:
 - 1. DuraVent; DuraStack Pro (DIS2): www.duravent.com/#sle.
 - 2. Metal-Fab, Inc: www.mtlfab.com/#sle.
 - 3. Security Chimneys International; Secure Stack Pro (CIX2): www.securitychimneys.com/#sle.
 - 4. Z-Flex U.S. Inc: www.z-flex.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.

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.
 - 3. Factory-built vents and chimneys used for venting natural draft appliances to comply with NFPA 211 and UL listed and labeled.
 - 4. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 FIELD FABRICATED BREECHINGS

- A. 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.
- B. 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.
- C. Provide adjustable self-actuating barometric draft dampers, where indicated on drawings, full size of breeching.
- D. Provide cleanout doors of same gauge as breeching where indicated on drawings.
- E. 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:
 - 1. Sizes up to 30 inches: No reinforcing required.
 - 2. Sizes 31 to 36 inches: 1-1/2 by 1-1/2 by 3/16 inches, at 60 inch centers.
- F. Fabricate breeching fittings to match adjoining breechings. Fabricate elbows with centerline radius equal to breeching width. Limit angular tapers to 20 degrees maximum.

2.04 DRAFT REGULATORS

- A. General Requirement: Comply with NFPA 54 and ANSI Z223.1.
- B. Remote Monitoring:
 - 1. Provide hardwired interface to local controller, see Section 251400.
 - 2. Provide compatible software interface, see Section 251500.
- C. Draft Regulator, Manifolded Appliances:
 - 1. Controller: Pressure modulating using external bidirectional static pressure sensor rated for minus 1 to 1 in-wc service.
 - 2. Regulator: 316 stainless steel opposed blade damper (OBD) with graphite bearings, and external 2-second stroke fast-acting modulating actuator.
 - 3. Manifold Duct Size: 12 inches.
 - 4. Service Temperature: 500 degrees F, maximum.
 - 5. Accessories: Provide flanged-collar fittings, gas-flow switch, and tubing.

2.05 SPECIAL GAS VENTING (CATEGORY II, III, AND IV)

- A. Single-Wall Special Gas Venting:
 - 1. Provide single-wall metal stacks, tested to UL 1738 and UL listed with positive pressure rating for use with building heating equipment; comply with NFPA 54.
 - 2. Fabricate with 28-gauge, 0.0156-inch 29-4C stainless steel minimum.
 - 3. Design, fabricate, and install gastight to prevent products of combustion from leaking into building. Securely connect inner joints and seal in accordance with manufacturer's instructions.
 - 4. Accessories, UL Labeled:
 - a. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers, and storm collar.
 - b. Exit Cone: Consists of inner cone and outer jacket to increase stack exit velocity 1.5 times.
 - c. Rain/Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.

- B. Double-Wall Special Gas Venting:
 - 1. Provide double-wall metal stacks, tested to UL 1738 and UL listed with positive pressure rating for use with building heating equipment; comply with NFPA 54.
 - 2. Fabricate with 1-inch minimum air space between walls and construct inner liner of 28-gauge, 0.015-inch 29-4C stainless steel minimum and outer jacket of 24 gauge, 0.025-inch stainless steel minimum.
 - a. Protect aluminized steel surfaces exposed to elements with minimum of one base coat of primer and one finish coat of corrosion-resistant paint suitable for outer jacket skin temperatures of application.
 - 3. Design, fabricate, and install gastight to prevent products of combustion from leaking into building. Securely connect inner joints and seal in accordance with manufacturer's instructions.
 - 4. Accessories, UL Labeled:
 - a. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers, and storm collar.
 - b. Exit Cone: Consists of inner cone and outer jacket to increase stack exit velocity 1.5 times.
 - c. Rain/Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.

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. Rigidly support breechings from building structure 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. Coordinate installation of dampers, and induced draft fans. See Section 260583.
- H. Insulate breechings in accordance with Section 230716.
- I. Assemble and install stack sections in accordance with NFPA 82, UL Listings, and industry practices. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.
- J. Level and plumb chimney and stacks.
- K. Clean breechings, chimneys, and stacks during installation, removing dust and debris.
- L. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

END OF SECTION

**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.

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 251500 - Integrated Automation Software.
- H. 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 BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2023, with Errata (2024).
- E. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); Current Edition.
- F. NFPA 54 - National Fuel Gas Code; 2024.
- G. 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. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 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 Installation Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.
- D. Manufacturer's Factory Inspection Report: Submit boiler inspection prior to shipment.
- E. 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.
 - 1. Provide results of the following combustion tests:
 - a. Boiler firing rate.
 - b. Over fire draft.
 - c. Gas flow rate.
 - d. Heat input.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- H. Software: Copy of software provided under this section.

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. Natural Gas, Propane, or Combination Natural Gas/Propane for Indoor Applications:
 - 1. Bosch Thermotechnology: www.bosch-thermotechnology.us/#sle.
 - 2. Bradford White Corporation: www.bradfordwhite.com/#sle.
 - 3. LAARS Heating Systems Company: www.laars.com/#sle.
 - 4. Lochinvar LLC: www.lochinvar.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Modular Condensing Hot Water Boiler for Indoor Applications:
 - 1. Bosch Thermotechnology: www.bosch-thermotechnology.us/#sle.
 - 2. Lochinvar LLC: www.lochinvar.com/#sle.
 - 3. 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 SOURCE QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Provide factory tests to check construction, controls, and operation of unit.
- C. Manufacturer to conduct boiler inspection prior to shipment; submit copy of inspection report to Architect.
- D. Non-Complying Work: See Section 014000.

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 on concrete housekeeping base, sized minimum of 4 inches larger than boiler base in accordance with Section 033000.
- D. Coordinate factory installed controls with Section 230913.
- E. Coordinate provisions for water treatment in accordance with Section 232500.
- F. Pipe relief valves to nearest floor drain.
- G. 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.

- H. Install primary boiler pump in accordance with Section 232123.
- I. Provide piping connection and accessories in accordance with Section 232114.
- J. Provide for connection to electrical service in accordance with Section 260583.
- K. Connect vent combustion generated fumes to breeching, chimney or exhaust stack; see Section 235100.
- L. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 251500.

3.02 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for closeout submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.
- C. Demonstrate proper operation of equipment to Owner's designated representative.
- D. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- E. 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.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

END OF SECTION

SECTION 237200
AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Energy recovery ventilators.
- B. Energy recovery heat exchangers.

1.02 RELATED REQUIREMENTS

- A. Section 077200 - Roof Accessories: Equipment roof curb.
- B. Section 230548 - Vibration and Seismic Controls for HVAC.
- C. Section 230923 - Direct-Digital Control System for HVAC.
- D. Section 251500 - Integrated Automation Software: BAS, BMS, or SCADA.
- E. Section 260583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. AHRI 1060 (I-P) - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment; 2023.
- B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2025.
- 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. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- E. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings; 2025.
- F. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.
- I. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's installation instructions, product data, and engineering calculations.
- C. Shop Drawings: Show design and assembly of energy recovery unit and installation and connection details.
- D. Closeout Submittals: Submit manufacturer's operation and maintenance instructions.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements for additional provisions.

2. Extra Stock Materials: One set of filters.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least five years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store equipment and products to be installed indoors in dry heated area.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 1-year manufacturer warranty for equipment including parts, materials, workmanship, and operation commencing on date of Substantial Completion. Complete forms in Owner's name and register with manufacturer.
- C. Motor Warranty: Provide 36-month manufacturer warranty against breakdowns, malfunctions, or defects in material and workmanship under expected service conditions.
- D. Energy Wheel Warranty: Provide 5-year manufacturer warranty against desiccant coating or wheel material and workmanship defects including issues arising from reduced performance under circumstances of normal use from listed design figures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. RenewAire: www.renewaire.com/#sle.
- B. Substitutions: See Section 016000 - Product Requirements.

2.02 ENERGY RECOVERY VENTILATOR

- A. ERV Equipment Construction Requirements:
 - 1. Energy Recovery Exchanger Type: Energy wheel.
 - 2. ERV Equipment Location: As indicated on drawings.
 - 3. Supply and Return Duct Connection Orientation: As indicated on drawings.
 - 4. Duct Connection Collars: Aluminum, continuously welded 0.08 inch, minimum.
 - 5. Casing and Frame:
 - a. Frame: Galvanized steel body or welded extruded aluminum tubular frame capable of supporting components and casings including integral base lifting holes.
 - b. Double Wall Panels: Minimum of 22 gauge, 0.029 inch galvanized steel.
 - c. Doors: Construct doors of same construction and thickness as wall panels. Include p-shaped extruded neoprene gasket, prop rod, chain with spring, exterior handle, and interior 3-point latching device. Label each door to identify equipment located within.
 - d. Insulation Requirements:
 - 1) Mold Resistance: "Pass" when tested in accordance with ASTM C1338.
 - 2) Fungal Resistance: No growth when tested in accordance with ASTM G21.
 - 3) Bacteria Resistance: No growth when tested in accordance with UL 181.

- 4) Flame spread index of 25 or less and maximum smoke developed index of 50.
- e. Isolation and Sealing: Form continuous, thermally isolated, weathertight seal between inner wall of panels and structural framing with closed cell PVC foam gasketing and seal seams to prevent job site caulking.
- f. Access Panels: Provide access to components through a large, tightly sealed and easily removable hinged or screwed access panel.
- g. Finish: Polyurethane enamel over weather-protected, corrosion-resistant assembly.
- h. Nameplate: Permanent name plate listing manufacturer, model number, serial number, voltage with tolerance, and amp ratings mounted inside door near electrical panel.
- 6. Supply and Exhaust Fans:
 - a. Provide separate non-overloading, statically and dynamically balanced, draw-through, forward curved centrifugal fan or fan-array for each air stream.
 - b. Fan Motor: Constant Speed, high efficiency, load matched, belt-driven, open drip proof, thermal overload protected TEFC motor with variable-sheave belt drive, and adjustable-removable motor-slide base. Size drives to 150 percent of load, minimum.
 - c. Belt Guards: Full sized, hinged, painted with high-visibility safety color, and accessible with standard tools.
 - d. Motor Bearings: Permanently lubricated sealed ball bearings rated for not less than 200,000 hours of operation with accessible greased fittings.
- 7. Dampers and Louvers:
 - a. Service Ratings: Up to 6 in-wc closed and 3,000 fpm when open.
 - b. Frame: Minimum of 20 gauge, 0.0359 inch galvanized steel channel with rear flange, prepunched mounting holes, and welded corner clips for maximum rigidity.
 - c. Exhaust Damper: Parallel blade, barometric damper for exhaust air stream isolation.
 - d. Outdoor-Intake Louver: Parallel blade, for exhaust air stream isolation. Provide weatherhood with intake insect screen and mist eliminator.
- 8. Filter Sections:
 - a. Outdoor-Intake and Exhaust Sides: 2 inch thick, pleated, MERV 13 filters, ASHRAE Std 52.2.
 - b. Filter Racks: Bolt-on rack constructed of aluminum with minimum size of 1/12 inch thick. Include hinged side access door and snap fasteners.
- 9. Vibration Isolation: Provide corrosion-resistant vibration isolation products for internal motors and other revolving parts. See Section 230548.
- 10. Electrical:
 - a. 208 VAC, 3-phase with single-point power connection to nonfused main disconnect interlocked with control panel and other components.
 - b. Install internal wiring in accordance with NFPA 70 within flexible, liquid tight steel conduit.
- 11. Controls and Local Control Panel:
 - a. Unit Controls: Factory supplied DDC with sensors, limit switches, and frost control.
 - b. Provide fused disconnect within local control panel with power supplies, transformers, terminal strip or terminal blocks for interface of field installed components.
 - c. Service Status: Provide both local and remote indication of sensor readings and status of safeties and other status items including power on, wheel-rotation alarm, outside-air loaded filter and exhaust-air loaded filter.
 - d. Provide temperature, humidity, dewpoint temperature, CO2, and wheel rotation sensors.

12. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
13. Configuration: Adjust listed requirements in conformance with ASHRAE Std 90.1 I-P.
14. Certification: AHRI 1060 (I-P) labeled, include copy of published ratings for operating conditions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that structure is ready for installation including openings, ductwork, mechanical utilities, and electrical utilities.
- B. Rooftop Installation: Verify that equipment supplied roof curbs are installed and ready to receive intended unit otherwise provide equipment matched roof curbs; see Section 077200.

3.02 INSTALLATION

- A. Install equipment in accordance with manufacturer's written installation instructions.
- B. Do not obstruct maintenance access to equipment piping, electrical conduit, or any other utility.
- C. Vibration Isolation: Provide corrosion-resistant equipment isolation products; see Section 230548.
- D. Electrical: Provide equipment raceway, wiring, and cables; see Section 260583.
- E. Coordinate installation and fire alarm system interface of system compatible duct-mounted smoke detectors and other appurtenances following NFPA 90A guidelines.
- F. Start system and adjust controls and equipment for satisfactory operation.
- G. Coordinate hardwired or software interfacing links to enable coordinate as minimum start-stop, occupied, unoccupied functions as well as specific schedules and setpoints functions with other DDC controls onboard airside systems serving common spaces; see Section 230923.
- H. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 251500.

3.03 SYSTEM STARTUP

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

3.04 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Clean filters, air plenums, interior and exposed-to-view surfaces prior to Substantial Completion.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for additional submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.
- C. Demonstrate proper operation of equipment to Owner's designated representative.
- D. Training: Train Owner's personnel on operation and maintenance of system.
 1. Training Reference: Operation and maintenance manual and additional training materials as required.
 2. Provide minimum of two hours of training.

END OF SECTION

**SECTION 237416
PACKAGED ROOFTOP AIR-CONDITIONING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged, intermediate-capacity, rooftop air-conditioning units.

1.02 RELATED REQUIREMENTS

- A. Section 230548 - Vibration and Seismic Controls for HVAC.
- B. Section 260583 - Wiring Connections: Installation and wiring of thermostats and other control components; wiring from unit terminal strip to remote panel.
- C. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AMCA 611 - Certified Ratings Program - Product Rating Manual for Airflow Measurement Stations; 2015.
- B. 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.
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- C. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- D. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- E. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. 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: One set for each unit.

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 units from physical damage by storing off site until roof mounting curbs are in place and ready for immediate installation of units.

1.07 WARRANTY

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

PART 2 PRODUCTS**2.01 PACKAGED, INTERMEDIATE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS**

- A. General: Roof mounted units having gas burner and electric refrigeration that are 7.5 tons to 25 tons in capacity.
- B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, heat exchanger and burner, heat recovery coil, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.
- C. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
- D. Disconnect Switch: Factory mount disconnect switch in control panel.

2.02 CASING

- A. Cabinet: Steel with baked enamel finish, including access panels with screwdriver-operated flush, cam type fasteners. Structural members to be minimum 18 gauge, 0.0478 inch, with access doors or panels of minimum 20 gauge, 0.0359 inch.
- B. Insulation: 2-inch thick, neoprene-coated glass fiber with edges protected from erosion.

2.03 FANS

- A. Supply and Return Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch pulley, and rubber isolated hinge mounted. Provide with high efficiency motor or direct drive as indicated. Isolate complete fan assembly. See Section 230548.

2.04 BURNERS

- A. Gas Burner: Atmospheric type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame-sensing device, and automatic 100 percent shutoff pilot.
 - 1. Construction: Welded stainless steel.
- B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.
- C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature, and energize burner when temperature drops to lower safe value.
- D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, with provisions for continuous fan operation.

2.05 EVAPORATOR COIL

- A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.

- B. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

2.06 HEAT PUMP HEATING

- A. The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4-way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
- B. The refrigerant system shall have a pump-down cycle.
- C. The unit shall have a natural gas furnace for hybrid heating. When the heatpump operation cannot maintain the discharge air temperature setpoint the natural gas furnace shall temper the airstream to the discharge air temperature setpoint.

2.07 HOT GAS REHEAT

- A. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser.
- B. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.
- C. Each coil shall be factory leak tested with high-pressure air under water.

2.08 CONDENSER COIL

- A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.
- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.
- C. Provide refrigerant pressure switches to cycle condenser fans.

2.09 COMPRESSORS

- A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
- B. Five minute timed off circuit to delay compressor start.
- C. Provide step capacity control by cycling compressors.
- D. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control utilizing thermistors.

2.10 MIXED AIR CASING

- A. Dampers: Provide manual outside and return air dampers for fixed outside air quantity.
- B. Gaskets: Provide tight fitting dampers with edge gaskets.
- C. Damper Operator, Units 7.5 Ton Cooling Capacity and Larger: 24 volt with gear train sealed in oil with spring return on.

- D. Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position on call for heating and above 75 degrees F ambient, or when ambient air temperature exceeds return air temperature.

2.11 ENERGY RECOVERY

- A. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
- B. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. 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 Heat Exchangers For Energy Recovery Ventilation Equipment.
- C. **(RTU-1)** The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. The energy recovery wheel shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.
- D. The rooftop unit (DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

2.12 AIR FILTERS:

- A. 2-inch thick, glass fiber disposable media in metal frames.

2.13 AIRFLOW MEASUREMENT

- A. Airflow Measurement Station:
1. Provide factory-installed airflow measurement station tested in accordance with AMCA 611 and bearing AMCA Ratings Seal for Airflow Measurement Performance.
 2. Station Location: Install in outdoor and return openings to measure airflow.
 3. Damper Blades:
 - a. Galvanized steel or extruded aluminum construction.
 - b. Housed in galvanized steel or extruded aluminum frame and mechanically fastened to a rotating axle rod.
 - c. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
 4. Measurement Range: Minimum of 15 percent to 100 percent of unit nominal flow.
 5. Operation: Provide low voltage signal corresponding to actual airflow for controlling and documenting airflow.
 6. Accuracy: Plus or minus 5 percent.

2.14 OPERATING CONTROLS

- A. Provide low voltage, adjustable room thermostat to control burner operation, compressor and condenser fan, and supply fan to maintain temperature setting.
1. Include system selector switch heat-off-cool and auto-on fan control switch.
 2. Locate thermostat in room as indicated on drawings.
- B. Provide terminal strip on unit for connection of operating controls to remote panel by others. Control to allow for two stages of heating and two stages cooling.

- C. Provide remote-mounted auto-on fan control switch.
- D. Provide low-limit thermostat in supply air to close outside air damper and stop supply fan.
- E. Provide night control energized by central time clock to maintain lower thermostat setting, lock out refrigeration, close outside air damper and open return air damper, stop supply air fan, for night and unoccupied operation. Provide time delay to maintain outside air damper closed and return air damper open after switching to day and occupied operation.
- F. Provide remote readout panels containing signal lights indicating system status, heating system failure, cooling system failure, and dirty filters; check switches proving signal light operations; system on-off switch, and cooling system on-off switch.
- G. Provide in panel manual 12-hour timer to override night control, remote damper control, low limit manual reset, and remote thermostat temperature setpoint.

2.15 ROOF CURBS

- A. Roof Mounting Curb: 14 inches high, galvanized steel, channel frame with gaskets, nailer strips.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that roof is ready to receive work and opening dimensions are as required by manufacturer.
- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 90A.
- C. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.
- D. Locate remote panels where indicated on drawings.

3.03 SYSTEM STARTUP

- A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for additional submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.
- C. Demonstrate proper operation of equipment to Owner's designated representative.

3.05 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of packaged rooftop units for one year from Date of Substantial Completion.
- D. Provide routine maintenance service with a two-month interval as maximum time period between calls.

- E. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.
- F. Provide 24-hour emergency service on breakdowns and malfunctions.
- G. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION

SECTION 238126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air-source heat pumps.
- B. Indoor air handling (fan and coil) units for ductless systems.
- C. 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; 2018.
- 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. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
- D. Design Data: Indicate refrigerant pipe sizing.
- E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- G. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. Project Record Documents: Record actual locations of components and connections.
- I. 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: One for each unit.

3. Extra Pilot Thermocouples: One for each unit.

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 factory-engineered 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.

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.
 1. Location: High-wall.
 2. Cabinet: Galvanized steel.
 - a. Finish: White.
 3. Fan: Line-flow fan direct driven by a single motor.
 4. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
- 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. Comply with AHRI 210/240.
 2. Refrigerant: R32.
 3. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
 4. 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.
 - 2. Provide heat pump reversing 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 manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install in accordance with NFPA 90A and NFPA 90B.
- C. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION

**SECTION 238129
VARIABLE REFRIGERANT FLOW HVAC SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air-source outdoor units.
- B. Refrigerant piping.
- C. Refrigerant branch units.
- D. Indoor units.

1.02 RELATED REQUIREMENTS

- A. Section 230529 - Hangers and Supports for HVAC Piping and Equipment.
- B. Section 230719 - HVAC Piping Insulation.
- C. Section 230800 - Commissioning of HVAC.
- D. Section 232300 - Refrigerant Piping.
- E. Section 250800 - Commissioning of Integrated Automation.
- F. Section 251500 - Integrated Automation Software.
- G. Section 284400 - Refrigerant Detection and Alarm.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Alternates: See Section 012300 - DO NOT USE BSD Alternates for product alternates affecting this section.
- B. Alternates: Owner requests a bid Alternate for a system designed and manufactured by a manufacturer other than that listed as the Basis of Design.
 - 1. Alternate systems will be considered only under the terms described for Substitutions within this section.
 - 2. Contractor shall include with Contractor's bid the amount to be deducted from the bid amount if the alternate is accepted by the Owner.

1.04 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.
- B. AHRI 1230 - Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment; 2021.
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- D. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2022, with Errata (2023).
- E. ITS (DIR) - Directory of Listed Products; Current Edition.
- F. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
 - B. Pre-Bid Submittals: For proposed substitute systems/products, as defined in PART 2, and alternate systems/products, as defined above, proposer shall submit all data described in this article, under the terms given for substitutions stated in PART 2.
 - C. Product Data: Submit manufacturer's standard data sheets showing the following for each item of equipment, marked to correlate to equipment item markings indicated in Contract Documents:
 - 1. Outdoor Units:
 - a. Refrigerant Type and Size of Charge.
 - b. Output and Input Cooling Capacity: Btu/h.
 - c. Output and Input Heating Capacity: Btu/h.
 - d. Operating Temperature Range, Cooling and Heating.
 - e. Fan Capacity: Flow in cfm with respective fan curves.
 - f. External Static Pressure (ESP): In-wc.
 - g. Sound Pressure Level: dB(A).
 - h. Electrical Data: Complete including motor size.
 - i. Maximum number of indoor units that can be served.
 - j. Maximum refrigerant piping run from outdoor unit to indoor unit(s).
 - k. Maximum height difference between outdoor unit to Indoor unit(s), both above and below.
 - 2. Indoor Units:
 - a. Output and Input Cooling Capacity: Btu/h.
 - b. Output and Input Heating Capacity: Btu/h.
 - c. Fan Capacity: Flow in cfm with respective fan curves.
 - d. External Static Pressure (ESP): In-wc.
 - e. Electrical Data: Complete including motor size.
 - f. Maximum Lift of Built-in Condensate Pump.
 - 3. Control Panels: Complete data of controllers, input-output points, and zones.
 - D. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts, locations of equipment items, refrigerant piping sizes and locations, condensate piping sizes and locations, remote sensing devices, control components, electrical connections, control wiring connections. Include:
 - 1. Detailed piping diagrams, with branch balancing devices.
 - 2. Condensate piping routing, size, and pump connections.
 - 3. Detailed power wiring diagrams.
 - 4. Detailed control wiring diagrams.
 - 5. Locations of required access through fixed construction.
 - 6. Drawings required by manufacturer.
 - E. Operating and Maintenance Data:
 - 1. Manufacturer's complete standard instructions for each unit of equipment and control panel.
 - 2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.
 - 3. Identification of replaceable parts and local source of supply.
 - F. Warranty: Executed warranty, made out in Owner's name.
 - G. Project Record Documents: Record the following:
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1. As-installed routing of refrigerant piping and condensate piping.
 2. Locations of access panels.
 3. Locations of control panels.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 5 years.
 2. Company that provides system design software to installers.
- B. Installer Qualifications: Trained and approved by manufacturer of equipment.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle equipment and refrigerant piping according to manufacturer's recommendations.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Compressors: Provide manufacturer's warranty for 6 years from date of installation.

PART 2 PRODUCTS**2.01 VARIABLE REFRIGERANT FLOW SYSTEM**

- A. Minimum System Requirements:
 1. System Testing, Capacity Rating, and Performance:
 - a. AHRI 1230 when cooling capacity is equal or greater than 65,000 Btu/h.
 - b. AHRI 210/240 when cooling capacity is below 65,000 Btu/h.
 2. Safety Certification: Bear UL 1995 tested and ITS (DIR) listed certification label.
 3. Outdoor Units: Furnish installation and surface support hardware products in accordance with ASCE 7 for wind restraint.
 4. Cooling Mode Interior Performance:
 - a. Daytime Setpoint: 68 degrees F, plus or minus 2 degrees F.
 - b. Setpoint Range: 57 degrees F to 77 degrees F.
 - c. Night Setback: 78 degrees F.
 - d. Interior Relative Humidity: 20 percent, maximum.
 5. Heating Mode Interior Performance:
 - a. Setpoint: 68 degrees F, plus or minus 2 degrees F.
 - b. Setpoint Range: 59 to 80 degrees F.
 - c. Night Setback: 60 degrees F.
 - d. Minimum Interior Relative Humidity: 10 percent RH.
 - B. System Design and Installation Considerations:
 1. Conditioned spaces and zones are indicated on drawings.
 2. Outside unit locations are indicated on drawings.
 3. Indoor unit locations are indicated on drawings.
 4. Required equipment unit capacities are indicated on drawings.
 5. Refrigerant piping sizes are not indicated on drawings.
 6. Condensate piping to nearest drain is indicated on drawings.
 7. Provide calculations showing ASHRAE Std 15 guideline compliance.
 - C. Refrigerant Piping Lengths Without Oil Traps:
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1. Minimum Piping Length from Outdoor Unit(s) to Furthest Indoor Unit: 620 feet.
 2. Minimum Combined Liquid Line Length: 3,280 feet.
 3. Minimum Piping Length Between Indoor Units: 49 feet.

2.02 AIR-SOURCE OUTDOOR UNITS

- A. Heat Pump Type:
 1. DX refrigeration unit piped to one or more compatible indoor units either directly or indirectly through one or more intermediate refrigeration branch units.
 2. Manifold two or to three units as recommended by manufacturer to handle sequencing and coordination of multiple indoor units.
 - B. Unit Cabinet:
 1. Capable of being installed with wiring and piping to the left, right, rear or bottom.
 2. Designed to allow side-by-side installation with minimum spacing and vibration isolation.
 3. Weatherproof and corrosion resistant; rust-proofed mild steel panels coated with baked enamel finish.
 4. Sound Pressure Level: 55 dB measured at 3 feet from front of unit.
 - C. Heat Sink Side:
 1. Condenser Fans:
 - a. Provide minimum of 2 fans for each condenser within the outdoor unit.
 - b. Minimum External Static Pressure: Factory set at 0.12 in-wc.
 - c. Fan Type: Vertical discharging, direct-driven propeller type with variable speed operation using DC-controlled ECM motors mechanically connected using permanently lubricated bearings having whole assembly protected with fan guards.
 2. Condenser Coils:
 - a. Hi-X seamless copper tubes expanded into aluminum fins to form mechanical bond; waffle louver fin and rifled bore tube design to ensure high efficiency performance.
 - D. Refrigeration Side:
 1. Factory assembled and wired with instrumentation, switches, and controller(s) to handle unit specifics with direct coordination of remote controller(s) from indoor unit(s).
 2. Refrigeration Circuit: ECM driven dual scroll compressors, fans, condenser heat sink coil, expansion valves, solenoid valves, distribution headers, capillaries, filters, shutoff valves, oil separators, service ports, and refrigerant regulator.
 3. Refrigerant: R-32 factory charged. Controller to alarm when charge is below capacity.
 4. Variable Volume Control: Modulate compressed refrigerant capacity automatically to maintain constant suction and condensing pressures under varying refrigerant volume required to handle remote loads. Include defrost control.
 5. Provide refrigerant subcooling to ensure the liquid refrigerant does not flash when supplying to use indoor units.
 6. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source; during heating operation, reverse cycle, oil return, or defrost is not permitted due to potential reduction in space temperature.
 7. Power Failure Mode: Automatically restarts operation after power failure without loss of programmed settings.
 8. Safety Devices: High pressure sensor with cut-out switch, low pressure sensor with cut-out switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, overcurrent protection for the inverter and antirecycling timers, refrigerant leak detection
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9. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
- E. Local Controls:
1. Include factory-wired instruments, sensors, switches, and safeties for unit control.
 2. Configured to coordinate internal unit operation with remote indoor units and with built-in capacity to coordinate other manifolded outdoor units and remote refrigerant branch unit(s).
 3. Include screen and button interface to setup operating schedules, setpoints, alarms, and remote unit setpoint coordination. Also used for system troubleshooting.
 4. Self diagnostic, auto-check functions to detect malfunctions and display the type and location.
- F. Power:
1. Electrical Requirement: 208 to 230 VAC, 3-phase, 60 Hz.
 2. Outdoor Mounted: Provide fused NEMA EN 10250 Type 4X disconnect switch.
 3. Interior Mounted: Provide fused NEMA EN 10250 Type 1 disconnect switch.

2.03 REFRIGERANT PIPING

- A. Two-Pipe Run: Provide low-pressure vapor and high-pressure vapor gas pipes for each indoor unit selected for seasonal heating or cooling service.
- B. Three-Pipe Run: Provide low-pressure vapor, high-pressure vapor gas, and liquid pipes for each indoor unit selected for off-season heating and cooling changeover service.
- C. Refrigerant Flow Balancing: Provide refrigerant piping joints and headers specifically designed to ensure proper refrigerant balance and flow for optimum system capacity and performance; T-style joints are prohibited.

2.04 INDOOR UNITS

- A. Manufacturers:
- B. Minimum Unit Requirements:
 1. DX Evaporator Coil:
 - a. Copper tubes expanded into aluminum fins to form a mechanical bond; waffle louver fin and high heat exchange, rifled bore tube design; factory tested.
 - b. 2-, 3-, or 4-row cross fin design with 14 to 17 fins per inch and flare end-connections.
 - c. Provide thermistor on liquid and gas lines wired into local controller.
 - d. Refrigerant circuits factory-charged with dehydrated air for field charging.
 2. Fan Section:
 - a. Variable or three-speed ECM fan with automatic airflow adjustment; external static pressure selectable during commissioning.
 - b. Thermally protected, direct-drive motor with statically and dynamically balanced fan blades.
 - c. Minimum-adjustable external static pressure 0.32 in-wc; provide for mounting of field-installed ducts.
 3. Local Unit Controls:
 - a. Temperature Control: Return air control using thermistor tied to computerized Proportional-Integral-Derivative (PID) control of superheat.
 - b. Temperature Zones:
 - 1) Single Indoor Unit: Set served space(s) as the local temperature zone.

- 2) Multiple Indoor Units: For large zones, group and coordinate related indoor units with served spaces as the local temperature zone with each indoor unit as sub-zone.
- 4. Return Air Filter:
- 5. Condensate:
 - a. Built-in condensate drain pan with PVC drain connection for drainage.
 - b. Units With Built-In Condensate Pumps: Provide condensate safety shutoff and alarm.
 - c. Units Without Built-In Condensate Pump: Provide built-in condensate float switch and wiring connections.
- 6. Cabinet Insulation: Sound absorbing foamed polystyrene and polyethylene insulation.
- C. Ceiling-Recessed Cassette, Indoor Units:
 - 1. Ceiling mount, 4-way, 2-way, or 1-way supply air flow units with central return air grill, DX coil, tubed drain pan, and built-in controls with thermostat remotely coordinated by outdoor air unit to maintain local air temperature setpoint.
 - 2. Cabinet Height: Maximum of 10 inches above face of ceiling.
 - 3. Exposed Housing: White, impact resistant, with washable decoration panel.
 - 4. Supply Airflow Adjustment:
 - a. Horizontally and vertically adjustable dampers with electronic actuators.
 - b. Four-way distribution field-modifiable to 3-way and 2-way airflow.
 - c. Three auto-swing positions, including standard, draft prevention and ceiling stain prevention.
 - 5. Return Air Filter: Manufacturer's standard.
 - 6. Sound Pressure Range: Between 28 to 33 dB(A) at low speed measured at 5 feet below the unit.
 - 7. Fan: Direct-drive turbo type, with motor output range of 1/16 to 1/8 hp.
 - 8. Condensate Pump: Built-in with minimum lift of 21 inches.
 - 9. Fresh Air Intake: Provide side-mounted outdoor air intake duct connection.
- D. Ceiling-Concealed Ducted Indoor Units:
 - 1. Type: Ducted unit with DX coil, tubed drain pan, and built-in controls with thermostat remotely coordinated by outdoor air unit to maintain local air temperature setpoint.
 - 2. Ducted horizontal discharge and side or back-end return; galvanized steel cabinet.
 - 3. Variable or three-speed ECM fan with automatic airflow adjustment; external static pressure selectable during commissioning.
 - 4. Return Air Filter: Manufacturer's standard.
 - 5. Sound Pressure: Measured at low speed at 5 feet below unit.
 - 6. Provide external static pressure switch adjustable for high efficiency filter operation
 - 7. Condensate Pump: Built-in, with lift of 9 inches, minimum.
 - 8. Switchbox accessible from side or bottom.
- E. Ceiling-Suspended, Indoor Units:
 - 1. DX coil, tubed drain pan, and built-in controls with thermostat remotely coordinated by outdoor air unit to maintain local air temperature setpoint.
 - 2. Variable or three-speed ECM fan with automatic airflow adjustment; external static pressure selectable during commissioning.
 - 3. Return Air Filter: Manufacturer's standard.

4. Provide exposed unit casing with removable front grille; foamed polystyrene and polyethylene sound insulation, and mounting brackets; mildew-proof polystyrene drain pan.
5. Airflow Control: Auto-swing louver that closes automatically when unit stops; five steps of discharge angle, set using remote controller; upon restart, discharge angle defaults to same angle as previous operation.
6. Sound Pressure Range: Measured at low speed at 3.3 feet below and away from unit.
7. Condensate Pump: Built-in, concealed, wide drain connection concealed in ceiling.
8. Condensate Drain Connection: Side (end), not concealed in wall.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that condensate piping has been installed and is in the proper location prior to starting installation.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
- C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
- D. Coordinate with installers of systems and equipment connecting to this system.
- E. Refrigerant Piping: See Section 232300 with Section 230719 for insulation, and Section 230529 for hangers and supports unless following specific manufacturer recommendations.
- F. Connect indoor units to condensate piping.
- G. Coordinate BAS, BMS, or Integrated Automation linking between local controller(s) and remote front-end interface; see Section 251500.
- H. Install refrigerant leak detection and alarm system in occupied spaces; see Section 284400.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Provide manufacturer's field representative to inspect installation prior to startup.

3.04 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform system startup.
- B. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
- C. Adjust equipment for proper operation within manufacturer's published tolerances.

3.05 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Clean exposed components of dirt, finger marks, and other disfigurements.

3.06 COMMISSIONING

- A. See Section 019113 - General Commissioning Requirements for additional requirements.
- B. Execute mechanical system commissioning as indicated on Section 230800.
- C. Execute BAS, SCADA, or other linked integration automation system commissioning as indicated on Section 250800.

- D. Replace components not functioning properly.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for additional submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.
- C. Demonstrate proper operation of equipment to Owner's designated representative.
- D. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- E. 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.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

3.08 PROTECTION

- A. Protect installed components from subsequent construction operations.
- B. Replace exposed components broken or otherwise damaged beyond repair.

3.09 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Provide a separate maintenance contract for specified maintenance service.

END OF SECTION

**SECTION 238200
CONVECTION HEATING AND COOLING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Finned tube radiation.
- B. Unit heaters.
- C. Cabinet unit heaters.
- D. Blower-coil units.
- E. Air coils.

1.02 RELATED REQUIREMENTS

- A. Section 232213 - Steam and Condensate Heating Piping.
- B. Section 232214 - Steam and Condensate Heating Specialties.
- C. Section 233100 - HVAC Ducts and Casings.
- D. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections. Installation of room thermostats. Electrical supply to units.

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 Addendum (2011).
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 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. Submit the following for blower-coil units indicating:
 - a. Overall dimensions including installation, operation, and service clearances.
 - b. Lift points, recommendations, and center of gravity.
 - c. Unit shipping, installation, and operating weights including dimensions.

- d. Fan curves with specified operating point clearly plotted.
- D. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- E. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- H. 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: One set of each type and size.

1.06 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.

PART 2 PRODUCTS

2.01 HYDRONIC FINNED TUBE RADIATION

- A. Required Directory Listing: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
- B. Heating Elements: 1 inch ID seamless copper tubing, mechanically expanded into evenly spaced aluminum fins sized 4 by 4 inches, suitable for soldered fittings.
- C. Heating Elements: 1-1/4 inch ID steel tube, mechanically expanded into evenly spaced steel fins.
- 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. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.
- H. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.

2.02 HYDRONIC UNIT HEATERS

- A. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- B. Perform factory run test under normal operating conditions, water, and steam flow rates.

- C. Casing: Minimum 18 gauge, 0.0478 inch thick sheet steel casing with threaded pipe connections for hanger rods for horizontal models and minimum 18 gauge, 0.0478 inch thick sheet steel top and bottom plates for vertical projection models.
- D. Finish: Factory applied baked primer coat.
- E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- F. Air Outlet: Adjustable pattern diffuser on vertical projection models and two, four, or ____ way louvers on horizontal projection models.
- G. Control: Local solid state disconnect switch.
- H. Electrical Characteristics:
 - 1. Refer to Section 260583.

2.03 HYDRONIC CABINET UNIT HEATERS

- A. 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.
- B. Coils:
 - 1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
 - 2. Heating Hot Water: Suitable for working temperatures up to a maximum not less than 200 degrees F.
 - 3. Steam: Suitable for working pressures not less than 10 psi.
- C. 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.
- D. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.
- E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- F. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- G. Control: Factory wired, solid state, infinite speed control, located in cabinet.
- H. Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.
- I. Electrical Characteristics:
 - 1. Refer to Section 260583.

2.04 BLOWER-COIL UNITS

- A. Performance Data and Safety Requirements:
 - 1. Coils rated and tested in accordance with AHRI 410.
 - 2. 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.
 - 3. Comply with NFPA 90A for unit construction, including filters and related equipment, for protection of life and property from fire, smoke, and gases resulting from conditions having manifestations similar to fire.
- B. Unit Casing:

1. Fabricate from heavy gauge galvanized steel sheet.
 2. Insulate inside walls with 1 inch thick, fiberglass insulation for thermal and acoustical control.
 3. Provide access panels allowing servicing of coils, drain pan, fan, motor, and drive.
 4. Provide knockouts or hanger rod holes at all four corners for suspended units.
- C. Air Coils:
1. Aluminum fins mechanically expanded or bonded to copper tubes having standard sweat connections.
 - a. Water: Manual, automatic or self-venting, designed to a working pressure and temperature of not less than 250 psig and 200 degrees F.
- D. Fans: Forward curved, centrifugal blower, dynamically balanced, adjustable speed V-belt drive with fan shaft supported by heavy-duty, permanently sealed ball bearings.
- E. Drain Pan: Cleanable, one-piece construction of polymer, galvanized steel, or stainless steel; with drain connection and sloped for positive drainage.
- F. Filters: Fully accessible, flat filter rack with throw-away filters.
- G. Motors: Single speed with sleeve or ball bearings, 1750 rpm, wired to unit junction box, and mounted on a resilient motor base.
- H. Mixing Box: Factory assembled fresh air and return air dampers including linkage and ready for field installation of damper actuator.
- I. Electrical Controls:
1. 24-volt control circuit transformer.
 2. Motor circuit fusing.
 3. Fan contactor.
 4. Terminal strip for connection of field wiring.
 5. Disconnecting means for main incoming power.
- J. Electrical Characteristics:
1. Refer to Section 260583.

2.05 AIR COILS

- A. Water Coils:
1. Coils rated and tested in accordance with AHRI 410.
 2. Tubes: Material to consist of seamless copper or brass, mechanically expanded or tension wound to fins; appropriate tube joining methods based on tube material.
 3. Fins: Material to consist of aluminum or copper, continuous plate type with full fin collars or individual helical finned tube type wound under tension.
 4. Casing: Heavy gauge galvanized steel with mounting holes, including intermediate tube supports if required by coil design and length.
 5. Headers (Manifolds): Construct of seamless copper pipe, cast iron, or nonferrous material with tube connection appropriate to header material provided.
 6. Acceptable Factory Testing Methods:
 - a. Proof test at 1.5 times the maximum operating pressure and leak test at the maximum operating temperature.
 - b. Leak test at minimum 300 psig air pressure under water.
 - c. Perform hydrostatic testing for coils with removable headers in accordance with approved shop drawings and normally accepted means and methods.

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. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C. Do not damage equipment or finishes.
- D. 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.
 - 5. Install wall angles where units butt against walls and align cabinet joints with window mullions.
- E. Unit Heaters:
 - 1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
 - 2. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- F. Cabinet Unit Heaters:
 - 1. Install as indicated.
 - 2. Coordinate to ensure correct recess size for recessed units.
- G. Blower-Coil Units:
 - 1. Verify all surfaces and openings at unit location can suitably accommodate unit(s).
 - 2. Install in accordance with manufacturer's recommendations.
 - 3. Provide manual shut-off valve on hydronic supply side of coil and balancing valve with memory stop on return side.
 - 4. General piping installation requirements are specified in other Sections and drawings indicate general arrangement of piping, fittings, and specialties.
- H. 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. Provide frames for maximum of three coil sections.
 - c. Arrange supports to avoid piercing drain pans.
 - d. Provide airtight seals between coil and casing or duct.
 - e. Refer to 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. Make connections to hydronic coils with unions and flanges.

5. Hydronic (Drainable) Coils:
 - a. Connect water supply to leaving air side of coil (counterflow arrangement).
 - b. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping.
 - c. Locate supply water connection on leaving air side at bottom of supply header, and return water connection at top.
 - d. Provide manual air vents with stop valves at high points.
 - 1) Install drain connections at low points of installation.
 - 2) Refer to Section 232113 and Section 232114.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Provide manufacturer's field representative to test, inspect, instruct, and observe.

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.

END OF SECTION

**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 including and not limited to elevator electrical inspection.
- 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 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.

1.12 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.

1.13 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.

1.14 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.

1.15 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.
-

1.16 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.

1.17 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.

END OF SECTION

**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.
- B. Section 028400 - Polychlorinate Biphenyl (PCB) Remediation: Removal of equipment and materials containing substances regulated under the Federal Toxic Substances Control Act (TSCA), including but not limited to those containing PCBs and mercury.

1.03 SUBMITTALS

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

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 field measurements and circuiting arrangements are as indicated.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. 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.

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 electrical devices and equipment serving utilization equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.

- G. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- H. 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.

END OF SECTION

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. Oxide inhibiting compound.
- G. Wire pulling lubricant.
- H. Cable ties.
- I. Firestop sleeves.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - FIRESTOPPING.
- B. Section 260505 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 263100 - Photovoltaic Collectors: Additional wiring requirements for photovoltaic systems.
- F. Section 284600 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2024).
- 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; 2024.
- 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; 2015.
- 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 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- O. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- P. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- Q. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- R. 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. Field Quality Control Test Reports.
- D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

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 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. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. 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.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed in hollow stud walls and above accessible ceilings for branch circuits up to 20 A.
 - 1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
 - 2. In addition to other applicable restrictions, may not be used:
 - a. Where not approved for use by the authority having jurisdiction.
 - b. Where exposed to view.
 - c. Where exposed to damage.
 - d. 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. Provide new conductors and cables manufactured not more than one year prior to installation.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- H. Conductors for Grounding and Bonding: Also comply with Section 260526.
- I. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.
- J. 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.
- K. Minimum Conductor Size:
1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
 2. Control Circuits: 14 AWG.
- L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- M. 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.
 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.
 - 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. 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.
 - 3. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
 - 4. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

- G. 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.
- H. Mechanical Connectors: Provide bolted type or set-screw 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.
 - d. Substitutions: See Section 016000 - Product Requirements.
- 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.
 - 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying 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.
 - 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with 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.
 - 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.

6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Burndy LLC; _____: www.burndy.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. IlSCO: www.ilSCO.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. American Polywater Corporation: www.polywater.com/#sle.
 - c. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- E. Cable Ties: Material and tensile strength rating suitable for application.
 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- F. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as 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.
 1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- G. 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 interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- 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. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
 - 8. 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. Exposed Cable Installation (only where specifically permitted):
 - 1. Route cables parallel or perpendicular to building structural members and surfaces.
 - 2. Protect cables from physical damage.
 - G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
-

- H. 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.
- I. Terminate cables using suitable fittings.
 - 1. Armored Cable (Type AC):
 - a. Use listed fittings and anti-short, insulating bushings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 - 2. 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.
- J. Install conductors with a minimum of 12 inches of slack at each outlet.
- K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- N. 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.
- O. 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.
- P. Insulate ends of spare conductors using vinyl insulating electrical tape.
- Q. Identify conductors and cables in accordance with Section 260553.
- R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- S. 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 - BSD 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.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

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.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground plate electrodes.

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 263100 - Photovoltaic Collectors: Additional grounding and bonding requirements for photovoltaic systems.
- D. Section 265600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2022.
- 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 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction 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 grounding and bonding system components.

- C. Field quality control test reports.
- D. Project Record Documents: Record actual locations of grounding electrode system components and connections.

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 products in accordance with manufacturer's instructions.

PART 2 PRODUCTS**2.01 GROUNDING AND BONDING REQUIREMENTS**

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. 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.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. 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. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
 - 4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
 - 5. Ground Rod Electrode(s):
 - a. Provide single electrode unless otherwise indicated or required.

- b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - 6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
 - E. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
 - 1. Provide grounding electrode system for each separate building or structure.
 - 2. Provide equipment grounding conductor routed with supply conductors.
 - 3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
 - 4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
 - F. 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.
 - b. Metal gas piping.
 - 8. Provide bonding for interior metal air ducts.
 - 9. Provide bonding for metal building frame.
 - G. Communications Systems Grounding and Bonding:
 - 1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 - 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
 - H. Photovoltaic Systems: Also comply with Section 263100.
 - I. Pole-Mounted Luminaires: Also comply with Section 265600.
-

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.
 - a. Exceptions:
 - 1) Use exothermic welded connections for connections to metal building frame.
 - 4. Manufacturers - Mechanical and Compression Connectors:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Burndy LLC: www.burndy.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.
 - d. Thomas & Betts Corporation: www.tnb.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 - 5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Cadweld, a brand of Erico International Corporation: www.erico.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Ground Bars:
 - 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 - 2. Size: As indicated.
 - 3. Holes for Connections: As indicated or as required for connections to be made.
 - 4. Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- E. Ground Rod Electrodes:
 - 1. Comply with NEMA GR 1.
 - 2. Material: Copper-bonded (copper-clad) steel.

3. Size: 5/8 inch diameter by 10 feet length, unless otherwise indicated.
- F. Ground Plate Electrodes:
 1. Material: Copper.
 2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.
 3. Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

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. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
- D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.
- E. 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.
- F. Identify grounding and bonding system components in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

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 055000 - METAL FABRICATIONS: Materials and requirements for fabricated metal supports.
- C. Section 260533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- D. Section 260533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- 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; 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- 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 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, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Installer Qualifications for Field-Welding: As specified in Section 055000.

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. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 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. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
 3. Manufacturers:

- a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.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.
- D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
 - 1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.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.
- E. 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. Comply with MFMA-4.
 - 2. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Indoor CTE Lighting Strut System: Use Stainless steel 304
 - c. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 - 4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
 - 5. Minimum Channel CTE Lighting Strut system: 1-5/8"W x 13/16"H with 9/16" x 1-1/8" oval openings and are 2" on center.
 - 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- F. 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. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
 - c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - e. Outlet Boxes: 1/4 inch diameter.
 - f. Luminaires: 1/4 inch diameter.
- G. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases 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.
 - 1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.

2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
4. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. PHP Systems/Design: www.phpsd.com/#sle.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- H. Anchors and Fasteners:
 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 4. Hollow Masonry: Use toggle bolts.
 5. Hollow Stud Walls: Use toggle bolts.
 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 7. Sheet Metal: Use sheet metal screws.
 8. Wood: Use wood screws.
 9. 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.
 10. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 11. 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.
 - e. Substitutions: See Section 016000 - Product Requirements.
 12. 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.
 - e. 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 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. Perform work in accordance with NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. 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 4 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.
- I. Conduit Support and Attachment: Also comply with Section 260533.13.
- J. Box Support and Attachment: Also comply with Section 260533.16.
- K. Interior Luminaire Support and Attachment: Also comply with Section 265100.
- L. Exterior Luminaire Support and Attachment: Also comply with Section 265600.
- M. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- N. Secure fasteners according to manufacturer's recommended torque settings.
- O. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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

SECTION 260533.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Flexible metal conduit (FMC).
- C. Liquidtight flexible metal conduit (LFMC).
- D. Electrical metallic tubing (EMT).
- E. Rigid polyvinyl chloride (PVC) conduit.
- F. Liquidtight flexible nonmetallic conduit (LFNC).
- G. Conduit fittings.
- H. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - FIRESTOPPING.
- B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
- 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.
- G. Section 271000 - Structured Cabling: Additional requirements for communications systems conduits.

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. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2025.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- G. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- J. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

- K. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.
- L. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- M. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- N. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- O. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- P. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 - 5. Notify Architect of any 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 is complete between outlet, junction and splicing points.

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.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.06 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 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use galvanized steel rigid metal conduit or rigid PVC conduit.

2. Exterior, Direct-Buried: Use rigid PVC conduit.
 3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit or rigid PVC conduit.
 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
 5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
- D. Embedded Within Concrete:
1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit.
 2. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit.
 3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
- E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit.
- F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- K. Exposed, Exterior: Use galvanized steel rigid metal conduit.
- L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.
- M. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
1. Maximum Length: 6 feet.
- N. Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit.
 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 3. Maximum Length: 6 feet unless otherwise indicated.
 4. Vibrating equipment includes, but is not limited to:
 - a. Motors.
 - b. Mechanical Equipment.

2.02 CONDUIT REQUIREMENTS

- A. Communications Systems Conduits: Also comply with Section 271000.
- B. Fittings for Grounding and Bonding: Also comply with Section 260526.
- C. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Minimum Conduit Size, Unless Otherwise Indicated:
 1. Branch Circuits: 3/4 inch (21 mm) trade size.

2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 3. Control Circuits: 1/2 inch (16 mm) trade size.
 4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
 5. Underground, Interior: 3/4 inch (21 mm) trade size.
 6. Underground, Exterior: 1 inch (27 mm) trade size.
- F. 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. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
 4. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
1. AFC Cable Systems, Inc: 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 to be used.
- C. Fittings:
1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.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.
 - a. Do not use die cast zinc fittings.

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 1. AFC Cable Systems, Inc: 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. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.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.
 - a. Do not use die cast zinc fittings.

2.06 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 steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.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.
 - a. Do not use die cast zinc fittings.
 4. Connectors and Couplings: Use compression (gland) type.
 - a. Do not use indenter type connectors and couplings.
 - b. Do not use set-screw type connectors and couplings.

2.07 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 - 1. Cantex Inc: www.cantexinc.com/#sle.
 - 2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.
 - 3. JM Eagle: www.jmeagle.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.08 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: 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 LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.
- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.09 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.
- G. 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.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.

- H. 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. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- I. 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.
- J. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for the conduit/duct arrangement to be installed.
 - 1. Products:
 - a. Advance Products & Systems, LLC; Duct Bank Spacers: www.apsonline.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- K. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for the casing and conduit/duct arrangement to be installed.
 - 1. Products:
 - a. Advance Products & Systems, LLC; Bore Spacers: www.apsonline.com/#sle.

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. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- E. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.
- F. 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 all 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.

- c. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.
 - 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 - 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 - 14. Group parallel conduits in the same area together on a common rack.
- G. Conduit Support:
- 1. Secure and support conduits in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
 - 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 non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
 - 9. Use of wire for support of conduits is not permitted.
 - 10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.
- H. 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 a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
 7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- I. 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. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
 7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 8. 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. Include proposed locations of penetrations and methods for sealing with submittals.
 9. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- J. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Include proposed conduit arrangement with submittals.
 2. Maximum Conduit Size: 1 inch (27 mm) unless otherwise approved.
 3. Install conduits within middle one third of slab thickness.
 4. Secure conduits to prevent floating or movement during pouring of concrete.
- K. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 033000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- L. 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 calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
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- 3. Where conduits are subject to earth movement by settlement or frost.
- M. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 - 1. Where conduits pass from outdoors into conditioned interior spaces.
 - 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
 - 3. Where conduits penetrate coolers or freezers.
- N. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- O. Provide grounding and bonding in accordance with Section 260526.
- P. Identify conduits in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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.

END OF SECTION

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. Accessories.

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 EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- 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. SCTE 77 - Specifications for Underground Enclosure Integrity; 2023.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

- K. UL 514A - Metallic Outlet Boxes; 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 flush-mounted 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.
1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.
- 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 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. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: Comply with Section 271000.
 - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
 14. Wall Plates: Comply with Section 262726.
 15. 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 EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA EN 10250 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. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
- 6. 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.
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
 - 1. Manufacturers:
 - a. Hubbell Incorporated: www.hubbell.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.02 ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.
 - 1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.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 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. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- F. 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.

3. 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. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 9. 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.
 10. 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.
- G. 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.
 2. 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.
 4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- H. Install boxes plumb and level.
- I. 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.
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- J. Install boxes as required to preserve insulation integrity.
- K. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
- L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- N. Close unused box openings.
- O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- P. Provide grounding and bonding in accordance with Section 260526.
- Q. 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.

END OF SECTION

SECTION 260533.23
SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface raceway systems.
- B. Wireways.

1.02 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260533.13 - Conduit for Electrical Systems.
- D. Section 260533.16 - Boxes for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 262726 - Wiring Devices: Receptacles.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.
- E. UL 111 - Outline of Investigation for Multioutlet Assemblies; Current Edition, Including All Revisions.
- F. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate rough-in locations of outlet boxes provided under Section 260533.16 and conduit provided under Section 260533.13 as required for installation of raceways provided under this section.
 - 3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install raceways until final surface finishes and painting are complete.
 - 2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

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

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
 - 1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 RACEWAY REQUIREMENTS

- A. Provide all components, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.02 SURFACE RACEWAY SYSTEMS (ONLY TO BE USED IN FIRST FLOOR AREA A1 FOR EXISTING WALLS)

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. Legrand North America, Inc: www.legrand.us/#sle.
 - 3. MonoSystems, Inc: www.monosystems.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Surface Metal Raceways: Listed and labeled as complying with UL 5.
- C. Surface Raceway System:
 - 1. Raceway Type: Single channel, painted steel.
 - 2. Color: White.
 - 3. Accessory Device Boxes: Suitable for the devices to be installed; color to match raceway.
 - 4. Integrated Device Provisions:
 - a. Receptacles:
 - 1) Comply with Section 262726, except for finishes.
 - 2) Color: Match raceway.
 - b. Communications Outlets:
 - 1) Voice and Data Jacks: As specified in Section 271000.
 - 5. Products:
 - a. Hubbell Incorporated; _____: www.hubbell.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.03 WIREWAYS

- A. Manufacturers:
 - 1. Eaton Corporation: www.eaton.com/#sle.
 - 2. Enduro Composites: www.endurocomposites.com/#sle.
 - 3. nVent: www.nvent.com/#sle.
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- 4. Schneider Electric: www.se.com/#sle.
- 5. Substitutions: See Section 016000 - Product Requirements.
- B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.
- C. Wireway Type, Unless Otherwise Indicated:
 - 1. Indoor Clean, Dry Locations: NEMA EN 10250, Type 1, painted steel with screw-cover.
 - 2. Outdoor Locations: NEMA EN 10250, Type 3R, painted steel with screw-cover; include provision for padlocking.
- D. Finish for Painted Steel Wireways: Manufacturer's standard grey unless otherwise indicated.
- E. Minimum Wireway Size: 4 by 4 inches unless otherwise indicated.
- F. Where wireway size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.
- C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.
- 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. Perform work in accordance with NECA 1 (general workmanship).
- C. Install raceways plumb and level.
- D. Arrange wireways and associated raceway connections to comply with NFPA 70, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.
- E. Secure and support raceways in accordance with Section 260529 at intervals complying with NFPA 70 and manufacturer's requirements.
- F. Close unused raceway openings.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Identify raceways in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Inspect raceways for damage and defects.
- C. Surface Raceway Systems with Integrated Devices: Test each wiring device to verify operation and proper polarity.
- D. Correct wiring deficiencies and replace damaged or defective raceways.

3.04 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 PROTECTION

- A. Protect installed raceways from subsequent construction operations.

END OF SECTION

**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. Floor marking tape.
- F. 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 260536 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.
- E. Section 262726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- F. Section 263100 - Photovoltaic Collectors: Additional identification requirements for photovoltaic systems.
- G. 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. 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) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Enclosed switches and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - c. Time Switches:
 - 1) Identify load(s) served and associated circuits controlled. Include location.
 - d. Enclosed Contactors:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
 - 4) Identify load(s) and associated circuits controlled. Include location.
 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 switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.
 5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
 6. Use identification label on inside of door at each fused switch to identify required NEMA fuse class and size.

7. Use identification label 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.
 8. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
 9. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
 - a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 099123 and 099113.
 10. 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.
 11. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
 2. Identification for Communications Conductors and Cables: Comply with Section 271000.
 3. 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.
 4. 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.
 5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
 6. Use underground warning tape to identify direct buried cables.
- C. 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:
 - (a) Fire Alarm System: Red.
 - 2) Vinyl Color Coding Electrical Tape: Comply with Section 260519.
 3. Use identification labels 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.
 4. Use identification labels or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
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- D. Identification for Cable Tray: Comply with Section 260536.
- E. Identification for Boxes:
 - 1. Use identification labels to identify circuits enclosed.
 - a. For exposed boxes in public areas, use only identification labels.
- F. Identification for Devices:
 - 1. Identification for Communications Devices: Comply with Section 271000.
 - 2. Wiring Device and Wallplate Finishes: Comply with Section 262726.
 - 3. 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.
 - 4. Use identification label to identify serving branch circuit for all receptacles.
- G. Identification for Luminaires:
 - 1. Use permanent red dot on luminaire frame or on ceiling grid to identify luminaires connected to emergency power system.
- H. Identification for Photovoltaic Systems: Comply with Section 263100

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 non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - 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 laser-etched 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.
 - a. Use only for indoor locations.
 - 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. System designation where applicable:
 - 1) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - c. Other Information: 1/4 inch.
 - 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Fire Alarm System: White text on red background.
- D. Format for General Information and Operating Instructions:
 - 1. Minimum Size: 1 inch by 2.5 inches.
 - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 1/4 inch.
 - 5. Color: Black text on white background unless otherwise indicated.
 - a. Exceptions:
 - 1) Provide white text on red background for general information or operational instructions for fire alarm systems.
- E. Format for Caution and Warning Messages:
 - 1. Minimum Size: 2 inches by 4 inches.
 - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 1/2 inch.
 - 5. Color: Black text on yellow background unless otherwise indicated.
- F. 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.
- G. 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.
1. Do not use handwritten text.
- 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:
 - a. Other Systems: Type of service.
- F. Color: Black text on orange background unless otherwise indicated.

2.05 UNDERGROUND WARNING TAPE

- 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. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

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- C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
 - D. Legend: Type of service, continuously repeated over full length of tape.
 - E. Color:
 - 1. Tape for Buried Power Lines: Black text on red background.
 - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.06 FLOOR MARKING TAPE

- 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. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlamine, 3 inches wide, with alternating black and white stripes.

2.07 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.brimar.com/#sle.
 - 2. Clarion Safety Systems, LLC: www.clarionsafety.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
 - 4. 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.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum 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 self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
 - 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.
 - 1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

**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.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Comply with NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Disconnect Switches: As specified in Section 262816.16 and in individual equipment sections.
- C. Wiring Devices: As specified in Section 262726.
- D. Flexible Conduit: As specified in Section 260533.13.
- E. Wire and Cable: As specified in Section 260519.
- F. Boxes: As specified in Section 260533.16.

2.02 EQUIPMENT CONNECTIONS

- A. _____:
1. Electrical Connection: Flexible conduit.
 2. Electrical Connection: Cord and plug (NEMA type located on drawings).
 3. Provide field-installed disconnect switch.

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.

END OF SECTION

**SECTION 260913.33
ELECTRICAL POWER MANAGEMENT SYSTEM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical power management system (EPMS) and associated hardware, software, and services.

1.02 RELATED REQUIREMENTS

- A. Section 262413.11 - Switchboards - Schneider Electric Square D FlexSeT/QED-2.
- B. Section 262416.11 - Panelboards.
- C. Section 262713.13 - Power and Energy Meters - Schneider Electric PowerLogic.
- D. Section 263213 - Engine Generators.
- E. Section 263623.16 - Automatic/Nonautomatic Transfer Switches - ASCO 300.

1.03 ABBREVIATIONS AND ACRONYMS

- A. PQ: Power quality.
- B. PTP: Precision time protocol.

1.04 DEFINITIONS

- A. Electrical power management system may also be identified as EPMS, EMS, PEMS, energy management system, electrical power monitoring system, power and energy monitoring system, or energy and power management system.
- B. Hot-Standby: Failover mechanism to provide reliability in system configurations using redundant hardware and software to prevent data loss and improve uptime.
- C. Precision Time Protocol: Protocol for accurate and precise network synchronization of clocks, complying with IEEE 1588.
- D. Smart Mobile Device: Smart phone or tablet compatible with iOS or Android OS capable of running apps used for specified functionality.

1.05 REFERENCE STANDARDS

- A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. CAL TITLE 24 P6 - California Code of Regulations, Title 24, Part 6 (California Energy Code); 2022, with Supplement (2024).
- C. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. IEC 60870-5-104 - Telecontrol Equipment and Systems – Part 5-104: Transmission Protocols – Network Access for IEC 60870-5-101 Using Standard Transport Profiles; 2006 (Corrigendum 2023).
- E. IEC 61850 (SET) - Communication Networks and Systems for Power Utility Automation - All Parts; 2026.

- F. IEC 61850-6 - Communication Networks and Systems for Power Utility Automation – Part 6: Configuration Description Language for Communication in Electrical Substations Related to IEDs; 2009, with Amendment (2024).
- G. IEC 62443-2-1 - Security for Industrial Automation and Control Systems – Part 2-1: Security Program Requirements for IACS Asset Owners; 2024.
- H. IEC 62443-2-4 - Security for Industrial Automation and Control Systems – Part 2-4: Security Program Requirements for IACS Service Providers; 2023.
- I. IEC 62443-3-3 - Industrial Communication Networks – Network and System Security – Part 3-3: System Security Requirements and Security Levels; 2013 (Corrigendum 2014).
- J. IEC 62443-4-1 - Security for Industrial Automation and Control Systems – Part 4-1: Secure Product Development Lifecycle Requirements; 2018.
- K. IEC 62443-4-2 - Security for Industrial Automation and Control Systems – Part 4-2: Technical Security Requirements for IACS Components; 2019 (Corrigendum 2022).
- L. IEC TR 62443-2-3 - Security for Industrial Automation and Control Systems – Part 2-3: Patch Management in the IACS Environment; 2015.
- M. IEC TR 62443-3-1 - Industrial Communication Networks – Network and System Security – Part 3-1: Security Technologies for Industrial Automation and Control Systems; 2009.
- N. IEC TS 62443-1-1 - Industrial Communication Networks – Network and System Security – Part 1-1: Terminology, Concepts, and Models; 2009.
- O. IEEE 1588 - IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems; 2019, with Amendment (2024).
- P. IEEE/IEC C37.111 - IEEE/IEC International Standard – Measuring Relays and Protection Equipment – Part 24: Common Format for Transient Data Exchange (COMTRADE) for Power Systems; 2013.
- Q. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).
- R. ISO 50001 - Energy Management Systems – Requirements with Guidance for Use; 2018, with Amendment (2024).
- S. ISO 50002 - Energy Audits – Requirements with Guidance for Use; 2014.
- T. ISO 50006 - Energy Management Systems — Evaluating Energy Performance Using Energy Performance Indicators and Energy Baselines; 2023.
- U. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- V. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- W. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work to provide EPMS-compatible equipment and systems with sensors, interfaces, and other appurtenances required for specified functionality.
- B. Software Configuration Review Meetings:
 - 1. Review proposed screens and report formats with Owner and Engineer throughout configuration process.

2. Convene minimum of two meetings at Owner's facilities, one for initial review and one at approximately 50 percent completion. EPMS supplier's programming personnel to attend initial review meeting.
- C. Preinstallation Meeting: Review material selections and installation procedures with manufacturer's representative and affected installers.
- D. Scheduling: Where source interruptions are required for testing and commissioning, arrange scheduling with Owner; allow minimum of one day for pretesting and one day for acceptance testing, with accommodations for testing outside of normal business hours where applicable.

1.07 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.
- C. Indicate deviations from contract documents with reference to corresponding drawing or specification number and written justification for deviation.
- D. Software Configuration Standards and Conventions:
 1. EPMS supplier to document decisions made during first EPMS software configuration review meeting.
 2. Provide color documents for accuracy, using accurately depicted colors and shapes proposed for use in final system; black and white documents are not acceptable.
 3. Include the following for review and approval before software configuration commences:
 - a. High Accuracy and Resolution Event Recording: Implementation details, including critical status points and time synchronization mechanism.
 - b. Capacity Management: Circuits for reporting, report formats, and dashboard layouts.
 - c. Backup Power Testing: Mechanisms of integration with generator system, report formats, and dashboard layouts.
 - d. Utility Bill Verification: Billing determinants and billing report formats.
 - e. Cost Allocation: Energy cost determinants, report formats, and dashboard layouts.
 - f. Energy Usage and Benchmarking:
 - 1) Energy usage determinants.
 - 2) Report formats and dashboard layouts.
 - 3) Data import mechanisms to integrate normalization data from external systems, such as building management systems and production systems.
 - 4) Data import mechanisms to integrate operating state information from external systems, such as HVAC and production systems.
 - g. Energy Performance Analysis and Verification (Modeling):
 - 1) Energy usage determinants.
 - 2) Report formats and dashboard layouts.
 - 3) Data import mechanisms to integrate relevant energy driver information, such as temperature and occupancy.
 - h. Greenhouse Gas: Report formats and dashboard layouts.
 - E. Product Data: Provide manufacturer's standard catalog pages and data sheets, including physical data, electrical performance, electrical characteristics, and connection requirements.
 - F. Shop Drawings:

1. Provide elementary and interconnection diagrams for field-monitoring devices and networking components, including power, signal, control, and communications wiring with network addresses.
 2. Identify network connections, protocols, device room locations, and recommended installation notations.
 3. EPMS-Connected LV Switchgear: Provide project-specific drawings for each switchgear/breaker.
- G. Commissioning Report: Provide detailed scope of work checklist document with delivered functionality listed and checked.
- H. Installer's qualification statement.
- I. EPMS services contract.
- J. Operation and Maintenance Data: Include sequence of operation (for control applications such as automatic transfer schemes and load control), layout drawings, bill of material, spare parts list, and component catalog information.
- K. Project Record Documents:
1. Construction, installation, schematic, and wiring diagrams updated to as-installed and commissioned state.
 2. Configured settings/parameters for adjustable components updated to as-installed and commissioned state, noted if different from factory default.
- L. Software: Copy of software required in this section, associated licensing documentation, and support contact information. Indicate licensing in Owner's name.
- M. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
1. Tools: Manufacturer-specific special tools required to install, remove, test, and maintain EPMS components.
 - a. Equipment Configuration Software: PC-based or smart mobile device application; provide one of each different communication interface cable required to connect computer/device for configuration and programming.
 - b. Electronic Configuration Files: For future upload into replaced/repaired components, in media format acceptable by Owner.

1.08 QUALITY ASSURANCE

- A. Comply with the following:
1. NFPA 70.
 2. Requirements of authorities having jurisdiction.
 3. Applicable local codes.
- B. Manufacturer Qualifications:
1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.
 2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.
 3. Service, repair, and technical support services available 24 hours per day, 7 days per week from manufacturer or their representative.
- C. Installer Qualifications: Firm with minimum 10 years experience with EPMS of similar type and scope.

D. Design Tests:

1. Test EPMS in test-bed environment with hardware devices representative of large-scale functional power distribution system, including both physical and simulated devices, such as advanced power quality meters, low-voltage main meters, low-voltage feeder meters, circuit breaker trip units, transformer monitoring units, protective relays, and branch circuit power meters.
2. Publish documented test results, including system response times, network performance, and recommended network architectures, available upon request.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.
- B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.
- C. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.
- D. Inspect products and report concealed damage or violation of delivery, storage, and handling requirements to Engineer.

1.10 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Electric; Square D EcoStruxure Power; www.se.com/#sle.
- B. Substitutions: See Section 016000 - Product Requirements.
- C. Source Limitations: Furnish products obtained from single supplier.

2.02 ELECTRICAL POWER MANAGEMENT SYSTEM (EPMS) - GENERAL REQUIREMENTS

- A. Basis of Design: Schneider Electric; Square D EcoStruxure Power; www.se.com/#sle.
- B. Provide data and analytics functionality for energy performance optimization, power reliability/availability, and sustainability metrics. Provide features, including but not limited to, real-time monitoring, alarming/event management, energy, power, and sustainability data analytics/visualization to facilitate the following functions:
 1. Analyze energy usage and uncover savings opportunities.
 2. Meet and exceed energy efficiency and sustainability standards and certifications.
 3. Measure return on investment of energy capital projects.
 4. Decrease frequency and duration of unplanned outages.
 5. Improve workplace safety by minimizing exposure to electrical hazards.
 6. Provide accurate and automated documentation for regulatory compliance.
 7. Improve effectiveness of equipment maintenance activities.
 8. Manage multiple power generation sources effectively.

9. Increase return on electrical distribution assets.
- C. Data and analytics for EPMS operations, including but not limited to, centralized display, analysis, logging, alarming, and event recording to be accessible from computer workstation with supported operating system and interface software.
- D. Software Licenses:
 1. License software programs provided with EPMS to Owner for use on specified system.
 2. Do not restrict Owner from using software on system provided or its replacement.
 3. Grant Owner right to make copies of software for use on system provided.
 4. Subject to review and approval by Owner and Engineer.
- E. Computer Hardware:
 1. Provided by EPMS supplier, meeting required system performance.
 2. Use current-generation, PC-based architectures with Microsoft operating systems.
- F. Connected Equipment and Devices:
 1. Provide EPMS network-connected devices as required to support specified EPMS functionality.
 2. For equipment containing connected devices, provide internal wired communications network to provide single point of connection to EPMS network.
 3. Meters:
 - a. Applications:
 - 1) Transfer Switches: Power quality meter; for automated generator test documentation.
 - 2) Generators: Advanced power quality meter; for automated generator test documentation.
 - 3) Low-Voltage Mains: Power quality meter; for network management, energy cost allocation, power quality analysis, asset management, operational efficiency, and compliance reporting.
 - 4) Low-Voltage Feeders: Power quality meter; for network management, energy cost allocation, power quality analysis, asset management, operational efficiency, and compliance reporting.
 - 5) Low-Voltage Sub-Metering for Individual Circuits: Energy meter, for energy cost management, energy cost allocation, and operational efficiency.
 - 6) Low-Voltage Sub-Metering for Multiple Circuits: Multi-circuit meter; for network management, energy cost allocation, and compliance reporting.
 - b. Power Meters: See Section 262713.13.
 - c. Energy Meters: See Section 262713.13.
 - d. Multi-Circuit Meters: See Section 262713.13.
- G. Communications and Interfaces:
 1. EPMS Network: Provide EPMS network using Ethernet, except where specifically indicated otherwise, for communication between EPMS system and connected equipment/devices, including but not limited to the following:
 - a. Connections to and use of Owner's existing Ethernet network. Coordinate with Owner to provide dedicated VPN for EPMS network where physical media is shared with other networks.
 - b. Serial communication connections as indicated to gateway devices for Ethernet EPMS network interface.
 - c. Connection to direct digital control (DDC) system for HVAC network.

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2. Cybersecurity: Comply with best practices and provide technical features to reduce risk to people, assets, and processes, including:
 - a. Secure network architecture.
 - b. User privilege/authentication policy.
 - c. Comply with IEC 62443 standards series, including but not limited to IEC TS 62443-1-1, IEC 62443-2-1, IEC TR 62443-2-3, IEC 62443-2-4, IEC TR 62443-3-1, IEC 62443-3-3, IEC 62443-4-1, and IEC 62443-4-2.
 - d. Comply with Owner's cybersecurity program/practices.
 3. Equipment Interfaces:
 - a. Equipment Connected to EPMS: Provide interface compatible with EPMS network/software and required appurtenances, including gateways, transceivers, and converters, integral to equipment.
 - b. Unless otherwise indicated, use Modbus TCP/IP Ethernet protocol. Use Modbus serial only where specifically indicated.

2.03 ELECTRICAL DISTRIBUTION MONITORING AND ALARMING

- A. Provide screens displaying real-time data from electrical infrastructure, such as incoming utility feeds, medium-voltage distribution, and low-voltage distribution.
 - B. Display relevant real-time data from energy meters and other facility metadata, such as WAGES, industrial process data, weather, and occupancy, from connected, compatible devices, equipment, and systems.
 - C. Organize and display real-time data of EPMS software to provide logical views for system health and support EPMS applications.
 - D. Provide set of screens for electrical single-line diagram of facility, including:
 1. Links to navigate between various levels of single-line diagram.
 2. Electrical parameters for equipment components on single-line diagram, such as MV switchgear, MV transformers, generators, unit substations, LV switchboards, UPS, and isolated panel system.
 3. Link to power equipment details screens.
 - E. Equipment Details:
 1. Provide screens to display details pertaining to each piece of equipment, including equipment picture (if available), local single-line diagram (if applicable), information for each electrical section (e.g., breaker and disconnect switch), and alarm points.
 2. Measured peak demand and loading of equipment (e.g., breakers, UPSs, transformers, and generators).
 3. Navigation link to default diagrams of each applicable meter/protection device.
 - F. Floor Plans:
 1. Provide set of screens displaying floor plans overlaid with relevant real-time data.
 2. Digital image files provided to EPMS supplier by Owner or Engineer.
 3. Provide navigation links to summary screens and equipment details screens.
 - G. Provide summary status screen for alarm indication for major power equipment components of electrical distribution system.
 - H. Alarms:
 1. Organize abnormal electrical conditions, events, and group-related incidents using alarm management practices for situational awareness and actionable intelligence.
 2. Notify appropriate staff members of alarms through email or SMS text messages.
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2.04 POWER EVENTS RECORDING AND ANALYSIS

- A. Provide event aggregation and analysis tools to gather timestamped events from compatible connected devices to provide consolidated system event view, showing date/time ordered list of events, event priority, and reporting device name.
- B. Automatically acquire onboard event data and associated waveforms from power quality monitoring devices without additional software configuration or data upload scheduling.
- C. Retrieve onboard, high-resolution timestamps of one-millisecond accuracy without degradation or modification, including devices supporting clock synchronization via GPS, IRIG-B, NTP, or precision time protocol (PTP).

2.05 LOW-VOLTAGE (LV) CIRCUIT BREAKER SETTINGS MONITORING

- A. Capabilities:
 - 1. View protection settings for LV circuit breakers in real-time.
 - 2. Generate report, for audit purposes, summarizing protection settings of LV circuit breakers.
 - 3. Trigger alarm upon changes to breaker settings as compared to previously recorded baseline.
- B. Provide breaker settings report, including:
 - 1. Breaker name, protection settings/modes, and maintenance status.
 - 2. Current recorded value with timestamp.
 - 3. Previously recorded baseline value with timestamp.
 - 4. Highlight changes between baseline and changed values.

2.06 EPMS ADVISORY SERVICES

- A. Provide separate contract to Owner, as proposal in addition to base bid, for EPMS advisory services for two years from date of Substantial Completion. Include proposal for yearly renewals.
- B. Provide ongoing technical support services to advise on, optimize, and tune performance of EPMS.
 - 1. Use EPMS via internet connection for read-only data access for functionality; do not modify data; devices not capable of being controlled.
 - 2. Analyze data on electrical power distribution equipment, identify problems through expert analysis, and provide recommended actions for system improvement.
 - 3. Provide expert analysis through review of data and reports by qualified electrical power distribution and power quality professionals.
- C. Services:
 - 1. Periodic monitoring of EPMS server(s) and software to alert for system problems, including but not limited to, areas of communications infrastructure and software diagnostics.
 - 2. Specialized EPMS diagnostic and analytics tools with capabilities for detection, diagnosis, and mitigation recommendations, including:
 - a. Communications issues (e.g., loss of communications and intermittent problems).
 - b. Electrical and load issues (e.g., CT shorting blocks left closed, voltage disconnects left open, miswired or disconnected phases, and incorrectly sized CTs).
 - c. Sensor issues (e.g., CT polarity errors, malfunctioning pulse counters, and incorrect phase wiring).

- d. Configuration issues (e.g., incorrectly configured logging triggers, measurement unit mismatches, and incorrect PT/CT ratios).
 - e. Measurement issues (e.g., energy balance mismatches).
 - f. Overall system health issues (e.g., data corruption, missing data, operating system errors, excessive CPU usage, disk usage, and low-memory errors).
 - g. Electrical systemic power quality issues (e.g., over/undervoltage, voltage imbalances, excessive lagging power factor, and excessive harmonic distortion).
 - h. Alarm diagnostics to detect nuisance alarm behaviors (e.g., chattering, intermittent, stale, and flooding).
 - i. Provide recommendations engine for:
 - 1) Harmonic mitigation equipment, to correct detected excessive harmonic conditions.
 - 2) Mitigation equipment, to correct detected excessive power factor conditions.
 - 3. Software verification, including provision of service packs and license upgrades for installed EPMS software. Software upgrades installed and verified at additional cost in accordance with advisory service rates and fees.
 - 4. Minimum of one yearly visit for on-site maintenance, including system repairs, database maintenance, firmware upgrades, and software installations. Training on system operation provided during on-site maintenance visit by application engineer.
 - 5. Basic support via telephone and email during regular business hours to provide technical guidance, incident diagnosis, basic troubleshooting, and instructions to operate installed software and hardware.
 - 6. Direct access to advanced-level support, with priority case escalation to expert-level support. Provide quarterly proactive system maintenance.
 - 7. Periodic reports with system optimization recommendations and actionable work orders.
 - 8. System benchmark of site with system score indicating percentage of load potentially impacted or affected. Include Owner and/or Engineer in setup of metering hierarchy in EPMS advisory services to ensure relevancy of benchmark.
 - 9. Periodic executive/detailed report to promote power reliability; prioritize identified electrical network issues based on severity.
 - 10. Quarterly recommendations for system optimization to improve data quality and system performance.
 - 11. On-demand, self-paced training with energy management, metering infrastructure, and power quality content modules.
- D. Products:
- 1. Schneider Electric; EcoStruxure Power Advisor.

2.07 UTILITY BILL VERIFICATION

- A. Provide verification of utility energy costs through internally generated "shadow bills" for utility sources including water, air, gas, electrical, and steam (WAGES).
- B. Configured Project-Specific Requirements:
 - 1. Shadow energy billing reports, scheduled at user-defined intervals.
- C. Capabilities:
 - 1. Pre-engineered rate files for common utility rate structures.
 - 2. Support for rate schedule configuration and business logic through configuration files without custom programming.
 - 3. Support for common rate determinants, including:
 - a. Energy usage (kWh, kVARh, and kVAh).

- b. Demand (kW and kVAR).
 - c. Power factor penalties.
 - d. Co-incident demand.
 - e. Time of use rates (e.g., off-peak and on-peak).
 - f. Seasonal rates (e.g., summer and winter).
 - g. Daily charges.
 - h. Tiered or block energy rates (kWh).
 - i. Taxes.
 - j. Dynamic rate formulas.
4. Web-based interface for rate schedule editing.

2.08 COST ALLOCATION

- A. Provide energy cost allocation features to encourage energy-efficient behavior and support cost accounting by allocating direct and indirect energy costs to departments/processes.
 - B. Capabilities:
 - 1. Report energy costs for energy sources, including water, air, gas, electric, and steam (WAGES).
 - 2. Aggregate energy costs for entities in organization hierarchy, such as business units, departments, areas, floors, buildings, cost centers, and tenants.
 - 3. Configurable start/end dates for energy cost reporting.
 - 4. Calculate apportionment by creating virtual measurements to allocate percentages of physical meters (e.g., "20 percent of Meter A plus 80 percent Meter B").
 - 5. Calculate net metering by creating summed or subtracted physical meters (e.g., "Meter A plus Meter B minus Meter C").
 - 6. Allocation of calculated values for common areas to entities in organization hierarchy.
 - 7. Allocation of cost by standard time intervals, including daily, weekly, monthly, yearly, or by specified time intervals (e.g., production shifts).
 - 8. Data integrity checks, including warnings for data gaps and duplicates.
 - 9. Customization of energy cost reports, including custom logos and headers.
 - C. Configured Project-Specific Requirements:
 - 1. Shadow energy cost allocation reports, scheduled at user-defined intervals.
 - 2. Dashboard screens displaying relevant cost allocation parameters.
 - D. Provide user-configurable report templates to facilitate energy cost allocation, including:
 - 1. Billing Report: For individual entities in hierarchy.
 - a. Configurable time periods and rate structures.
 - b. Itemized entries with each item in rate structure and associated costs.
 - 2. Billing Summary Report: For multiple entities in hierarchy.
 - a. Subtotals for each individual entity.
 - b. Combined total for multiple entities.
 - 3. Multiple Billing Report: For multiple entities in hierarchy.
 - a. Separate sections for each individual entity.
 - b. Itemized entries with each item in rate structure and associated costs.
 - E. Support exporting of energy cost data/metadata for integration with external billing systems, with flexible export mechanisms to support:
 - 1. Common data file formats (e.g., .xml, .csv) and multiple files.
 - 2. XSLT transformations for customizing format to match systems for billing, accounting, SAP, and ERP.
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2.09 ENERGY USAGE AND BENCHMARKING

- A. Provide energy analysis and benchmarking features to isolate factors contributing to energy usage, analyze energy usage patterns, and implement energy conservation measures.
- B. Capabilities:
 - 1. Categorize energy usage by load types to identify where to focus energy conservation initiatives.
 - 2. Compare energy usage across various entities, such as buildings, departments, plants, and processes.
 - 3. Analyze factors contributing to energy usage/patterns and isolate energy waste.
 - 4. Compare energy usage by normalizing consumption with respect to area, production volume, or other energy drivers.
- C. Configured Project-Specific Requirements:
 - 1. Energy analysis reports, scheduled at user-defined intervals.
 - 2. Dashboard screens displaying relevant energy analysis parameters, model, and other performance parameters.
- D. Provide report templates to support benchmarking initiatives for improved energy efficiency, including:
 - 1. Energy Comparison Report: Display and compare normalized energy consumption.
 - 2. Energy Dashboards: Compare normalized energy consumption between sites or other organizational entities, such as buildings, plants, and processes.
 - 3. Calendar Trend: Display energy data in interactive monthly/weekly calendar views monthly/weekly, with overlaid target lines.
 - 4. Duration Curve: Display data organized by order of magnitude, rather than chronological, with overlaid target lines.
- E. Support importing and logging parameters for normalization calculations, including:
 - 1. Area (square feet/square meters).
 - 2. Outdoor temperature.
 - 3. Humidity.
 - 4. Building occupancy.
 - 5. Manufacturing productivity (number of devices produced).
- F. Operating States: Support energy usage analysis for operating states to facilitate energy efficiency initiatives for operational systems, such as HVAC and industrial processes, including:
 - 1. For each operating state, such as off, normal, and high, calculate and display equipment energy and power consumption, including percentages for water, air, gas, electricity, and steam (WAGES).
 - 2. Calculate and display operational equipment statistics, including hours of operation in each state/mode, percentage hours in each state/mode, activations for each state/mode, and average duration operating in each state/mode.
 - 3. Provide report templates that support:
 - a. Configurable reporting/aggregation time periods and state annotation.
 - b. Flexible output formats, such as pie, stacked column, and data table.

2.10 ENERGY PERFORMANCE ANALYSIS AND VERIFICATION (MODELING)

- A. Provide modeling and analysis tools to determine factors contributing most to energy usage, find energy usage patterns, and implement energy conservation measures.
- B. Support importing of energy driver data, including:

1. Outdoor temperature.
 2. Humidity.
 3. Building occupancy.
 4. Manufacturing productivity, such as number of devices produced.
- C. Configured Project-Specific Requirements:
1. Energy modeling reports, scheduled at user-defined intervals.
 2. Dashboard screens displaying relevant energy model and performance parameters.
- D. Energy Analysis:
1. Model data using linear regression or 'best-fit' functions for assessing relationship of two variables to find anomalies and track performance.
 2. Plot single or broken "best-fit" line and trend actual values against expected values based on linear regression calculations.
- E. Provide user-configurable report template to support energy modeling and verification.
1. Represent relationship between measurement datasets through:
 - a. X-Y scatter plot with overlay "best-fit" or broken-line regression lines.
 - b. Model summary table with model output variables, including slope, y-intercept, R2, and RMSE.
 2. Display measured values versus expected model output values.
 3. Plot cumulative summation report to show cumulative deviation between measured values and expected values.
 4. X-Axis Calculation Methods: Cooling degree days (CDD), heating degree days (HDD), average, sum, and delta.
 5. Y-Axis Calculation Methods: Average, sum, and delta.
 6. Support data quality checks with option to exclude missing data.
- F. Greenhouse Gas: Support conversion of energy consumption values to greenhouse gas equivalent values, including:
1. Convert energy consumption values to equivalent representations of tons of CO2, saved trees, and miles/kilometers driven.
 2. Dashboard display and reporting capabilities to track calculated greenhouse gas values.
 3. Export raw energy consumption values or greenhouse gas equivalent values to third-party, emissions-tracking systems via open-data mechanisms, such as OPC and .csv files.

2.11 ENERGY EFFICIENCY COMPLIANCE

- A. Measure, aggregate, visualize, and report energy and power data in accordance with applicable codes, standards, and sustainable design certification programs, including but not limited to:
1. NFPA 70.
 2. ICC (IECC).
 3. ASHRAE Std 90.1 I-P.
 4. CAL TITLE 24 P6.
 5. U.S. Green Building Council (USGBC) LEED certification programs.
- B. Support native integration of energy/power metering devices capable of measuring required parameters, including but not limited to:
1. Apparent power (kVA).
 2. Power demand (kW).
 3. Energy (kWh).

- 4. Power factor.
- C. Segregate energy/power metering devices to apportion data by total building and load type, such as lighting, HVAC, plug loads, process loads/pumps, renewable power sources, elevators, and escalators.
- D. Aggregate energy/power data by load type; record and store data at minimum of 15-minute intervals for 36 months.
- E. Energy/Power Monitoring Capabilities:
 - 1. Display screens with real-time energy/power measurements.
 - 2. Alarm and send email/text notifications upon exceeding configurable energy/power thresholds.
 - 3. Display dashboards, historical reporting, and real-time trending based on metered energy/power values.
- F. Provide configurable peak demand and energy by utility rate period reporting.

2.12 ARC-FLASH PROTECTION

- A. Provide visualization, event logging, and root-cause analysis of arc-flash events.
- B. Capabilities:
 - 1. Graphically indicate occurrence of arc-flash event on real-time display.
 - 2. Aggregate arc-flash alarms within EPMS integrated electrical distribution monitoring/alarm management system and root-cause analysis tools.
- C. Support native integration of compatible protective relays with integral arc-flash sensor inputs.

2.13 EPMS SOFTWARE

- A. Basis of Design: Schneider Electric; Square D EcoStruxure Power Operation; www.se.com/#sle.
- B. Provide dedicated, edge control, software platform designed as operational interface for EPMS to manage safe, reliable, and efficient power within buildings/facilities.
- C. Provide specialized data acquisition, visualization, analysis, and reporting tools designed for power management applications.
- D. Support minimum of 75 devices designed for power distribution and power quality (PQ) monitoring, including programmable power analyzers, power meters, branch/multi-circuit meters, smart panels with communicating circuit breakers, protective relays, and electrical distribution thermal sensors.
- E. Provide native device support, without requiring additional installation or configuration, including:
 - 1. Registers premapped to standard measurement names.
 - 2. Factory-tested support.
- F. Cybersecurity:
 - 1. Certified to comply with IEC 62443-4-1.
 - 2. Certified to comply at component level with IEC 62443-4-2 Security Level 2 (SL2).
 - 3. Support compliance with IEC 62443-2-4 and IEC 62443-3-3.
- G. Certify for use in energy data management system in accordance with ISO 50001 and ISO 50002, including:
 - 1. ISO 50001:
 - a. Energy review.

- b. Energy baseline.
 - c. Energy performance indicators.
 - d. Monitoring, measurement, and analysis.
 - e. Input to management review.
 - 2. ISO 50002:
 - a. Data collection.
 - b. Measurement plan.
 - c. Analysis.
 - d. Energy audit reporting.
 - 3. ISO 50006:
 - a. Obtain relevant energy performance information from energy review.
 - b. Identify energy performance indicators.
- H. Natively support continuous electrical thermal monitoring system with capability to detect abnormal bus bar or cable temperatures due to loose/faulty connections in order to prevent equipment damage and fire.
- I. Natively support active arc flash protection system with capability to detect/display arc flash alarm.
- J. Support extensible functionality by adding capabilities via software license activation codes without requiring installation of additional software modules or add-ons.
- K. Real Time Monitoring and Control:
 - 1. Provide graphical monitoring and analysis application with support for custom graphics/images.
 - a. Support creation of diagrams representing power monitoring system, including electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays.
 - b. Support animation of electrical network status (energized, de-energized) on electrical one-line diagrams based on tag-value expressions.
 - c. Support monitoring of complex auto-transfer schemes in real time.
 - 2. Support writing to device registers for operations (e.g., resetting, triggering, toggling, switching, manual waveform capture, controlling remote devices, equipment, and circuit breakers) for power management applications such as source and network control and multi-source management.
 - 3. Provide power monitoring trending application with graphical charts for real-time trending of power usage (kW, V, A, and kWh) or measurements supported by metered equipment (e.g., generators and switchgear).
 - 4. Provide web-enabled, real-time tables application with interactive side-by-side visualization of real-time measurements.
 - 5. Graphical Monitoring:
 - a. Support HTML5-enabled graphics.
 - b. Support resizing of graphics based on monitor/viewing device used.
 - c. Support automatic display of additional graphics and details as operators zoom in.
 - d. Support use of JavaScript to customize behavior of each graphic.
 - e. Provide graphics editor capable of importing scalar vector graphics (SVG) technology.
 - f. Provide integrated library of ANSI and IEC power graphics symbols.
 - g. Enable operators to change from one graphic to another by selecting object with mouse and without requiring menus.

- h. Support creation and saving of graphical components and JavaScript code in reusable and transferrable, customized libraries.
 - i. Support editing of single instance of graphic to change multiple instances.
 - j. Support importing of .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays with support for layering.
 - 6. Support arc flash protection devices with integral set of real-time graphical indicators to represent occurrence of arc flash incidents in electrical one-line diagrams.
 - 7. Support continuous monitoring of health status for arc flash sensors and associated interconnection between devices with alarm notification for abnormal conditions.
- L. Alarm/Event Analysis and Notification:
 - 1. Provide mechanism to create standard, user-defined alarm hierarchy views.
 - 2. Alarm Performance:
 - a. Maximum 10-second response time from event capture in device and display in software alarm viewer.
 - b. Retrieve and display timestamped alarms directly from devices that support onboard alarm logging.
 - c. Retrieve and display timestamps to 1-millisecond resolution from devices that support 1-millisecond timestamp resolution.
 - d. Create PC-based alarms to 1-millisecond resolution from reading device values.
 - e. Support multiple alarm types including timestamped, digital, analog, advanced, multi-digital, timestamped digital, and timestamped analog.
 - 3. Provide mobile alarm notification component with native high availability and hot-standby failover redundancy, not its own separate redundancy mechanism.
 - 4. Provide web-based power events analysis application that supports:
 - a. Automatic, intelligent clustering of events into alarms and multiple alarms from multiple devices into incidents to simplify analysis of multiple cascading events.
 - b. Automatic categorization of alarms and incidents into predefined categories (e.g., arc flash).
 - c. Predefined views for events, alarms, and incidents with configurable filters based on priority, status, source, and categories.
 - d. Pop-up window with detailed information about where, what, and when alarm/incident occurred and thumbnail summary view of associated waveforms.
 - e. Graphical indication of direction of disturbance (e.g., upstream or downstream relative to device) for power quality alarms/incidents captured by compliant devices.
 - f. Representation of percentage impact of load lost due to power event for prioritization of alarms most impacting system.
 - 5. Provide graphical timeline view of alarms/events that constitute incidents in electrical distribution network.
 - a. Display alarms/events stacked by order of time for sequence of events analysis.
 - b. Display start and end of alarms/events with color-coded dots.
 - c. Indicate if there are captured waveforms associated with incident.
 - d. Provide configurable analysis window with color-coded time slider that uses color to indicate areas in timeline with greater numbers of alarms.
 - 6. Provide web-based smart waveform analyzer interface that supports:
 - a. Toggle on/off of voltage/current channels.
 - b. RMS calculation, zoom, pan, and export to CSV.
 - c. Interactive phasor and harmonic voltage/current diagrams.
 - d. Comparison of multiple waveforms to each other.

- e. Waveforms in COMTRADE format complying with IEEE/IEC C37.111.
- 7. Provide alarm annunciator to display total number of unacknowledged alarms with breakdown of how many are high, medium, and low priority with single-click navigation to alarm viewer.
- 8. Support acquisition of specialized, high-speed power disturbance data directly from onboard advanced power quality meters for power events analysis:
 - a. Timestamped power events with disturbance direction detection.
 - b. Pre- and Post-Event Waveform Captures: Voltage and current for all phases.
- 9. Automatically perform analytics on captured waveforms and when possible provide plain language description of likely cause of power quality event.
- M. Data Analytics and Visualization:
 - 1. Provide interactive, web-based dashboard application with auto-updating dashboard views for energy, power, and water, air, gas, electric, steam (WAGES) data, historical data trends, power quality, images, and external content from URL addresses.
 - 2. Provide capability to create, modify, view, and share dashboards, including graphics, labels, scaling, measurements, and date ranges, using only browser without requiring separate software application to design, create, modify, or publish dashboards.
 - 3. Support creation and configuration of kiosk slideshow displays to run independently on computer with browser in unattended mode, scrolling through designated dashboards at configurable time interval.
 - 4. Provide library of graphical objects (gadgets):
 - a. Standard: Include bar, pie, trend, real time, and web portal.
 - b. Specialized Energy Usage: Include period over period comparison, pareto charts, heat map/carpet plot, and sankey diagrams.
 - 5. Provide interactive, web-enabled interactive reports application with capability to generate, modify, save, and manage reports based on up to 64 pre-formatted report templates for:
 - a. Energy billing, verification, and allocation.
 - b. Energy management and performance.
 - c. Power quality performance and compliance.
 - d. Operation and performance for electrical equipment, such as breakers, UPSs, and generators.
 - 6. Support automatic distribution of reports via email or shared folder on scheduled basis, based on event, or manual export including .csv, .xlsx, .pdf, .tiff, .html, and .xml formats.
- N. Technical Infrastructure:
 - 1. Support installation on physical computer or virtual machine, on Server and non-Server class Windows operating systems.
 - 2. Support SQL Server, including Enterprise, Standard, and Express editions.
 - 3. Only require SQL Server Database Engine Services and Basic Management Tools; do not require additional SQL components, such as Analysis Services or Reporting Services.
 - 4. Cybersecurity:
 - a. Support secure development lifecycle product development processes.
 - b. Support minimum of two-factor authentication.
 - c. Support two-factor or multi-factor authentication on isolated networks without Internet access.
 - d. Support encrypted transmission of data between software platform server and web clients using transport layer security (TLS) version 1.3.

- e. Support secure authentication between software platform server and web clients using certification authority (CA) certificates.
 - f. Support encryption and hashing of system credentials using AES256 and SHA-512, respectively.
 - g. Support installation in environment complying with Federal Information Processing Standards (FIPS).
 - h. Support application whitelisting.
 - i. Encrypt transmission of data between software platform primary node and secondary node using transport layer security (TLS) version 1.3.
 - j. Support security events in SYSLOG format.
 - k. Support digitally signed files for verification of authenticity of installed software.
- 5. Provide capability of operating in network environment with configurable firewalls that perform deep packet inspection for Modbus communications.
 - 6. Support integration of Windows Active Directory for users and groups across multiple domains, including:
 - a. Login using Windows credentials.
 - b. Enforcement of password complexity and expiration policies via Windows.
 - c. Role-based access control (RBAC).
 - 7. Support definition and mass deployment of role-based access control (RBAC) settings for software and connected system devices.
 - 8. Provide capability to log up to 100,000 tags of historical data at 1-minute intervals and store up to 2 years of data; provide access to data via Single Device Usage, Multi Device Usage, and Trend and Tabular reports that can be formatted as XML, Excel, Word, or PDF documents.
 - 9. Automatically acquire device data, including onboard events, trends, and waveforms, from natively supported device types without software configuration or data upload scheduling.
 - 10. Retrieve onboard, high-resolution (1 ms) timestamps of one-millisecond accuracy without degradation or modification, including devices supporting clock synchronization via GPS, IRIG-B, NTP, or precision time protocol (PTP).
 - 11. Retrieve timestamp quality status directly from supported devices.
 - 12. Device-Level Modbus Integration:
 - a. Support dynamic scaling of register values without requiring separate scaling register to perform value scaling for power and energy data.
 - b. Modbus master to read/write registers in Modbus devices for monitoring and control applications.
 - c. Support creation of Modbus device definitions/device drivers for integration of third-party Modbus protocol devices.
 - 13. Support specialized diagnostics user interface designed for power management that displays power devices, automatically highlighting errors and potential causes of underperformance.
 - 14. Support sharing of OPC AE Server alarm and event data with OPC AE compliant systems.
 - 15. OPC Data Access Server 2.01 Support:
 - a. Provide default OPC server tag mappings for natively supported device types without requiring selection, configuration, or programming mapping of device registers to OPC tags.
 - b. Add or change OPC mappings or add custom measurements.
 - 16. Support OPC Data Access Client 2.01 real-time interoperability.

17. Support OPC Unified Architecture Client and Server for data sharing between OPC UA compliant systems.
 18. Support integration of web applications into web interface via pluggable web content widgets.
 19. Provide reporting and dashboard web applications simultaneously accessible from their own individual web addresses to support embedding into other web-based software environments.
 20. Web Services Interoperability:
 - a. Web services server to share real-time, historical (i.e., timestamped trend data), and alarm (i.e., timestamped event strings) data to other web services client applications.
 - b. User interface for web services configuration and mapping.
 - c. Ability to acknowledge alarms by authenticated and authorized clients.
 21. Provide extract, transform, and load (ETL) engine to exchange data between files, databases, and systems, including:
 - a. User interface to specify connection information, data formats, measurement mappings, and schedules.
 - b. Support for importing data from .csv and .xml data files, AVEVA Historian databases, and third-party databases via OleDb connections.
 22. Support function without disruptions including communications, logging, and alarming:
 - a. Support installation and availability of software components on primary and secondary nodes.
 - b. Software components on secondary node not to process data or requests to avoid double polling of connected devices.
 - c. Mirror data in near real time; provide both nodes with identical data. Support replication of data with recovery time in seconds automatically if primary node is unavailable (hot-standby).
 - d. Provide capability to achieve up to eight times device redundancy per connected device.
 - e. Synchronize and backfill historical data and in data historian following primary node failover recovery.
 23. Provide single end-user software application specifically designed for integrating Modbus, IEC 61850 (SET), IEC 60870-5-104, and DNP3 device types.
 - a. Support creation and management of device definitions/drivers.
 - b. Support predefined, default measurement system (common data model) for consistent mapping of Modbus, IEC 61850 (SET), IEC 60870-5-104, and DNP3 tags to standard measurements.
 24. Support integration of IEC 61850 (SET), Modbus, or IEC 60870-5-104 devices via import of system configuration document (SCD) file complying with IEC 61850-6.
 25. Support offline software configuration management for efficient system deployments and upgrades.
 26. Support internationalization and regional settings.
 27. Provide factory support for multiple languages, including Chinese (simplified), English, French, German, Russian, Spanish, Norwegian, and Swedish.
 28. Support ability to change default language directly from web client without need for additional installation or advanced software configuration.
 29. Provide web-accessible, self-paced training content and documentation on configuration and operation of software platform.
- O. System Optimization:
-

1. Provide set of specialized power analytics and reporting tools designed to help service professionals evaluate configuration and performance of EPMS, diagnose specific power system problems, and suggest recommended actions based on probable causes.
2. Analytics and Reporting Tools:
 - a. Certify as part of energy data management system in accordance with data validation requirements of ISO 50001.
 - b. Diagnose data quality and power monitoring system configuration issues and suggest probable causes:
 - 1) Device removed or not logging requested measurements.
 - 2) Lost or intermittent device communications.
 - 3) Multiple devices assigned to same connection information.
 - 4) Load removed or repair needed.
 - 5) Current transformer shorting blocks left closed or voltage disconnects left open.
 - 6) Tripped breaker.
 - 7) Pulse counter malfunction.
 - 8) Control system malfunction.
 - 9) Current transformer polarity error.
 - 10) Dual load/generator or generator operation during reporting period.
 - 11) Metering device has multiple or high-frequency logging triggers configured.
 - 12) Mismatch of measurement units across system metering devices.
 - 13) Mismatch of logging interval across system metering devices.
 - c. Diagnose power monitoring system energy balance problems and suggest probable causes:
 - 1) Submeters not fed by current meter.
 - 2) Incorrect device names or communication information.
 - 3) Power meter misconfigured current transformer or potential transformer ratio.
 - 4) Main power meter or submeter incorrect phase wiring.
 - 5) Miswired or disconnected phase.
 - 6) Locally generated power reported as consumed power.
 - 7) Nonradial distribution system.
 - 8) Current transformer too large to accurately measure load.
 - d. Diagnose and report power quality issues:
 - 1) Overvoltage/undervoltage.
 - 2) Voltage imbalance.
 - 3) Transformer overcapacity.
 - 4) Excessive voltage and current harmonic distortion.
 - 5) Excessive lagging power factor.
 - e. Make suggestions for harmonic mitigation equipment suitable to counteract detected chronic excessive harmonics conditions.
 - f. Make suggestions for mitigation equipment suitable to counteract detected excessive lagging power factor conditions and estimate return on investment for equipment installation compared to estimated utility power factor penalties.
3. System Optimization Service:
 - a. Delivered by power management service professionals from EPMS supplier or certified system integrator partner organization.
 - b. Provided at minimum twice annually at approximately six-month intervals.

- c. Capable of being applied to existing EPMS systems without requiring system to be upgraded or connected to internet.

P. Products:

- 1. Schneider Electric; Square D EcoStruxure Power Operation; www.se.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine equipment exterior and interior for damage, including but not limited to, structure, moisture, and mildew.
- B. Examine for conditions detrimental to completion of work.

3.02 INSTALLATION

- A. Install equipment in accordance with manufacturer's written instructions.
- B. Install equipment in accordance with NECA 1.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.
 - 1. Include necessary material, equipment, labor, and technical supervision.
 - 2. On-site commissioning to be performed by factory-trained personnel using automated commissioning tools.
 - 3. EPMS manufacturer to provide trained and certified project manager during project installation and commissioning.
 - 4. For control applications, such as automatic transfer, include verification of approved sequence of operation in both manual and automatic modes. Include testing of source outage and breaker exercising.
 - 5. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.
 - 6. Identify EPMS equipment with label indicating inspection/testing agency and date of service.

3.04 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for additional submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.
- C. Functional Demonstration Testing: As part of commissioning, manufacturer's field representative to demonstrate proper operation of EPMS and associated systems under normal operating conditions and simulated scenarios.
- D. Training:
 - 1. On-Site Training: Train Owner's personnel on operation and maintenance of system.
 - a. Accommodate minimum of four attendees.
 - b. Provide not less than two repeated sessions with four hours of hands-on training.
 - c. Training Reference: Provide training manuals for each student; include agenda, defined objectives for each lesson, detailed description of subject matter , and descriptive labs to complete hands-on exercises.
 - d. Instructor: Factory-trained manufacturer's representative with direct experience with EPMS.

2. Provide sufficient time and detail in each session to cover the following at minimum:
 - a. Operation theory.
 - b. Major equipment components.
 - c. System and software function and operation.
 - d. Definition and use of various system data, such as energy, demand, power factor, load profile, time of use, and KYZ.
 - e. System architecture and communications methods.
 - f. System optimization.
 - g. Electric meter function and operation.
3. Additional Training Sessions:
 - a. Instructor-led, remote web-based training providing real-time interaction with trainer using virtual servers to perform labs and exercises.

3.05 PROTECTION

- A. Protect installed EPMS equipment from subsequent construction operations.

3.06 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements relating to maintenance service.
- B. See Section 260160.13 for additional information.
- C. Provide to Owner, as alternate to base bid, separate contract for switchgear service plan for two years from date of Substantial Completion including, but not limited to, dedicated customer success management team, priority remote and on-site (within 100 miles of service location) expert support, discounted service rates, continuous monitoring and alarming, online training.

END OF SECTION

SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Occupancy and Daylighting Sensor Control
 - 2. Daylight Photocells
 - 3. Emergency Lighting Control
- B. Control Intent – Control Intent includes, but is not limited to:
 - 1. Defaults and pre-defined calibration settings for such items as daylighting, occupancy sensor times, sensitivity, fade rates, etc.
 - 2. Wallstation pre-defined control sequences
 - 3. Daylight sensor and switching zones

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.
 - 1. Includes finish requirements for wall controls specified in this section.
 - 2. Includes accessory receptacles, switches, dimmers and wall plates, to match lighting controls specified in this section.
- F. Section 265100 - Interior Lighting.
- G. Section 265600 - Exterior Lighting.

1.03 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) (www.ansi.org and www.ieee.org)
- B. Underwriter Laboratories of Canada (ULC) (www.ulc.ca)
- C. International Electrotechnical Commission (www.iec.ch)
- D. International Organization for Standardization (ISO) (www.iso.ch):
- E. National Electrical Manufacturers Association (NEMA) (www.nema.org)
- F. WD1 (R2005) - General Color Requirements for Wiring Devices.
- G. NEMA WD7 -
- H. Underwriters Laboratories, Inc. (UL) (www.ul.com):
 - 1. 508 – Industrial Control Equipment.
 - 2. 924 – Emergency Lighting
 - 3. 2043 – Plenum

1.04 SYSTEM DESCRIPTION & OPERATION

- A. The Lighting Control and Automation system as defined under this section covers the following equipment:
 - 1. Room Controller System – Pre-defined solutions to meet typical applications. The NX Network system includes defined equipment shown below
 - 2. Room Controllers – Pre-configured, three relay controllers with 0-10 volt control for ballasts (if applicable) with integral UL924 emergency relay (if applicable), that NX smart devices connect to over the NX communications network
 - 3. Occupancy Sensors – Auto adjusting, MicroSet technology NEMA WD7 compliant occupancy sensors
 - 4. Wallstations – Smart device that is pre-configured, pre-engraved digital pushbutton wallstations, dimmers, and scene switches
 - 5. NX communication network – Pre-defined lengths of QuickConnect cable (RJ45) for power and data to smart devices.

1.05 LIGHTING CONTROL APPLICATIONS

- A. Minimum lighting control performance required, unless local Energy Code is more stringent.
 - 1. Occupancy requirements – Provide an occupancy/vacancy sensors with Automatic On/ Automatic Off functionality in all spaces. Automatic On of lighting via occupancy sensor cannot exceed 30% of lighting. Systems that do that allow the user to select Occupancy mode shall not be acceptable.
 - 2. Daylit Zones – Primary sidelighted or toplighted areas within an enclosed space shall be controlled separately and automatically by a multilevel photocontrol device without the need for programming. Adjustments to the daylight zones must be provided by a simple to use intuitive remote handheld device.
 - 3. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to dim electric light to the lowest light level.
 - 4. Provide the ability to adjust the high end and low end trim of the dimmers to ensure the lighting automatically provides energy saving even when daylighting calls for full illumination.
 - 5. Provide the ability for the dimmers and the relays to function separately. Systems where the 0-10V dimmers and relays are tied together reduce design capabilities and shall not be acceptable.

1.06 PERFORMANCE REQUIREMENTS

- A. The Room Controller system shall be accompanied by: Recessed or Suspended luminaires specified as LED with defined CRI, and lumen output, provided by the same manufacturer as the control systems.
- B. The Room Controller system shall include: The Room Controller NX, Entry and wallstations (up to four), matching color screwless wallplates, Occupancy Sensors (up to two), QuickConnect cable (plenum or non-plenum pre-terminated and defined for package),

1.07 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections of 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.

1.08 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.
- C. Product Data: Catalog sheets, specifications and installation instructions.
- D. Shop Drawings:
 1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).
 2. Scale drawing for each area showing exact location of each sensor, room controller, and digital switch.
- E. Field Quality Control Reports.
- F. Operation and Maintenance Data: Include detailed information on device programming and setup.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 - Product Requirements, for additional provisions.
- H. Project Record Documents: Record actual installed locations and settings for lighting control devices.
- I. Include data for each device which:
 1. Indicate best mounting and installation locations for each device, this may be contained within drawings or installation instructions depending upon the project.
- J. Warranties: Standard and special warranty information

1.09 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer: Minimum [10] years experience in manufacture of lighting controls.
- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

- F. Products: All electrical components and devices shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency and marked for intended use.
- G. Comply with NFPA 70

1.10 DELIVERY, STORAGE AND HANDLING

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.
- B. The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements.
- C. Packaging: All components of the lighting control system shall be packaged in a single box as a QuickKit. The catalog number will be marked on package label along with bill of materials.
- D. Storage: Packaging labeling will provide a space for the receiver to clearly mark the room number/location for the lighting controls to be installed.
- E. Handling: Packaging labeling will clearly include an image of the Current NX Lighting defined AutoCAD block for this QuickKit package. The installing contractor can easily match each package to the AutoCAD block on the design floor plans.

1.11 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 0° to 40° C (32° to 104° F).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.
- B. Coordinate layout and installation of luminaries and controls with other construction.
- C. Coordinate site commissioning with manufacturer no less than 21 day prior to required date.

1.12 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer shall supply a 5-year warranty on all hardware and software. These warranties will be in affect for all installations. Systems that provide special warranties based on installation shall not be acceptable.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer:
 - 1. Current NX Lighting Controls
 - a. System: Room Controller NX Series
 - b. Or approved Equivalent
 - 2. Basis of design product: Current NX Lighting Controls Room Controller or subject to compliance and prior approval with specified requirements of this section, one of the following:
 - a. Current Controls Room Controller NX Series or equal
- B. Substitutions:
 - 1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.

2. Any substitutions provided by the contractor shall be reviewed at the contractor's expense by the electrical engineer at a rate.
3. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.02 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 the complete operating system.

2.03 WALL OR CEILING MOUNTED OCCUPANCY PERFORMANCE REQUIREMENTS

- A. Sensing mechanism:
 1. [Dual technology]:
 - a. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
 - b. Utilize an operating frequency of 32 kHz or 40 kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
 - c. Incorporate Doppler shift ultrasonic and passive infrared motion detection technologies. Products that react to noise or ambient sound shall not be considered.
- B. Power failure memory:
 1. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.
- C. Designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.
- D. Products tested in identical manner, complaint to NEMA WD 7 -2011 Occupancy Motion Sensors Standards.
- E. Sensor shall have time delays from 8 to 30min.
- F. When specified, sensors shall automatically adjust time delay and sensitivity settings.
- G. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
- H. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.

2.04 CEILING MOUNTED SENSORS

- A. Product: NXOS-OMNIDT2
- B. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
- C. Provide all necessary mounting hardware and instructions.
- D. Sensors shall be Class 2 devices.
- E. Connect to Room Controller via Click & Go cable to eliminate wiring errors.
 1. NX Room Controller accessory is used to allow any standard Occupancy/ Vacancy Sensor to utilize Click & Go cable connections.
 2. Two RJ45 connection ports for connection to Room Controller

3. Occupancy Sensor and Daylight sensor shall be capable of a daisy chain connection to the Room Controller
- F. Device calibration and features
 1. Sensitivity – 0-100% in 10% increments
 2. Time delay – 1-30, self-adjusts to 8 min based on room occupancy
 3. Test mode – Fifteen second time delay
 4. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 5. Walk-through mode
 6. Dual Technology Sensors utilizes two independent sensor detection circuits simultaneously to ensure optimum performance regardless of location or proximity to walls and structures.
 7. Dual Technology Sensors utilize Variable Drive Circuitry (VDC) in cases of over saturation from misapplication, which automatically adjusts the volumetric output without reducing detection capability. Systems that reduce detection coverage area shall not be acceptable.
 8. Automatically and continually self-adjust ultrasonic frequency to ignore specific frequency continuous noise from airflow to prevent detuning which can lead to inadvertent lights out. Sensors that require detuning shall not be acceptable.
 9. All load parameters including Automatic-On/Manual-ON, blink warning, and daylight enable/disable when daylight sensors are pre-defined with the Room Controller local network.
- G. Device Status LEDs including:
 1. PIR Detection
 2. Ultrasonic detection
- H. Occupancy sensor are pre-defined to specific loads within the room without wiring or special tools for maximum energy savings.
- I. Manual override of controlled loads.
- J. Multiple occupancy sensors may be installed in a room by simply daisy chaining them together to the Room Controller via Click & Go cable. No additional configuration will be required
- K. Where specified, sensor packaging shall be 100% recycled [made entirely from post consumer waste (100% post consumer fiber content) as well as, 100% recyclable].
- L. Sensors shall be RoHS compliant.

2.05 LOW VOLTAGE ROOM CONTROLLER DIGITAL WALLSTATIONS

- A. Low voltage momentary pushbutton switches in 2 or 4, button configuration; white switch with stainless steel brushed metal wall plates with decorator opening. Wallstations shall include the following features:
 1. Removable buttons for field replacement with engraved buttons and/or alternate color buttons [ENGRV-*BTNL-*],[ENGRV-*BTNS-*]. Button replacement may be completed without removing the switch from the wall.
 2. Intuitive button labeling to match application and load controls. Buttons shall have up/down (RAISE/LOWER) arrows and ON/OFF custom engraved buttons.
- B. Two RJ-45 ports for connection to the Room Controller (Power Pack PP)local network.
- C. Multiple digital wallstations may be installed in a room by simply connecting them to the Room Controller local network. No additional configuration will be required to achieve multi-way switching.

- D. Room Controller digital wallstations are delivered with pre-defined functions including, raise, lower, A/V mode, Quiet Time, manual and scene control. No additional configuration is required to provide a fully functional system. Systems that require configuration or load binding and do not deliver maximum energy savings out of the box shall not be acceptable.
- E. Optional custom labeling is available for application or location specific wallstation button labels.
- F. Current NX Lighting Controls Wall switch: 4 button – ON/Raise/Lower/Off switch position. Catalog numbers: NXSW – ORLO-WH. (White Finish)
 - 1. Substitutions: See Section 016000 - Product Requirements.

2.06 DUAL TECH WALL SWITCH SENSOR

- A. Dual tech wall switch sensor
 - 1. Digital dual tech: (US) and (PIR) sensors.
 - 2. Single gang..
 - 3. IntelliDAPT self-adaptive tech – no manual adjustment required.
 - 4. Dual circuit has isolated relays
 - 5. Occupancy (auto-on) and Vacancy (manual-on) operating modes
 - 6. 1000 square-foot, 180degree coverage area
 - 7. RhinoTuff vandal resistant lens
 - 8. No minimum load requirement
 - 9. Five-year limited warranty
 - 10. Low voltage device:24vdc
 - 11. Construction: High impact injection molded plastic
- B. Current NX Lighting Controls: LHMTS 1 - G-WH (White Finish)
 - 1. Substitutions: See Section 016000 - Product Requirements.

2.07 HANDHELD REMOTE CONTROLS

- A. Battery-operated handheld 10 button configuration for remote daylight sensor configuration. Remote controls shall include the following features:
 - 1. Two-way infrared (IR) transceiver for line of sight communication with the Room Controller daylight sensors within up to 30 feet.
 - 2. Red communication LED on the daylight sensor confirms button press.
 - 3. Inactivity timeout to save battery life.
- B. Three intuitive daylight sensor range push buttons.
- C. Intuitive daylight zone adjustment raise/lower pushbuttons
- D. Current NX Lighting Controls

2.08 ROOM CONTROLLERS (PP)

- A. Room Controllers are fully functional out of the box to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will include line voltage wiring space and will not require additional electrical junction boxes. The control units will include the following features:
- B. Fully functional room configuration to the most energy-efficient sequence of operation based upon the connected devices in the room.
- C. Simple replacement – Using the automatic configuration capabilities, a Room Controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.

- D. Quick installation features including:
 - 1. Included line voltage space to simplify wiring and eliminate the need for separate junction boxes.
 - 2. Included emergency voltage space to simplify wiring of emergency luminaire connections.
 - 3. Breakouts for direct conduit connection.
 - 4. Line and low voltage sections include conduit connection points. Systems that require special accessories for direct conduit connections may not comply with local building codes and shall not be acceptable.
 - 5. Quick low voltage connections using standard RJ-45 QuickConnect cable
 - 6. Plenum rated
 - 7. Dual voltage (120/277 VAC, 60 Hz)
 - 8. Zero cross circuitry for each load.
 - 9. Three relay configuration
 - 10. Efficient 150 mA switching power supply
 - 11. Six RJ-45 Click & Go local network ports
 - 12. All models support local network connections of wallstations, occupancy-based controls and receptacle controls.
- E. On/Off/Dimming Room Controllers shall include:
 - 1. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
 - 2. All models support local network connections of wallstations, occupancy-based controls and receptacle controls.
 - 3. 2 SPST Switched, 2 0-10V analog outputs dimming controls of compatible ballasts and LED drivers.
 - 4. Current NX Lighting Controls: NXRC 2RD UNV.
 - a. Substitutions: See Section 016000 - Product Requirements.

2.09 DAYLIGHT PHOTOSENSORS

- A. Daylight photosensors work with Room Controllers to provide automatic daylight dimming capabilities for any load type connected to a room controller. Open loop daylight sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Daylight sensors shall be interchangeable without the need for rewiring. Daylight sensors shall be capable of daisy chaining with occupancy sensors in each room.
- B. Digital daylight sensor include the following features:
 - 1. An internal photodiode that measures only within the visible spectrum, and has a response curve that closely matches the photopic curve.
 - 2. The daylight sensor has three light level ranges: Foot candle Range 3-6,000 fc
 - 3. For dimming daylight harvesting, the daylight sensor shall provide the capability of controlling multiple (up to three) daylight zones immediately upon connection without programming.

2.10 UNIVERSAL VOLTAGE POWER PACKS

- A. Power Pack
 - 1. Universal voltage:100-277VAC; 50/60HZ
 - 2. Automatic voltage detection
 - 3. Electrical load switching capacity: maximum of 20amps
 - 4. Regulated 24VDC current; 150mA output
 - 5. Zero Arc Point Switching
 - 6. Plenum rated

7. Mounts: inside or outside a junction box; inside fixture
8. Available with exclusive Quick-to-install (QTI) connector
9. Companion aux relay device available (MPSA)
10. UL and cUL listed
11. Five-year limited warranty
12. Low voltage device: 24VDC.
13. Manual on/off control

B. Current NX Lighting Controls: UVPPM

2.11 ROOM CONTROLLER LOCAL NETWORK

- A. The Room Controller local network is a physical connection and communication protocol designed to optimally control a space within a building. Room Controller devices connect to the local network using CAT 5e cables with RJ-45 QuickConnect cables which provide both data and power to room devices. Features of the Room Controller local network include:
1. Click & Go default functionality of occupancy sensors, wallstations, slider station, daylight sensors, receptacle controls, BMS status output and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 2. Replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.

2.12 FINISHES

- A. Device Color:
1. Wiring Devices (normal): White in all area unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wall Plate Color: All cover plates in areas of renovations shall be brushed stainless steel.
- B. Wall plates in all other areas shall be brushed stainless steel.

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 in 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 prior to starting work.

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.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switch Occupancy Sensors: 48 inches above finished floor.
 - 2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
 - 3. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- C. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- D. The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits.
- E. All low voltage smart devices shall connect using QuickConnect wire provided by Current NX Lighting Controls. When using wire for connections other than the QuickConnect low voltage wire (pre-defined lengths of RJ45 cable), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements.
- F. Install lighting control devices plumb and level, and held securely in place.
- G. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.
- H. Provide required supports in accordance with Section 260529.
- I. 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 opening. Do not use oversized wall plates in lieu of meeting this requirement.
- J. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
- K. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- L. Identify lighting control devices in accordance with Section 260553.
- M. 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 to 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.

N. 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.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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 damages 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. Adjust position of directional occupancy sensors to achieve optimal coverage as required.
- D. 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.
- E. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect. Record settings in written report to be included with submittals.
- F. 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 PRODUCT SUPPORT AND SERVICE

- A. Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment

3.08 FACTORY COMMISSIONING

- A. The system manufacturer shall provide a factory authorized field engineer to the project site after installation has been completed and prior to system energization for the purpose of testing and adjustment of the system for a minimum of 2 full days. Factory field engineer shall test and verify all system functions and ensure proper operation of the system components in accordance with the specifications and on-site conditions. The installing contractor shall notify the system manufacturer in writing that the system is completely wired and ready to be energized and tested 2 weeks prior to scheduling a field engineer for start-up of the system. Should the field engineer arrive on the job site and find the installation incomplete, the installing contractor shall pay the cost of any future visits by the field engineer required to complete the system start-up.
- B. During the start-up procedure, the factory field engineer shall provide programming assistance and guidance to the building operating personnel in order to program the systems for initial operation.
- C. Allow for up to 4 hours of on-site training on the use and maintenance of the lighting control system to be scheduled at the completion of startup and programming of the system.

3.09 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 lighting control devices to Architect, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of 4 of training.
 - 3. Instructor: Manufacturer's authorized service representative.
 - 4. Location: At project site.

END OF SECTION

**SECTION 262416.11
PANELBOARDS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Lighting and appliance panelboards.
- B. Molded case circuit breakers.

1.02 RELATED REQUIREMENTS

- A. Section 260913.33 - Electrical Power Management System.
- B. Section 260913.83 - Condition Monitoring Services - Schneider Electric Square D EcoStruxure Asset Advisor.
- C. Section 262713.13 - Power and Energy Meters - Schneider Electric PowerLogic.

1.03 ABBREVIATIONS AND ACRONYMS

- A. CT: Current transformer.
- B. MVP: Measurement and Verification Panelboard.

1.04 DEFINITIONS

- A. Panelboards may also be identified as LP (lighting panelboard).

1.05 REFERENCE STANDARDS

- A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011 (Reaffirmed 2017).
- B. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).
- C. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).
- D. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015, with Amendment (2024).
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NEMA PB 1 - Panelboards; 2011.
- G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less; 2023.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.
- J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- L. UL 67 - Panelboards; Current Edition, Including All Revisions.
- M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- N. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Digital Model Support:
 - 1. Contractor to provide required support for digital first/digital continuity approach employed for all project stages from design through commissioning to operation and maintenance.
 - 2. Electrical system design and analysis software was used to model, design, and analyze facility electrical power network. Digitized network model will be made available to Contractor to enable end-to-end life cycle management of various project assets.
 - a. Basis of Design: ETAP by Operation Technology, Inc: www.etap.com/#sle.
 - 3. Alternate digital tools proposed must be fully compatible with digitized network operational model provided, with ability to import and integrate design project file and libraries supplied by specifier, and upgradeable to digital twin to facilitate integrated and unified model from design and analysis to operation and maintenance.
 - 4. Resulting digital twin technologies will help predict outcomes of operation and maintenance activities with model-driven applications for predictive simulation, operator training simulator/simulation before operation integration with electrical power management and control or SCADA software.
 - 5. See Sections 260160.23, 260573.10, and 260913.83 for additional requirements.

1.07 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
 - B. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.
 - C. Indicate deviations from Contract Documents with reference to corresponding drawing or specification number and written justification for deviation.
 - D. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, components, and accessories.
 - E. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, instruments, features, and accessories.
 - 1. Include details for environmental protection, interior mounting dimensions, and wiring gutter dimensions.
 - 2. Indicate location of main, branch circuits, and solid neutral, where applicable.
 - 3. Include one-line diagrams with applicable voltage systems.
 - F. Operation and Maintenance Data:
 - 1. Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - 2. Manufacturer's installation instructions and NEMA PB 1.1.
 - G. Executed warranty.
 - H. Project Record Documents:
 - 1. Digitized network operational model, updated to as-installed and commissioned state.
 - I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
 - 1. See Section 016000 - Product Requirements for additional provisions.
 - 2. Panelboard Keys: One for each lock.
 - 3. Tools: Manufacturer-specific special tools required to install, remove, test, and maintain panelboard components.
-

- a. Equipment Configuration Software: PC-based or mobile device application; provide one of each different communication interface cable required to connect computer/device configuration and programming.

1.08 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70.
 - 2. Requirements of local authorities having jurisdiction.
 - 3. Applicable local codes.
- B. Manufacturer Qualifications:
 - 1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 50 years.
 - 2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.
 - 3. Service, repair, and technical support services available 24 hours per day, 7 days per week from manufacturer or their representative.
 - 4. Certified in accordance with ISO 14001.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.
- B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.
- C. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.
- D. Inspect products and report concealed damage or violation of delivery, storage, and handling requirements to Engineer.

1.10 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.11 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for 12 months from date of commissioning or 18 months from date of shipment, whichever comes first. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Electric; Square D NQ and NF; www.se.com/#sle.
- B. Substitutions: See Section 016000 - Product Requirements.

- C. Source Limitations: Furnish products produced by same manufacturer as other electrical distribution equipment for project and obtained from single supplier.

2.02 LIGHTING AND APPLIANCE PANELBOARDS

- A. Basis of Design: Schneider Electric; Square D NQ and NF; www.se.com/#sle.
- B. Comply with NEMA PB 1; listed and labeled as complying with UL 67.
- C. Short Circuit Current Rating: Where not specified, provide panelboards with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.
- D. Provide panelboards marked for use as service equipment where required for application.
- E. Panelboard Interiors:
1. 240 VAC Maximum Panelboards:
 - a. Continuous main current ratings up to 600 A.
 - b. Available Circuit Capacity: Up to 84 circuits.
 - c. Minimum Short Circuit Current Rating:
 - 1) 240 VAC:
 - (a) Series Rated: 22 kA.
 - d. Provide branch circuit connectors suitable for both plug-on and bolt-on branch circuit breakers.
 - e. Circuit Breaker Orientation:
 - 1) Main Circuit Breakers up to 150 A: Horizontally mounted.
 - 2) Main Circuit Breakers up to 600 A: Vertically mounted.
 - 3) Sub-Feed Circuit Breakers: Vertically mounted.
 - f. Products:
 - 1) Schneider Electric Square D NQ.
 - 2) Substitutions: See Section 016000 - Product Requirements.
 2. 208Y/120 VAC Maximum Panelboards:
 - a. Continuous main current ratings up to 800 A.
 - b. Suitable for use in lower potential AC voltage systems.
 - c. Available Circuit Capacity: Up to 84 circuits in one interior; up to 54 circuits with continuous bus bar.
 - d. Minimum Short Circuit Current Rating:
 - 1) 208Y/120 VAC:
 - e. Circuit Breaker Orientation:
 - 1) 208Y/120 VAC:
 - (a) Main Circuit Breakers up to 125 A: Horizontally mounted.
 - (b) Main Circuit Breakers up to 800 A: Vertically mounted.
 - 2) Sub-Feed Circuit Breakers: Vertically mounted.
 - f. Products:
 - 1) Schneider Electric Square D NF.
 3. Bussing:
 - a. Provide sequentially phased branch circuit connectors for each bus bar.
 - b. Provide fully rated bussing with one continuous bus bar per phase, unless otherwise indicated.
 - 1) Split-Bus and Separated-Distribution Panelboards:
 - (a) Provide one continuous bus bar per phase for each branch distribution section.

- (b) Split-Bus Panelboard Sections: Connected from upstream lugs or branch circuit breaker to one back-fed main circuit breaker in downstream section.
 - (c) Separated-Distribution Panelboard Sections: Connected via removable, stranded copper cables, secured via mechanical lugs on each section.
 - c. Determine bus current ratings in accordance with UL 67 heat-rise tests.
 - d. Maximum current ratings apply for main-lug-only or main-circuit-breaker panelboards.
 - e. Rated 100 A to 400 A: Plated copper.
 - f. Rated 600 A and Above: Plated copper.
 - g. Run bus bar plating entire length of bus bar.
 - h. Predrill interior phase bus to accommodate field-installed options (e.g., sub-feed lugs, sub-feed breakers, thru-feed lugs).
 - 4. Neutral:
 - a. Panelboards 20 inches Nominal and Wider: Plated, solid, and split.
 - b. Panelboards 14 inches Wide and Column Width: Plated and solid.
 - 5. Ground:
 - a. Provide solidly bonded copper equipment ground bar.
 - 6. Interiors in Type 1 and 2 Enclosures:
 - a. Field convertible for top or bottom incoming feed.
 - b. Provide interior leveling provisions for flush mounting applications.
 - 7. Interior Trim: Dead-front construction to shield energized parts, with filler plates to cover unused mounting spaces.
 - 8. Main-Lug Interiors up to 600 A: Field-convertible to main circuit breaker.
- F. Enclosures:
- 1. Comply with UL 50 and UL 50E.
 - 2. Key all lock assemblies alike.
 - 3. Mount clear plastic directory cardholder or welded metal frame directory cardholder on inside of door.
 - 4. Type 1 Enclosures:
 - a. Provide surface-mounted or flush-mounted enclosures as indicated on drawings.
 - b. Boxes:
 - 1) Hot zinc dipped galvanized steel; unpainted galvanized steel is not acceptable.
 - 2) Provide removable end walls with knockouts at one end.
 - 3) Provide standard 5.75-inch deep enclosures with permanently affixed interior mounting studs; provide interior mounting brackets as required.
 - 4) Box Width:
 - (a) Standard Box Width: 20 inches; provide box widths of 26 inches or 27 inches where required by application.
 - c. Fronts:
 - 1) Finish: ANSI 49 gray enamel paint baked onto cleaned, phosphatized steel.
 - 2) Provide one-piece fronts with door.
 - 3) Provide doors with rounded corners and edges, free of burrs.
 - 4) Provide cylindrical tumbler-type lock with catch and spring-loaded steel door pull, quarter-turn fasteners, or three-point latch.
 - 5. Type 3R, 5, and 12 Enclosures:
 - a. Finish: ANSI 49 gray enamel paint baked onto cleaned, phosphatized steel.
 - b. Provide gasketed doors for Type 5 and Type 12 enclosures.

- c. Provide at least one L-Handle lock mechanism. For enclosures 59 inches or more in height, provide additional L-Handle mechanism or two additional quarter-turn fasteners.
 - d. Nominal Enclosure Dimensions:
 - 1) Type 3R, 5, and 12 Enclosures: 21 inches wide and 6.75 inches, excluding handle.
 - 2) Door-in-Door Type 12 Enclosures: 21 inches wide and 8.75 inches deep, excluding handle.
 - 3) Vented Type 3R Enclosures: 27 inches wide and 8.75 inches deep, excluding handle.
- 6. Type 4 and 4X Enclosures:
 - a. Provide gasketed doors.
 - b. Provide L-Handle lock mechanism.
 - c. Provide additional clamps or fasteners on top, bottom, and/or side for tight closure.
 - d. Nominal Enclosure Dimensions: 23 inches wide and 7.25 inches deep, excluding handle.
- G. Markings and Labeling:
 - 1. Provide identification and warning labels/nameplates exterior to equipment resistant to weather, UV, and intended installation environment.
 - 2. Provide engraved nameplate identifying project-specific equipment tag and service description.
 - 3. Provide warning labels/nameplates complying with ANSI Z535.4 at access locations to advise personnel of possible hazards in accordance with listing, NFPA 70, NFPA 70E, and other applicable standards.
 - 4. Provide nameplates containing system information and catalog number or factory order number.
 - 5. Display interior wiring diagram, neutral wiring diagram, and short circuit current rating on interior or in booklet format.
- H. Power Metering; Schneider Electric Measurement and Verification Panelboards (MVP):
 - 1. Factory installed, integrated within panelboards.
 - 2. Main Circuit Metering:
 - a. Utilize power meter to provide power metering for mains.
 - b. Power Meters:
 - 1) See Section 262713.13 for additional information.
 - 2) Capable of monitoring for network management, energy cost allocation, asset management, operational efficiency, and compliance reporting.
 - 3) Support communication via Modbus RTU, Modbus TCP/IP, Ethernet Modbus TCP/IP, or BACnet IP.
 - 4) Products:
 - (a) Schneider Electric PowerLogic PM5563 Meter.
 - c. Integrated within panelboard; face accessible without removing deadfront.
 - d. Support external data connection to monitoring software or application as stand-alone meter.
 - e. Metering Values: Including, but not limited to, current, current demand, energy (kWh), power demand (kW), power factor, voltage, and frequency.
 - f. Provide device event alarming with standard alarms for over/under voltage, over/under current, and phase loss.

3. Branch Circuit Metering:
 - a. Utilize integrated panelboard multi-circuit meter to provide power metering for main and all individual branch circuits.
 - b. Integrated Panelboard Multi-Circuit Meters:
 - 1) See Section 262713.13 for additional information.
 - 2) Capable of monitoring mains and branch circuits for network management, energy cost allocation, and compliance reporting.
 - 3) Support communication via Modbus RTU, Modbus TCP/IP, BACnet/IP, or SNMP.
 - 4) Products:
 - (a) Schneider Electric PowerLogic BCPM series.
 - (b) Schneider Electric HPDM6000 series.
 - (c) Substitutions: See Section 016000 - Product Requirements.
 - c. Metering for All Individual Branch Circuits:
 - 1) Arrange CT strips arranged to clearly associate metered branch circuit with metering CT.
 - 2) Transmit CT data to power meter via RS-485 Modbus RTU or Ethernet.
 - 3) Metering Values for Main and Branch Circuits: Including, but not limited to, current, current waveform capture, current demand, total demand distortion, current total harmonic distortion, real energy (kWh), reactive energy (kVARh), apparent energy (kVAh), real power demand (kW), reactive power demand (kVAR), apparent power demand (kVA), power factor, voltage, voltage waveform capture, and frequency.
 - d. Provide device event alarming with standard alarms for over/under voltage, over/under current, and phase loss.
 - e. Where indicated on drawings, or where required by energy or electrical codes, provide integral gateway device for connectivity via Modbus TCP/IP for use with monitoring software.
- I. Electrical Power Management System Capabilities:
 1. See Section 26 0913.33 (EcoStruxure Power Operation on premises software) for additional requirements.
 2. Provide communications connectivity and functionality to support electrical power management system (EPMS), including but not limited to:
 - a. Communications connectivity via Ethernet network and protocols of EPMS and related equipment, either through communications gateway or integral interface.
 - b. Compliance with recognized cybersecurity requirements.
 - c. Breaker aging modeling for electronic trip circuit breakers.
 - d. Remote EPMS capability for equipment configuration, electrical power monitoring, power quality monitoring, compliance, and correction; alarm monitoring with event log.
 - e. Continuous thermal monitoring capabilities, including alarming, notification, and visualization.
 3. Provide factory-tested native software compatibility, including the following:
 - a. Capability for pre-engineered, interactive graphical display screens to view and analyze real-time device data.
 - b. Pre-mapping of registers to standard measurement names without need for additional configuration or internal device registers.

- c. Automatic collection and logging of device data by EPMS software without additional configuration.

2.03 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break circuit breakers with over-center, trip-free toggle mechanism; ratings, configurations, and features/accessories as indicated on drawings.
- B. Comply with FS W-C-375; listed and labeled as complying with UL 489.
- C. Interrupting Capacity: As required to provide short circuit current rating indicated.
- D. Multi-Pole Circuit Breakers: Provide common tripping for all poles.
- E. Thermal Magnetic Circuit Breakers:
 - 1. Provide permanent trip unit with thermal and magnetic trip elements in each pole.
 - 2. Thermal Elements: True RMS-sensing, factory calibrated to operate in 104 degrees F ambient temperature; ambient compensating above 104 degrees F.
- F. Vertically Mounted Main Circuit Breakers and Sub-Feed Circuit Breakers:
 - 1. Trip Units:
 - a. Up to 400 A: Thermal magnetic.
 - b. 150 A to 800 A: Electronic trip.
 - 2. Electronic Trip Units:
 - a. Basic Electronic Trip Units: Provide adjustable trip current.
 - b. Where indicated on drawings, provide electronic trip units with field-adjustable long-time and instantaneous protection settings.
 - c. Provide current transformers combining iron-core sensors for self-powered electronics and air-core, Rogowski coil sensors for measurement accuracy.
 - 3. Provide push-to-trip button for maintenance and testing purposes.
 - 4. Indicate rated ampacity on circuit breaker handle and faceplate.
 - 5. Listed for reverse connection without restrictive line or load markings.
 - 6. Frame Sizes Above 125 A: Provide single magnetic trip adjustment on front of circuit breaker to simultaneously select desired trip level of all poles.
 - 7. Provide escutcheon with international I/O markings in addition to standard ON/OFF markings.
 - 8. Lugs:
 - a. Listed to accept solid or stranded copper conductors only.
 - b. Listed to accept 75 degree C rated wire.
 - c. Bolt lug body in place; snap-in designs are not acceptable.
 - 9. Listed for use with the following accessories:
 - a. Shunt trip.
 - b. Undervoltage trip.
 - c. Ground fault shunt trip.
 - d. Auxiliary switch.
 - e. Alarm switch.
 - f. Mechanical lug kits.
 - g. Compression lug kits.
 - h. Handle Locking Provisions: For locking handle in ON or OFF position.
 - 10. Products:
 - a. Schneider Electric; Square D PowerPacT series.
 - b. Substitutions: See Section 016000 - Product Requirements.

- G. Horizontally Mounted and Back-Fed Main Circuit Breakers:
 - 1. Trip Units: Thermal magnetic.
 - 2. Operating Range: Between 14 degrees F and 140 degrees F.
 - 3. Branch Circuit Breakers in 240 VAC Panelboards:
 - a. Mounting: Bolt on or plug on to bus, without requiring additional external mounting hardware, except when installed into IP2X enhanced finger-safe interiors.
 - b. Available Nominal Current Ratings:
 - 1) Single-Pole Breakers: From 10 A to 70 A.
 - 2) 2-Pole Breakers: From 15 A to 125 A; up to 200 A in single-phase panelboards.
 - 3) 3-Pole Breakers: From 15 A to 125 A; up to 150 A for QOB-VH.
 - c. Products:
 - 1) Schneider Electric; Square D QO/QOB/QH/QHB.
 - 4. Provide two forms of visible trip indication:
 - a. Circuit breaker handle resides in position between ON and OFF.
 - b. Red Visi-Trip indicator appears in clear window of circuit breaker housing.
 - 5. Lugs:
 - a. Listed to accept solid or stranded copper conductors only.
 - b. Listed to accept 75 degree C rated wire.
 - 6. Listed for use with the following factory-installed accessories:
 - a. Shunt trip.
 - b. Auxiliary switch.
 - c. Alarm switch.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine equipment exterior and interior for damage, including but not limited to, structure, moisture, and mildew.
- B. Examine for conditions detrimental to completion of work.

3.02 INSTALLATION

- A. Install equipment in accordance with manufacturer's written instructions.
- B. Install panelboards in accordance with NECA 1 and NEMA PB 1.1.
- C. Maintain proper phasing for multi-wire branch circuits.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.
 - 1. Include necessary material, equipment, labor, and technical supervision.
 - 2. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.
- C. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- D. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads within 20 percent of each other.

- E. Inspect tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's written specifications.

3.04 PROTECTION

- A. Protect installed panelboards from subsequent construction operations.

3.05 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements relating to maintenance service.
- B. See Section 260160.13 for additional information.
- C. Provide to Owner, as alternate to base bid, separate contract for switchgear service plan for two years from date of Substantial Completion including, but not limited to, dedicated customer success management team, priority remote and on-site (within 100 miles of service location) expert support, discounted service rates, continuous monitoring and alarming, online training.

END OF SECTION

**SECTION 262713.16
POWER QUALITY METERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power quality meters.
- B. Metering cabinets.

1.02 RELATED REQUIREMENTS

- A. Section 260160.13 - Maintenance Services for Electrical Distribution Equipment - Schneider Electric EcoCare.
- B. Section 260913.33 - Electrical Power Management System.

1.03 ABBREVIATIONS AND ACRONYMS

- A. EPMS: Electrical power management system.
- B. PQ: Power quality.
- C. PTP: Precision time protocol.

1.04 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- B. ANSI C12.20 - American National Standard for Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes; 2022.
- C. CENELEC EN 50160 - Voltage Characteristics of Electricity Supplied by Public Electricity Networks; 2022.
- D. IEC 61000-4-7 - Electromagnetic Compatibility (EMC) – Part 4-7: Testing and Measurement Techniques – General Guide on Harmonics and Interharmonics Measurements and Instrumentation, for Power Supply Systems and Equipment Connected Thereto; 2002, with Amendment (2008).
- E. IEC 61000-4-30 - Electromagnetic Compatibility (EMC) - Part 4-30: Testing and Measurement Techniques - Power Quality Measurement Methods; 2015, with Amendments (2021).
- F. IEC 61000-6-5 - Electromagnetic Compatibility (EMC) – Part 6-5: Generic Standards – Immunity for Equipment Used in Power Station and Substation Environment; 2015 (Corrigendum 2017).
- G. IEC 61326-1 - Electrical Equipment for Measurement, Control and Laboratory Use – EMC Requirements – Part 1: General Requirements; 2020.
- H. IEC 61557-12 - Electrical Safety in Low Voltage Distribution Systems Up to 1 000 V AC and 1 500 V DC - Equipment for Testing, Measuring or Monitoring of Protective Measures - Part 12: Power Metering and Monitoring Devices (PMD); 2018 (Corrigendum 2022).
- I. IEC 61850 (SET) - Communication Networks and Systems for Power Utility Automation - All Parts; 2026.
- J. IEC 62053-22 - Electricity Metering Equipment - Particular Requirements - Part 22: Static Meters for AC Active Energy (Classes 0,1S,0,2S and 0,5S); 2020.
- K. IEC 62586-2 - Power Quality Measurement in Power Supply Systems – Part 2: Functional Tests and Uncertainty Requirements; 2017, with Amendment (2021).

- L. IEEE 519 - IEEE Standard for Harmonic Control in Electric Power Systems; 2022.
- M. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).
- N. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015, with Amendment (2024).
- O. ISO 50001 - Energy Management Systems – Requirements with Guidance for Use; 2018, with Amendment (2024).
- P. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- Q. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- R. UL 61010-1 - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements; Current Edition, Including All Revisions.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.
- C. Indicate deviations from Contract Documents with reference to corresponding drawing or specification number and written justification for deviation.
- D. Product Data: Provide manufacturer's standard catalog pages and data sheets for electricity metering systems and associated components and accessories. Include ratings, configurations, standard wiring diagrams, dimensions, service condition requirements, and installed features.
- E. Operation and Maintenance Data:
 - 1. Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- F. Executed warranty.
- G. Project Record Documentation:
 - 1. Digitized network operational model, updated to as-installed and commissioned state.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
 - 1. See Section 016000 - Product Requirements for additional provisions.
 - 2. Tools: Manufacturer-specific special tools required to install, remove, test, and maintain metering components.
 - a. Equipment Configuration Software: PC-based application; provide one of each different communication interface cable required to connect computer/device configuration and programming.
 - b. Equipment Configuration Files: For future upload into replaced/repaired components, in media format acceptable by Owner.

1.06 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70.
 - 2. Requirements of local authorities having jurisdiction.
 - 3. Applicable local codes.

B. Manufacturer Qualifications:

1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.
2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.
3. Service, repair, and technical support services available 24 hours per day, 7 days per week from manufacturer or their representative.
4. Certified in accordance with ISO 14001, with product environmental profiles (PEPs) for specified products.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.
- B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.
- C. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.
- D. Inspect products and report concealed damage or violation of delivery, storage, and handling requirements to Engineer.

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. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship. Complete forms in Owner's name and register with manufacturer.
 1. Power Quality Meters: 5 years from date of invoice.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Electric; PowerLogic; www.se.com/#sle.
- B. Source Limitations: Furnish products produced by same manufacturer as other electrical distribution equipment for project and obtained from single supplier.

2.02 GENERAL REQUIREMENTS

- A. List as complying with UL 61010-1.
- B. Certified for use in energy management systems in accordance with ISO 50001.
- C. Electromagnetic Compatibility:
 1. Comply with IEC 61000-6-5 and IEC 61326-1.
 2. Comply with FCC requirements of 47 CFR 15, Class B.

2.03 POWER QUALITY METERS

- A. Capable of monitoring for network management, energy cost allocation, power quality analysis, asset management, operational efficiency, and compliance reporting.
- B. Voltage and Current Inputs:
 - 1. Support direct connection of low-voltage circuits up to 600 VAC without requiring voltage (potential) transformers.
 - 2. Provide four metered 5 A nominal current inputs for 3-phase measurement plus neutral; control power voltage range of 90-415 VAC/120-300 VDC or 20-60 VDC.
- C. Measured and Calculated Metering Parameters: Support full range of 3-phase voltage, current, power, and energy measurements, total harmonic distortion (THD), and individual current/voltage harmonics readings.
- D. Measurement Accuracy:
 - 1. ANSI C12.20; Class 0.2, current classes 2 and 10.
 - 2. IEC 62053-22; Class 0.2S.
 - 3. IEC 61557-12.
- E. High-Visibility Color Graphical Display: User-programmable to display up to six parameters per screen.
- F. Input/Outputs:
 - 1. Provide integrated I/O with minimum of three digital inputs and one digital output for equipment status/position monitoring and equipment control/interface.
 - 2. I/O Modules:
 - a. Support addition of up to four field-installable I/O modules.
 - b. Digital I/O Modules: Provide six digital status/counter inputs and two Form C relay outputs rated at 250 V, 8 A.
 - c. Analog I/O Modules: Provide four inputs configurable for 4-20 mA or 0-30 V ranges, and two outputs configurable for 4-20 mA or 0-10 V ranges.
- G. Communications:
 - 1. Provide multi-port Ethernet and serial communications with minimum of two Ethernet ports and one RS485 serial port.
 - 2. Support IPv4 and IPv6.
 - 3. Support email on alarm, onboard web server, HTTPS, SNMP network management, and PTP/NTP time synchronization.
 - 4. Provide Ethernet-to-serial RS-485 gateway function.
 - 5. Communication Protocols: Support Modbus, DNP3, IEC 61850, ION, Secure ION, MV-90.
- H. Cybersecurity:
 - 1. Support independent enable/disable of communication ports, enable/disable of communication protocols per communications port, and assignment of TCP/IP port numbers per communications protocol.
 - 2. Support secure protocols including HTTPS in accordance with Transport Layer Security Protocol (TLS) 1.2.
 - 3. Provide security log to capture security-related events including log-in/log-out (successful or failed), configuration changes, and resets identifying date/time of event and user name of requestor.
 - 4. Support Syslog protocol to deliver security events to network management server.
- I. Power Quality Analysis and Compliance Monitoring:

1. Provide specified capabilities without requiring separate software.
 2. Display statistical indicators of power quality on front display.
 - a. Include voltage dips/swells, harmonics, and frequency in accordance with CENELEC EN 50160 (for PM83XX and PM82XX models only); provide indication of pass/fail in web interface.
 - b. Concurrently with CENELEC EN 50160 power quality analysis, include total voltage/current harmonic distortion and total voltage/current demand distortion in accordance with IEEE 519 (PM83XX and PM82XX models only); provide indication of pass/fail in web interface.
 3. Certified by third-party laboratory as complying with IEC 61000-4-30, Class 'S' and IEC 62586-2 (PM82XX models only).
 4. Provide low-pass anti-aliasing signal filters complying with IEC 61000-4-7.
- J. Fault Recording and Waveform Capture:
1. Support up to 225 COMTRADE disturbance capture files for waveforms available via FTP; provide client notification of new captures through RDRE logical node in accordance with IEC 61850 (SET).
 2. Capable of viewing waveforms directly on meter's webpages.
- K. Onboard Logging:
1. Provide nonvolatile timestamps at one-millisecond resolution with onboard logging of input/output (I/O) conditions, minimum/maximum values, energy and demand, maintenance data, alarms, measured parameters, and waveforms.
 2. Provide trending and short-term forecasting of energy and demand.
- L. Alarming:
1. Provide custom alarming with timestamping.
 2. Capable of learning setpoint limits based on system behavior.
 3. Support minimum of 65 setpoint-driven alarms evaluated once per second or once every 1/2 cycle.
 4. Support combining alarms using Boolean logic.
- M. Disturbance Detection (PM83XX and PM82XX models only):
1. Provide high-speed sag/swell detection of voltage disturbances on cycle-by-cycle basis, providing duration of disturbance, minimum, maximum, and average value of voltage for each phase during disturbance.
 2. Determine location of disturbance by identifying direction of disturbance relative to meter; record disturbance direction in event log with timestamp and confidence level indicating level of certainty.
- N. Programming Capability:
1. Support graphical flexible programmable modules that access metered and input data which can be arbitrarily linked together to create application functionality, e.g., totalizations, efficiency measurements, control functions, load shedding, demand response, power factor correction, and compliance monitoring.
 2. Capable of deriving values for combinations of measured or calculated parameters using arithmetic, trigonometric, and logic functions.
- O. Products:
1. Schneider Electric; PowerLogic HDMP6000 series.

2.04 METERING CABINETS

- A. Construction: Steel, with factory-supplied knockouts.

- B. UL 50E Rating, Unless Otherwise Indicated:
 - 1. Indoor Clean, Dry Locations: Type 1.
 - 2. Outdoor Locations: Type 3R.
- C. Lockable, with provisions for security seal.
- D. Provide single set of incoming terminals for connecting voltage metering leads.
- E. Provide separate control power and voltage-sensing power for distribution to each meter from main set of incoming terminals.
- F. Support power systems up to and including 480 V without requiring external control power transformers.
- G. Provide standard wiring harnesses for internal meter control power and voltage-sensing connections; support daisy-chaining of voltage connections from meter to meter on each row; provide finger-safe terminals for wiring harness connections at meter.
- H. Provide common daisy chain for communications wiring, with single loop for meters connected to circuit and each end terminated in common location; arrange to minimize interference from power wiring.
- I. Except for meters compatible with low-voltage current transducers, provide shorting terminal blocks to connect current transformer leads from field to ordered meters with factory-installed wiring harness to connect CT circuit from shorting block to meter.
- J. Support field installation of meters without requiring cutting or splicing of voltage/communication wiring harnesses.
- K. Provide terminal blocks for incoming and outgoing communications circuit connections.
- L. Products:
 - 1. Schneider Electric; Square D PowerLogic Metering Cabinet.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install equipment in accordance with manufacturer's written instructions.

3.02 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.
 - 1. Test and adjust controls and safeties.
 - 2. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.

3.03 PROTECTION

- A. Protect installed meters from subsequent construction operations.

3.04 MAINTENANCE

- A. See Section 260160.13 for additional information.
- B. Provide to Owner, as alternate to base bid, separate contract for switchgear service plan for two years from date of Substantial Completion including, but not limited to, dedicated customer success management team, priority remote and on-site (within 100 miles of service location) expert support, discounted service rates, continuous monitoring and alarming, online training.

Ossining Union Free School District
R24.16761.00

OUFSD_24BD_PH 1 - HS LKR RM & CTE Addition
Power Quality Meters

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END OF SECTION

CPL

**SECTION 262726
WIRING DEVICES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Wall plates.

1.02 RELATED REQUIREMENTS

- A. Section 260533.16 - Boxes for Electrical Systems.
- B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

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 (Validated 2023).
- 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.

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.

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.
- C. 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 Classrooms and rooms accessible to students, unless otherwise indicated on plans.
- 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 stainless steel wall plate.
- E. Wiring Devices Installed in Wet or Damp Locations: Gray 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.
 4. Substitutions: See Section 016000 - Product Requirements.
- 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 standard toggle type switch actuator and maintained contacts; single pole single throw as indicated on the drawings.

2.04 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. Automatically Controlled Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; split controlled receptacle permanent marking label on device face per NFPA 70; single, duplex or quad as indicated on the drawings.
 2. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single, duplex or quad 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.
 2. Weather Resistant GFCI Receptacles (Rooftop & Exterior Only): Industrial 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.
 3. Automatically Controlled Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

- 4.
5. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
- 6.

2.05 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.
- 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 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. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 48 inches above finished floor.
 - b. Receptacles: 18 inches above finished floor or 6 inches above counter.
 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.

3. Where multiple receptacles or wall switches are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 5. 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 vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
 - L. 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.
 - M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
 - N. Identify wiring devices in accordance with Section 260553.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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.

END OF SECTION

**SECTION 262813
FUSES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fuses.

1.02 RELATED REQUIREMENTS

- A. Section 262816.16 - Enclosed Switches: Fusible switches.

1.03 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
- B. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.
- C. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.
- D. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.
- E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - a. Fusible Enclosed Switches: See Section 262816.16.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment 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 data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com/#sle.
- B. Littelfuse, Inc: www.littelfuse.com/#sle.
- C. Mersen: ep-us.mersen.com/#sle.
- D. Substitutions: See Section 016000 - Product Requirements.

2.02 APPLICATIONS

- A. Feeders:
 - 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
 - 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.

- B. General Purpose Branch Circuits: Class RK1, time-delay.
- C. Individual Motor Branch Circuits: Class RK1, time-delay.
- D. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.

2.03 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
- H. Class L Fuses: Comply with UL 248-10.
- I. Class CC Fuses: Comply with UL 248-4.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

**SECTION 262816.16
ENCLOSED SWITCHES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed safety switches.

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. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).
- D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within 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. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. 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 enclosed switches and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 - Product Requirements, for additional provisions.

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. 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.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB/GE: www.geindustrial.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 enclosed switches 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 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 1. Altitude: Less than 6,600 feet.
 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.

- I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- J. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- L. Heavy Duty Switches:
 - 1. Comply with NEMA BS 31047.
 - 2. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Copper, suitable for terminating copper conductors only.
 - 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
 - a. Provide means for locking handle in the ON position where indicated.
- M. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Hubs: As required for environment type; sized to accept conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- 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. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Identify enclosed switches in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches 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 switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

**SECTION 263100
PHOTOVOLTAIC COLLECTORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Photovoltaic system requirements.
- B. Photovoltaic modules.
- C. Photovoltaic module mounting system.
- D. Photovoltaic combiner boxes.
- E. Photovoltaic inverters.
- F. Monitoring system.

1.02 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260529 - Hangers and Supports for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 262816.16 - Enclosed Switches.
- F. Section 264300 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. IEC 61215-1 - Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval - Part 1: Test Requirements; 2021, with Corrigendum.
- B. IEC 61215-1-1 - Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval - Part 1-1: Special Requirements for Testing of Crystalline Silicon Photovoltaic (PV) Modules; 2021.
- C. IEC 61215-2 - Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval - Part 2: Test Procedures; 2021.
- D. IEEE 1547 - IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces; 2018, with Amendment (2020).
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- F. NECA 412 - Standard for Installing and Maintaining Photovoltaic (PV) Power Systems; 2025.
- G. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 489B - Outline of Investigation for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures for Use with Photovoltaic (PV) Systems; Current Edition, Including All Revisions.
- J. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.
- K. UL 1699B - Outline of Investigation for Photovoltaic (PV) DC Arc-Fault Circuit Protection; Current Edition; Current Edition, Including All Revisions.
- L. UL 1703 - Flat Plate Photovoltaic Modules and Panels; Current Edition, Including All Revisions.

- M. UL 1741 - Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources; 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 spaces dedicated for photovoltaic system components.
 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 3. Roof-Mounted Arrays: Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Convene one week prior to commencing work of this section; require attendance of all affected installers. Include adequate instruction on the electrical hazards associated with photovoltaic systems and appropriate safety procedures to be followed.
- C. Rebates and Incentives: Prepare and submit documentation as required for Owner to secure funds from available federal, state, and utility company rebate and incentive programs. Notify Owner of any time constraints affecting program qualification.

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 each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.
- C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, attachment locations and details, and proposed size, type, and routing of conduits and cables. Include system interconnection schematic diagrams showing all factory and field connections.
1. Include proposed locations of roof penetrations and proposed methods for sealing.
- D. Design Data:
1. Include electrical calculations for array and associated equipment.
- E. Certify that products of this section meet or exceed specified requirements.
- F. Certify that work of this section does not void roof warranty.
- G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- H. Manufacturer's detailed field testing procedures.
- I. Manufacturer's detailed startup procedures.
- J. Rebate and incentive documentation.
- K. Field quality control test reports.
1. Include manufacturer's field reports.

- L. 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 that will be providing contract maintenance and trouble call-back service.
- M. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- N. Maintenance contracts.
- O. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.
- P. Software: One copy of software provided under this section.
- Q. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience with photovoltaic systems of similar size, type, and complexity.
 - 1. Licensed in the State in which the Project is located to install photovoltaic systems.
 - 2. Manufacturer's authorized installer.
 - 3. Installer Personnel: At least 2 years of experience installing photovoltaic systems.
- C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
 - 1. Contract maintenance office located within 50 miles of project site.
- D. 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. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Specified warranties indicate minimum requirements. Provide additional warranties or extended warranty periods where required to qualify for rebate and incentive programs.
- C. Photovoltaic Modules:
 - 1. Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
 - 2. Provide manufacturer warranty guaranteeing minimum 90 percent of rated power output for 10 years and minimum 80 percent of rated power output for 20 years.
- D. Photovoltaic Module Mounting System: Provide minimum 10 year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
- E. Photovoltaic Combiner Boxes: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

- F. Photovoltaic Inverters: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
- G. Charge Controllers: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Photovoltaic Modules, Crystalline Silicon:
 - 1. CW Energy - CTW-450-108TNB10 450wp (Basis of Design)
 - 2. Kyocera Solar, Inc: www.kyocerasolar.com/#sle.
 - 3. SolarWorld Americas: www.solarworld-usa.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Photovoltaic Module Mounting System:
 - 1. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - 2. Direct Power and Water Corporation: www.dpwsolar.com/#sle.
 - 3. Metal Roof Innovations, Ltd. S-5! Attachment Solutions; S-5! PV Kit: www.s-5.com/#sle.
 - 4. PHP Systems/Design: www.phpsd.com/#sle.
 - 5. TRA Snow and Sun: www.trasnowandsun.com/#sle.
 - 6. Unirac, Inc: www.unirac.com/#sle.
 - 7. Substitutions: See Section 016000 - Product Requirements.
- C. Photovoltaic Combiner Boxes:
 - 1. SolarEdge; Basis of Design: .
 - 2. SolarBOS, Inc: www.solarbos.com/#sle.
 - 3. Solectria Renewables, LLC: solectria.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- D. Photovoltaic Inverters:
 - 1. Schneider Electric: www.se.com/#sle.
 - 2. SMA America, LLC: www.sma-america.com/#sle.
 - 3. Solectria Renewables, LLC: www.solctria.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- E. Monitoring System:
 - 1. Schneider Electric: www.se.com/#sle.
 - 2. SMA America, LLC: www.sma-america.com/#sle.
 - 3. Solectria Renewables, LLC: www.solren.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- F. Photovoltaic Junction Boxes:
 - 1. Unirac Solobox Rail
 - 2. Substitutions: See Section 016000 - Product Requirements

2.02 PHOTOVOLTAIC SYSTEM REQUIREMENTS

- A. Provide complete photovoltaic system consisting of photovoltaic modules and associated balance of system components necessary for connection to facility electrical system.
- B. System Description:
 - 1. Photovoltaic array is roof-mounted in location indicated on the drawings.
 - 2. Orientation of array is as indicated on the drawings.
 - 3. Photovoltaic DC system is negative grounded.

4. System does not include battery storage system.
 5. System does not include engine generator.
 6. System includes DC system surge protection.
 7. System includes monitoring system.
- C. Capacity:
1. Total Nominal Rated Power Output of Array: Equal to or greater than the rated output of the basis of design array.
 2. Nominal Rated Power Output of Individual Modules: Equal to or greater than the rated output of the basis of design module.
- D. Size:
1. Array: Designed to fit within the area designated on the drawings.
- E. Appearance:
1. Arrange array such that modules are aligned with uniform spacing.
 2. Final determination of acceptable appearance is by Architect.
- F. Provide photovoltaic system and associated components suitable for wind loads, snow loads, seismic loads, and other structural design considerations of the installed location.
- G. Provide photovoltaic system and associated components suitable for continuous operation under the service conditions at the installed location.
- H. Provide products listed, classified, and labeled as suitable for the purpose intended.
- I. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system.
- J. DC Arc Fault Circuit Protection: Provide DC photovoltaic arc-fault protection devices listed as complying with UL 1699B as required for compliance with NFPA 70.
- K. Rapid Shutdown of Photovoltaic Systems on Buildings: Provide listed equipment arranged to provide rapid shutdown in accordance with NFPA 70.
- L. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- M. Arrange array to provide adequate access to rear of string(s) for maintenance.
- N. Arrange array to minimize shading during peak production periods.
- O. Roof-Mounted Arrays:
1. Arrange array such that normal roof drainage is not affected.
 2. Arrange array to maintain required safety clearances from edges of roof as indicated.
 3. Arrange array to maintain access and clearance requirements for other roof-mounted equipment.
 4. Arrange array to avoid spanning of expansion joints.

2.03 PHOTOVOLTAIC MODULES

- A. Acceptable Module Types: Only crystalline silicon modules are acceptable. Thin film modules will not be considered for this project.
- B. General Requirements:
1. Photovoltaic Modules: Factory assembled; consisting of photovoltaic cells, frame, junction box, cables for series connection, and bypass diodes for shade tolerance; rated for 600 V DC; complying with IEC 61215-1 and IEC 61215-2 and listed as complying with UL 1703.

2. Crystalline Silicon Photovoltaic Modules: Comply with IEC 61215-1-1.
3. Frame: Anodized aluminum.
4. Factory-Installed Junction Box: Weatherproof, with factory-installed terminals and bypass diodes.
5. Factory-Installed Cables: Type USE-2 or listed photovoltaic (PV) wire with polarized locking connectors.
6. Unless otherwise indicated, specified module performance characteristics are rated under Standard Test Conditions (STC).

2.04 BALANCE OF SYSTEM COMPONENTS

- A. Photovoltaic Module Mounting System:
 1. Provide complete mounting system compatible with modules to be installed and suitable to properly install them in the location indicated, including all necessary hardware and accessories.
 2. Support Structure and Associated Hardware Materials: Use aluminum, galvanized steel, or stainless steel.
 3. Roof-Mounted Arrays:
 - a. Acceptable System Types: Only non-penetrating systems are acceptable. Penetrating systems will not be considered for this project.
 - b. Provide system compatible with the roof at the installed location.
 - c. Module Tilt Angle: As required to provide maximum energy production for installed location.
 - d. Provide minimum clearance of 3 inches between roof and module for air circulation and drainage.
- B. Photovoltaic Combiner Boxes:
 1. Provide combiner box(es) for termination of strings as indicated or as required for the array configuration installed.
 2. Combiner Boxes: Rated for 600 V DC; current ratings suitable for connected strings; equipped with fuseholders; listed as complying with UL 1741.
 3. Fuseholders: Touch-safe; suitable to accept fuses indicated.
 4. Number of Input Circuits: As indicated or as required for termination of strings, with minimum of 25 percent spare capacity for future expansion.
 5. Enclosure: NEMA EN 10250, Type 3R, unless otherwise indicated.
- C. Photovoltaic Junction Boxes:
 1. Diecast aluminum metal box suitable for mounting on solar array racking system.
 2. Gasketed weathertight sealing cover and all fittings.
 3. Internal DIN mounting rails to install either DIN DC circuit breakers or DIN termination lugs.
 4. Terminal and/or circuit breakers shall be suitable to terminate 600V PV free-air wiring and THWN-2 wiring.
- D. Photovoltaic Inverters:
 1. Provide inverter(s) as indicated or as required for connection of the photovoltaic array DC system to the AC system indicated.
 2. Inverters: Suitable for the requirements of the connected array; output configuration compatible with connected system; listed as complying with UL 1741; furnished with the following features:
 - a. Maximum power point tracking (MPPT).

- b. LCD display.
 - c. Integral AC disconnect.
 - d. Integral DC ground fault detection and interruption (GFDI).
 - e. Communications Interface: As required for connection to system indicated.
- 3. Grid-Tied Inverters: Comply with IEEE 1547, including over/under grid voltage and frequency protection, and anti-islanding protection to automatically disconnect upon loss of utility power and to remain disconnected until utility power restoration has been maintained for five minutes.
- 4. Grounded Photovoltaic DC Systems: Furnish with integral isolation transformer. Transformerless inverters may be used if a separate isolation transformer is provided.
- 5. Total Harmonic Distortion: Less than five percent.
- 6. Enclosure Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
- E. Enclosed Switches, in Addition to Requirements of Section 262816.16:
 - 1. Switches for DC System: Rated for 600 V DC.
- F. Surge Protective Devices, in Addition to Requirements of Section 264300:
 - 1. Surge Protective Devices for DC System:
 - a. Rated for 600 V DC.
 - b. Listed and labeled as complying with UL 1449, Type 1.
 - c. Surge Current Rating: Not less than 50 kA per mode.
 - d. UL 1449 Nominal Discharge Current (I-n): 20 kA.
- G. Molded-Case Circuit Breakers and Switches for DC System: Rated for 600 V DC; listed as complying with UL 489B.
- H. Monitoring System:
 - 1. Provide a system to monitor photovoltaic system performance including all sensors, dataloggers, connections, software, equipment and accessories necessary for a complete operating system.
 - 2. System communications interfaces to be wired or wireless, with compatible interconnected components.
 - a. Provide suitable raceway, minimum 3/4 inch trade size, for all required wired connections.
 - 3. System to monitor and record, in 15 minute intervals:
 - a. Inverter status.
 - b. Instantaneous power (kW).
 - c. Cumulative energy production (kWh).
 - 4. Energy Production Meter: Revenue grade, with accuracy of plus or minus two percent.
 - 5. System real-time and historical data to be accessible from the following locations:
 - a. Personal computer(s), via internet connection.
 - b. Remote personal display(s), quantity and location as indicated on the drawings.
 - c. Remote public display(s), quantity and location as indicated on the drawings.
 - 6. System to provide alarm notification via e-mail or instant message.
 - 7. System to be compatible with third party monitoring service to be selected by Owner.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Use open circuiting, short circuiting, or opaque covering to disable modules, array or portions of array prior to installation and service.
- B. Roof-Mounted Arrays: Protect roof and adjacent roof-mounted items from damage.

3.03 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
 - B. Install products in accordance with manufacturer's instructions.
 - C. Provide required support and attachment in accordance with Section 260529.
 - D. Mount equipment such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor, ground, or working platform.
 - E. Circuiting Requirements, in Addition to Requirements of Section 260519:
 - 1. Wiring Methods:
 - a. Unless otherwise indicated, use exposed type USE-2/RHH/RHW-2 single-conductor cable or listed photovoltaic wire (not routed inside building) for module interconnections.
 - b. Unless otherwise indicated, use exposed type USE-2/RHH/RHW-2 single-conductor cable or listed photovoltaic wire (not routed inside building) for wiring between string(s) and transition junction box(es).
 - c. Unless otherwise indicated, use type THHN/THWN-2 single-conductor building wire in suitable raceway for wiring between combiner box(es) and point of interconnection.
 - d. Secure exposed cables in accordance with NFPA 70. Where possible, conceal behind array.
 - e. Install cables in suitable raceway where readily accessible or where required by authority having jurisdiction.
 - 2. Photovoltaic DC System Conductor Color Code:
 - a. Negative Grounded System:
 - 1) Positive: Red.
 - 2) Negative/Grounded: White.
 - 3. Maintain separation of photovoltaic and non-photovoltaic circuits in accordance with NFPA 70.
 - F. Grounding and Bonding Requirements, in Addition to Requirements of Section 260526:
 - 1. Ensure that there is only one AC System bonding connection between grounding system and grounded/neutral conductor, including external connections and connections internal to equipment.
 - 2. Grounded DC Systems: Ensure that there is only one point of system grounding connection to the grounded conductor, including external connections and connections internal to equipment.
 - G. Identification Requirements, in Addition to Those Specified in Section 260553:
-

1. Color for Photovoltaic System Identification Nameplates and Labels: White text on red background, unless otherwise required by NFPA 70 or authorities having jurisdiction.
2. Use identification nameplate or means of identification acceptable to authority having jurisdiction to identify the presence of multiple power sources and the location of main service disconnecting means and each photovoltaic system disconnecting means. Locate at main service disconnecting means and at each photovoltaic system disconnecting means. Verify format and descriptions with authorities having jurisdiction.
3. Use identification nameplate to identify each photovoltaic system disconnecting means with text "PV SYSTEM DISCONNECT".
4. Use identification nameplate or identification label to identify systems equipped with rapid shutdown and associated rapid shutdown switch(es). Format, descriptions, and locations to comply with NFPA 70 and requirements of authorities having jurisdiction.
5. Use identification nameplate or identification label to identify the information required by NFPA 70 for marking of direct-current photovoltaic power sources. Locate at each DC disconnect means requiring marking.
6. Use identification nameplate or identification label to identify the interactive system point of interconnection at the disconnecting means as a power source and with the rated AC output current and the nominal operating AC voltage.
7. Where the inverter output connection is located in a panelboard on the opposite (load) end from the input feeder location or main circuit location in order to meet requirements of NFPA 70, use identification nameplate or identification label to identify the overcurrent device with the word message "Warning; Inverter output connection; Do not relocate this overcurrent device".
8. Use warning labels to identify electrical hazards for photovoltaic system disconnecting means. Include the word message "Warning - Electric Shock Hazard; Terminals on the line and load sides may be energized in the open position" or approved equivalent.
9. Use wire and cable markers to identify photovoltaic system source, output, and inverter circuit conductors at all points of termination, connection, and splices.
10. Use voltage markers, identification labels, stenciled text, or suitable permanent marking approved by authority having jurisdiction to identify exposed raceways, cable trays, pull boxes, junction boxes, and conduit bodies with the text "Warning: Photovoltaic Power Source" at maximum intervals of 10 feet in accordance with NFPA 70.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. See article "SYSTEM STARTUP" below for additional requirements related to testing and inspection.
- C. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- D. Inspection and testing to include, at a minimum:
 1. Inspect each system component for damage and defects.
 2. Verify that equipment enclosures, boxes, and associated connections installed outdoors are weatherproof.
 3. Verify proper wiring connections have been made and check for conductor continuity. Verify proper polarity.
 4. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.

5. Measure and record voltages at the inverter AC and DC inputs.
6. Measure and record AC output power.
7. Perform inverter functional test.
 - a. Grid-Tied Inverters: Include simulation of loss of utility power and subsequent power restoration.
8. Verify proper operation of monitoring system.
- E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- F. Diagnostic Period: After successful completion of inspections and tests, operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 1. Record all system operations and malfunctions.
 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
- G. Repair roof or adjacent roof-mounted items damaged as a result of work of this section.

3.05 SYSTEM STARTUP

- A. Obtain Owner's approval prior to performing system startup.
- B. Grid-Tied Systems: Obtain Utility Company's approval prior to performing system startup.
- C. Prepare and start system in accordance with manufacturer's instructions.

3.06 CLEANING

- A. Clean modules using only methods recommended by manufacturer to avoid scratches and other damage. Clean exposed surfaces on other components to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 COMMISSIONING

- A. See Section 019113 - General Commissioning Requirements for commissioning requirements.

3.08 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of photovoltaic system.
 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 2. Provide minimum of four hours of training.

3.09 PROTECTION

- A. Protect installed products from subsequent construction operations.

3.10 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Conduct site visit at least once every six months to perform inspection, testing, and preventive maintenance. Conduct tests similar to those made during original field quality control testing. Submit report to Owner comparing test results with those of original tests along with evaluations and recommendations.
- C. Provide trouble call-back service upon notification by Owner:

1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION

**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.
 - 1. Includes automatic controls for lighting including occupancy sensors and time switches.
 - 2. Includes lighting contactors.
- E. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.
- F. Section 265600 - Exterior Lighting.

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; 2024.
- 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 Commercial Lighting Systems; 2025.
- 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 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- L. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- M. UL 1598 - Luminaires; Current Edition, Including All Revisions.

- N. 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. 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: Instructions for each product including information on replacement parts.
- F. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

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. 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 three year manufacturer warranty for LED luminaires, including drivers.
- C. Provide five year pro-rata warranty for batteries for emergency lighting units.

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. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. 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.
- E. 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.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
- H. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.
- 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. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.
 - 1. LED Tape - General Requirements:
 - a. Listed.
 - b. Designed for field cutting in accordance with listing.
- K. 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. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. 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.
- C. Battery:
 - 1. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- E. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- F. 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.
- G. Accessories:
 - 1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
 - 2. Provide compatible accessory wire guards where indicated.
 - 3. 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.
- C. Accessories:
 - 1. Provide compatible accessory wire guards where indicated.

2.05 BALLASTS AND DRIVERS

- A. 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.
- B. 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.
 - 2. 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.
 6. 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.
 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
- I. Suspended Luminaires:
1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
 4. Install canopies tight to mounting surface.
- J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- K. Install accessories furnished with each luminaire.
- L. Bond products and metal accessories to branch circuit equipment grounding conductor.
- M. 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.
- N. 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.
- O. Remote Ballasts: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.
- P. Identify luminaires connected to emergency power system in accordance with Section 260553.
- Q. Install lamps in each luminaire.
- R. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- D. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

**SECTION 265600
EXTERIOR LIGHTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Exterior luminaires.
- B. Ballasts.
- C. Poles and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 260529 - Hangers and Supports for Electrical Systems.
- B. Section 260533.16 - Boxes for Electrical Systems.
- C. Section 260923 - Lighting Control Devices.
 - 1. Includes automatic controls for lighting including time switches and outdoor photo controls.
 - 2. Includes lighting contactors.
- D. Section 262726 - Wiring Devices: Receptacles for installation in poles.
- E. Section 265100 - Interior Lighting.

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; 2024.
- 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 501 - Standard for Installing Exterior Lighting Systems; 2000 (Reaffirmed 2006).
- F. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2023.
- G. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2023.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- J. 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 placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
 - 2. 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.
 - 3. Provide structural calculations for each pole proposed for substitution.
- 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, weight, effective projected area (EPA), and installed accessories; 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.
 - 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. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
- 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, installation, and starting of product.
- F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- G. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

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, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturer warranty for all LED luminaires, including drivers.

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. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. 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.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
- H. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
- 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. Exposed Hardware: Stainless steel.

2.03 BALLASTS AND DRIVERS

- A. 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.

2.04 POLES

- A. All Poles:
 - 1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
 - 2. Finish: Match luminaire finish, unless otherwise indicated.
 - 3. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.
 - 4. Unless otherwise indicated, provide with the following features/accessories:
 - a. Top cap.
 - b. Anchor bolts with leveling nuts or leveling shims.
 - c. Anchor base cover.
- B. Metal Poles: Provide ground lug, accessible from handhole or transformer base.

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. Install products in accordance with manufacturer's instructions.
- C. Install luminaires in accordance with NECA/IESNA 501.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
- G. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- H. Pole-Mounted Luminaires:
 - 1. Foundation-Mounted Poles:
 - a. Install foundations plumb.
 - b. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
 - c. Tighten anchor bolt nuts to manufacturer's recommended torque.
 - d. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
 - e. Install anchor base covers or anchor bolt covers as indicated.
 - 2. Grounding:
 - a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
 - 3. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
- I. Install accessories furnished with each luminaire.
- J. Bond products and metal accessories to branch circuit equipment grounding conductor.
- K. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD 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. 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. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect.

3.06 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 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. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- D. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

**SECTION 271000
STRUCTURED CABLING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Fiber optic cable and interconnecting devices.
- E. Communications equipment room fittings.
- F. Communications outlets.
- G. Communications grounding and bonding.
- H. Communications identification.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - FIRESTOPPING.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes intersystem bonding termination.
 - 2. Includes bonding jumpers for bonding of communications systems and electrical system grounding.
- C. Section 260533.13 - Conduit for Electrical Systems.
- D. Section 260536 - Cable Trays for Electrical Systems.
- E. Section 260533.16 - Boxes for Electrical Systems.
- F. Section 260553 - Identification for Electrical Systems: Identification products.
- G. Section 262726 - Wiring Devices.

1.03 REFERENCE STANDARDS

- A. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.
- B. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; 2005e.
- C. ICEA S-83-596 - Indoor Optical Cable; 2021.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 1988a (Reaffirmed 2012).
- F. TIA-492AAAB - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009a.
- G. TIA-492AAD - Detail Specification for 850-nm Laser- Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber; 2009.

- H. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; IEC 61280-4.1 Edition 3.1, Fiber Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant- Multimode Attenuation Measurement; 2023d.
- I. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2024.
- J. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2018d, with Addenda (2020).
- K. TIA-568.3 - Optical Fiber Cabling and Components Standard; 2022e.
- L. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).
- M. TIA-598 - Optical Fiber Cable Color Coding; 2014d, with Addendum (2018).
- N. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.
- O. TIA-607 - Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2024e.
- P. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- Q. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
- R. UL 1651 - Fiber Optic Cable; Current Edition, Including All Revisions.
- S. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
 - 3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Arrange for Communications Service Provider to provide service.
- C. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.

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 each product.
- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- D. Evidence of qualifications for installer.
- E. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.

- F. Field Test Reports.
- G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.
 - 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 - 3. Identify distribution frames and equipment rooms by room number on drawings.
- H. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
- B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
 - 2. Supervisors and installers factory certified by manufacturers of products to be installed.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
 - 1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
 - 2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
 - 3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 - 4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
- B. Main Distribution Frame (MDF): Existing centrally located support structure for terminating horizontal cables that extend to telecommunications outlets and backbone cables that extend to intermediate distribution frames (IDFs), functioning as point of presence to external service provider.
- C. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
 - 1. Locate intermediate distribution frames as indicated on the drawings.

- D. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.
- E. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.02 PATHWAYS

- A. Conduit: As specified in Section 260533.13; provide pull cords in all conduit.
- B. 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.

2.03 COPPER CABLE AND TERMINATIONS

- A. Manufacturers:
 - 1. CommScope: www.commscope.com/#sle.
 - 2. General Cable Technologies Corporation: www.generalcable.com/#sle.
 - 3. Siemon Company: www.siemon.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Copper Horizontal Cable:
 - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
 - 2. Cable Type - Voice and Data: TIA-568.2 Category 6A UTP (unshielded twisted pair); 23 AWG.
 - 3. Cable Capacity: 4-pair.
 - 4. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
 - 5. Cable Jacket Color -Data Cable: Blue.
 - 6. Cable Jacket Color - Security Cameras, access control: Yellow.
 - 7. Product(s):
 - a. CommScope; SYSTIMAX Twisted Pair Cables; GigaSPEED X10D Category 6A U/UTP Cable: www.commscope.com/#sle.
 - b. CommScope; Uniprise Twisted Pair Cables; CS44 Series Category 6A U/UTP Cable: www.commscope.com/#sle.
 - c. General Cable Technologies Corporation; GenSPEED Cables: www.generalcable.com/#sle.
- C. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- D. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
 - 1. Performance: 500 mating cycles.
 - 2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.
 - 3. Color to match Category 6A cable jacket color for each system type.

4. Product(s):
 - a. CommScope; Uniprise RJ45 Jacks; Ultra 10 UNJ10G Series Category 6A U/UTP Modular Jacks: www.commscope.com/#sle.
- E. Copper Patch Cords:
 1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
 2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: 3 feet.
 3. Patch Cords for Work Areas:
 - a. Quantity: One for each work area outlet port.
 - b. Length: 15 feet.
 4. Product(s):
 - a. CommScope; Uniprise Category 6A U/UTP Patch Cords: www.commscope.com/#sle.

2.04 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Manufacturers:
 1. CommScope: www.commscope.com/#sle.
 2. General Cable Technologies Corporation: www.generalcable.com/#sle.
 3. Siemon Company: www.siemon.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
 - B. Fiber Optic Backbone Cable:
 1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
 2. Cable Type: Multimode, laser-optimized 50/125 um (OM4) complying with TIA-492AAAD.
 3. Cable Capacity: Quantity of fibers as indicated on drawings.
 4. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type OFNR riser cable or Type OFNP plenum cable.
 5. Cable Jacket Color:
 - a. Laser-Optimized Multimode Fiber (OM3/OM4): Orange.
 6. Product(s):
 - a. CommScope Fiber Optic Cables; LazrSPEED 550 OM4 Multimode Fiber: www.commscope.com/#sle.
 - C. Fiber Optic Interconnecting Devices:
 1. Connector Type: Type LC.
 2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
 3. Maximum Attenuation/Insertion Loss: 0.3 dB.
 4. Product(s):
 - a. CommScope Fiber Optic Connectors; QWIK II-LC Fiber Connectors: www.commscope.com/#sle.
 - D. Fiber Optic Patch Cords:
 1. Description: Factory-fabricated 2-fiber cable assemblies with suitable connectors at each end.
 2. Patch Cords for Patch Panels:
-

- a. Quantity: One for each pair of patch panel ports.
- b. Length: 6 feet.
- 3. Product(s):
 - a. CommScope Fiber Optic Patch Cords; LazrSPEED 550 Fiber Patch Cords:
www.commscope.com/#sle.

2.05 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

- A. Copper Cross-Connection Equipment:
 - 1. Manufacturers:
 - a. CommScope: www.commscope.com/#sle.
 - b. Siemon Company: www.siemon.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
 - 2. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
 - a. Jacks: Non-keyed RJ-45 Category 6A, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
 - b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
 - c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - d. Provide incoming cable strain relief and routing guides on back of panel.
 - e. Color to match Category 6A cable jacket color for each system type.
 - 3. Product(s):
 - a. CommScope; Uniprise Copper Panels; UNP-XX-DM Series Patch Panels:
www.commscope.com/#sle.
- B. Fiber Optic Cross-Connection Equipment:
 - 1. Manufacturers:
 - a. CommScope: www.commscope.com/#sle.
 - b. Siemon Company: www.siemon.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
 - 2. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
 - a. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adaptors per standard panel width.
 - b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - c. Provide incoming cable strain relief and routing guides on back of panel.
 - d. Provide rear cable management tray at least 8 inches deep with removable cover.
 - e. Provide dust covers for unused adapters.
 - 3. Product(s):
 - a. CommScope; Uniprise Fiber Panels; SD Series Patch Panels:
www.commscope.com/#sle.
- C. Equipment Cabinets:
 - 1. Manufacturers:
 - a. CommScope: www.commscope.com/#sle.
 - b. Siemon Company: www.siemon.com/#sle.

- c. Substitutions: See Section 016000 - Product Requirements.
- 2. Component Racks: EIA/ECA-310 standard 19 inch wide.
- 3. Freestanding Cabinets: Front and rear doors with locks; removable side panels with locks; vented top and rear door; adjustable leveling feet; cable access in roof and base; grounding bar.
 - a. (6) Single AC outlet power strip inside cabinet.
 - b. Roof mounted (2) fans, capacity 200cfm.
- 4. Wall Mounted Cabinets: Front doors with locks, louvered side panels, top and bottom cable access, and ground lug.
 - a. Cover inside of cabinet back with plywood backboard as specified.
 - b. Roof mounted fan, capacity 150cfm.
 - c. (6) single AC outlet power strip inside cabinet.
- 5. Cabinets: Steel construction with corrosion resistant black finish.
- 6. Locks: Keyed alike.
- 7. Product(s):
 - a. _____.
- D. Cable Management:
 - 1. Manufacturers:
 - a. CommScope: www.commscope.com/#sle.
 - b. Siemon Company: www.siemon.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
 - 2. Product(s):
 - a. CommScope Cable Runway: www.commscope.com/#sle.
 - b. CommScope Horizontal/Vertical Cable Managers; HCM-SS-XX-XX/VCM-DS-XX-XX Series: www.commscope.com/#sle.
 - c. CommScope FiberGuide Raceway: www.commscope.com/#sle.

2.06 COMMUNICATIONS OUTLETS

- A. Manufacturers:
 - 1. CommScope: www.commscope.com/#sle.
 - 2. Siemon Company: www.siemon.com/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.
- B. Outlet Boxes: Comply with Section 260533.16.
 - 1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
 - 2. Minimum Size, Unless Otherwise Indicated:
 - a. Data or Combination Voice/Data Outlets: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
- C. Wall Plates:
 - 1. Comply with system design standards and UL 514C.
 - 2. Accepts modular jacks/inserts.
 - 3. Capacity:
 - a. Voice Only Outlets: 2 port.
 - b. Data or Combination Voice/Data Outlets: 2 ports.
 - 4. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 262726.
 - 5. Product(s):

- a. CommScope Faceplates; M Series: www.commscope.com/#sle.

2.07 GROUNDING AND BONDING COMPONENTS

- A. Comply with TIA-607.
- B. Comply with Section 260526.

2.08 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. Comply with Section 260553.

2.09 SOURCE QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with Communication Service Provider requirements.
- C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.
- D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

3.02 INSTALLATION OF PATHWAYS

- A. Install pathways with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches from power conduits and cables and panelboards.
 - 3. 5 inches from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Conduit, in Addition to Requirements of Section 260533.13:
 - 1. Arrange conduit to provide no more than the equivalent of two 90 degree bend(s) between pull points.
 - 2. Conduit Bends: Inside radius not less than 10 times conduit internal diameter.
 - 3. Arrange conduit to provide no more than 100 feet between pull points.
- C. Outlet Boxes:
 - 1. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of telecommunications outlets provided under this section.
 - a. Mounting Heights: As indicated on the drawings.
 - 1) Telephone and Data Outlets: 18 inches above finished floor.
 - b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - c. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
 - d. Locate outlet boxes so that wall plate does not span different building finishes.
 - e. Locate outlet boxes so that wall plate does not cross masonry joints.

3.03 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 - 2. Do not over-cinch or crush cables.
 - 3. Do not exceed manufacturer's recommended cable pull tension.
 - 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
 - 1. At Distribution Frames: 120 inches.
 - 2. At Outlets - Copper: 12 inches.
- C. Copper Cabling:
 - 1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 - 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 - 3. Use T568B wiring configuration.
- D. Fiber Optic Cabling:
 - 1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 - 2. Support vertical cable at intervals as recommended by manufacturer.
- E. Wall-Mounted Racks and Enclosures:
 - 1. Install to plywood backboards only, unless otherwise indicated.
 - 2. Mount so height of topmost panel does not exceed 78 inches above floor.
- F. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.
- G. Identification:
 - 1. Use wire and cable markers to identify cables at each end.
 - 2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
 - 3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Comply with inspection and testing requirements of specified installation standards.
- C. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
 - 4. Inspect patch cords for complete labels.
- D. Testing - Copper Cabling and Associated Equipment:
 - 1. Test backbone cables after termination but before cross-connection.
 - 2. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay. Fluke Linkware meter testing

3. One electronic copy of the test report shall be provided.
- E. Testing - Fiber Optic Cabling:
1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
 2. Multimode Backbone: Perform tests in accordance with TIA-526-14.
 3. Links: Perform optical fiber end-to-end attenuation tests and field reel tests.
- F. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION

**SECTION 275116
IP PUBLIC ADDRESS AND CLOCK SYSTEM**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract Documents apply to this Section.

1.02 DEFINITIONS

A. CALL-IN

1. A call placed via a classroom call-switch or classroom workflow interface and intended to request assistance from the front office. A call-in will initiate a tone on the office located, administrative console and will be answered by front office staff using the handset or hands-free option on the console.

B. WORKFLOW REQUEST

1. A Workflow Request is any action request placed by touching a specifically labeled widget on the classroom workflow interface (not just a standard call-switch) that specifically communicates a need directly to a location other than the main office, maintenance, IT, nurse, Library etc. System of design has minimum of 168 various Workflow Requests initiations that can accommodate specific labeling. System allows for user defined customization of Workflow Requests actions and request target destinations.

1.03 SUMMARY

- A. This section includes a fully operational, IP-based system for a district-wide and individual school internal communication, notification, and classroom workflow enhancement system. The system shall provide bell scheduling, general paging and intercom functions, school safety enhancements and critical communications with individual school and districtwide emergency notification and management capabilities, and classroom workflow enhancement features, all provided on an enterprise-based, single server platform. The following attributes shall be required and shall be described as:
1. A TCP/IP enterprise platform installed on a single server that serves the entire district. All capabilities listed within these specifications are intended to be native to a single platform. Systems that require third party application/platform integration or more than one server, or individual servers or PCs at individual school locations shall not be acceptable.
 2. Classrooms shall be capable of initiating indication of changing room attributes such as "Needs Cleaned." Rooms needing cleaned will be identified by illuminating room status light and changing room status on mapping. When the room has been cleaned a "Cleaned" status change shall be initiated from the classroom and each status shall be logged on integrated system software. Workflow requests and completion statuses shall be indicated on classroom Status Lights and integrated mapping. Emails relating to requests shall also be sent to user defined response group and each status shall be logged on integrated system software.
 3. Shall benefit hallway protocols with wayfinding, workflow and shall be accomplished through user-defined, preprogrammed messaging in hallways between classes. Visual indication of direction of hallway traffic flow shall be visible on hallway message boards and incremental audio messages reminding students of proper hallway etiquette shall be heard on overhead speakers in hallway zones.

4. Shall include the ability for emergency announcements to override any field adjusted volume levels, assuring that all Emergency/Lockdowns etc., are heard at each speaker location. Any systems requiring local, hardwired volume controls to control speaker volumes shall not be acceptable.
5. Capable of sending written Emergency Notification instructions directly to classroom or office staff on the interactive POE workflow interface.
6. Capable of creating custom, pre-recorded emergency announcements that can be activated by an administrative console, panic button, SIP trunk connected phone, mobile application, POE classroom workflow interface, REST API and web browser user interface.
7. Integrated two-way, handsfree audio separate from district or facility VOIP phone systems. Platforms that rely on district or facility VOIP telephones as the only two-way audio path to classrooms shall not be acceptable.
8. Including a REST Application Programming Interface (API) for interface to third party systems. Systems that do not provide logic-based integration or rely solely on unsupervised, electronic relay inter-connections shall not be acceptable.
9. Including a same-source, interactive floor plan that displays system activity including call-in and lockdown initiation location as well as device status at each connected school in the district. System device failures and/or off-line status as displayed on floorplan map shall be communicated via email to user defined recipient, or group of recipients. Maps shall be customizable and specific to each school and viewed on system browser-based, user interface.
10. Capable of generating visual notifications based on system activity. Emergency priority calls from classrooms shall be visually indicated on all message boards. Visual notification shall include the priority of the call and its origin by classroom name and/or number. Notifications shall also include indication on all associated Status Lights.
11. Capable of providing authorized administrators the ability to initiate any preprogrammed emergency condition from any classroom with the proper credentials. Systems that are limited to classroom telephone integration, 3rd party mobile applications, or unsupervised hardware to accomplish this shall also provide a second, supervised means to initiate school-wide emergency notifications from all classrooms.
12. Classroom emergency calls shall initiate a Text-To-Speech, location specific, real-time audio message to a speaker, zone of speakers or all speakers. Emergency call-in generated overhead audio messaging shall also be automatically activated or deactivated based on time of day.
13. Including the ability to send a live or pre-recorded audio page to a SIP trunk connected SIP phone or group of SIP phones.
14. Providing an associated, same-source IOS and Android mobile application. The mobile application shall give the authorized user the ability to initiate local emergencies from their mobile device, from any location within a school. The mobile application shall also provide authorized users the ability view, in real-time, classroom check-in status on their mobile device. Mobile application must deactivate once the mobile device has left the school it is associated with. Users of the APP shall be managed via the browser-based user interface.
15. Capable of network time protocol synchronization (NTP) with class change tones utilizing multiple, programmable schedules for each zone.
16. Providing district-wide and individual school distribution of pre-recorded and live pages, tones, music and visual messaging.

17. Including a web-based user interface for programming, configuration, bell scheduling and access for all uses as described herein with the proper credentials.
18. Providing multiple levels of call-in priorities which shall be user-definable, allowing each call station to place a call with a user-selected priority as chosen from a minimum of 999 different priorities.
19. Allowing any authorized administrator to call from outside the school into any classroom, page a zone, or entire school directly, via the School District supplied, SIP trunk enabled Telephone Network. This access shall include remote monitoring, and two-way conversation from outside the facility as well as paging into the system. Call-ins from the intercom platform to the SIP Trunk connected VIOP phone system shall display all Caller ID information on SIP phones with a display.
20. Providing the capability for authorized system users to create automated sequences that include any or all of the following: voice instructions, tones, emails, program distribution, systems activations by relay and logical integration through a REST API, message board notification and automatic Text-To-Speech announcements.
21. Capable of initiating automated audio and visual message strings from a single-button on a console, a panic button, mobile app, web-based user interface and third-party interfaces as directed by the end user.
22. Providing paging from any system console or SIP trunk connected telephone for each campus or the whole district.
23. Providing the means to allow each single campus installation to remain 100% operational for intercom, paging, bells, and emergencies such as lockdown, even when the main, district connection is unavailable. Survivability of individual schools shall last for a minimum of 14 days without connection to main server.
24. Capable of providing a same-source, integrated, district-wide option for displaying all schools' locations on a single map, showing school status including active emergencies and connection status. Integrated, same source District-Wide application shall allow for live and prerecorded district-wide audio and initiation of emergency sequences to one or all schools in the district. Systems that require a third party or OEM option for this purpose shall not be acceptable.
25. Including the ability to send specific and appropriate written response instructions to all classrooms when an emergency or non-emergency condition has been initiated. Written instructions shall be in addition to audio and visual notifications sent to speakers and message boards. The instructions must be specific as to the type of condition and shall have the ability to be included or excluded from condition sequences. Receipt of instructions shall not solely rely on classroom computers to be received and read.
26. Any costs for annual system firmware updates shall be provided at no charge from the manufacturer for the life of the product (local installation fees may apply). Any fees for annual licensing shall be provided by the installing contractor, for the life of the product.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Submittals shall include documentation from the manufacturer that the installer is an authorized provider of the system.
- B. Factory authorized installers must have a minimum of (XX, not less than 3 years) years, as an authorized installer and service provider of the system being provided for this project and must provide a minimum of three reference sites that attest to their affiliation and competency.

1.05 IN-SERVICE TRAINING

- A. The contractor shall provide and implement a complete and comprehensive 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 system providing contractor and trained by the manufacturer. Manufacturer certification of trainer shall be provided in the submittals
- 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 the staff and faculty members who attended, received, and completed the training program.

1.06 WARRANTY

- A. Provide a manufacturer's five-year warranty of the internal communication, notification and classroom workflow enhancement system equipment against defects in material and workmanship. This warranty will cover all electronic system components. Additional warranties cover clocks, speakers, and call-in switches. 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 internal communication, notification and classroom workflow enhancement system 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. 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.
- C. Make available a service contract offering continuing factory authorized service of the system for regular maintenance on items not covered within the warranty.
- D. Due to potential distributor turn-over, all equipment warrantees must be provided by the manufacturer and shall adhere to the 5-year warranty offered by the system selected as the basis of design in these specifications. Submittals shall include documentation of the manufactures five-year warranty.

1.07 MANUFACTURERS

- A. The basis of design for the internal communication, notification and classroom workflow enhancement system is the Rauland Telecenter U. Other manufactures shall be considered however, final acceptance of the system will be by the owner. If the installed system for this project is not the basis of design and the owner is not satisfied with the installed system, Final Acceptance will not be given and the system providing contractor must provide the basis of design, installed at no cost to the owner and to the owner's satisfaction in accordance with the performance requirements of these specifications and adhering to the manufacturer's recommended installation guidelines. Requests for substitution or addition of any of the below manufacturer's approved for bidding must be received by the General Contractor and granted by the Engineer of record 10 days prior to the bidding date.
 - 1. Rauland Telecenter U
 - 2. Authorized Distributor:
 - a. Name Open Systems Metro
 - b. Contact:

c. Email:

PART 2 PRODUCTS

2.01 SYSTEM REQUIREMENTS

- A. Provide complete and satisfactorily operating school internal communication, notification, management, and classroom workflow enhancement system as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated.
- B. The single, MS Windows server, software-based platform shall natively provide but not be limited to, a minimum of 10 audio channels for each individual school, classroom IP Speaker Modules, Status Lights, Message Boards, call switches, IP Zone Modules, IP Administrative Console(s), SIP trunk enabled VOIP integration, local and district-wide paging, emergency notifications, calendar-based scheduling, application programming interface and integrated mapping. System shall include the latest classroom workflow enhancement capabilities as described herein.
- C. Each Classroom shall be provided with a speaker, a Speaker Module interface, a status light, and call-in capability from the POE classroom workflow interface. The interface shall provide the classroom teacher with the ability to place up to 168 different types of calls and workflow requests to specific locations, including "Normal," "Emergency," "Check-in," "Needs Cleaned," "Cleaned," etc. Systems that rely solely on a phone or intercom handset or systems that cannot silently indicate classroom lockdown status shall not be acceptable.
- D. Call-ins shall be prioritized, and each classroom shall be able to select a minimum of 5 call locations simultaneously. Systems that do not allow for classrooms to initiate call-ins and or workflow requests to more than one location, simultaneously shall not be acceptable.
- E. Call-ins shall automatically display priority and origin location on administrative consoles, interactive map, and SIP trunk enabled phones. System shall provide the ability to annunciate a Text-To-Speech audio message of call-ins that include priority and origin location information, automatically using overhead speakers. Workflow requests shall also be capable of initiating a Text-to-Speech overhead page and visual notification on message boards as described herein.
- F. Call-ins shall be programmed to automatically change priority and annunciation destination based on age of call-in or time of day the call-in is placed. Workflow requests shall also be capable of being escalated as described herein.
- G. After office staff depart for the day, classroom call-in destinations shall be automatically re-routed to locations attended by security personnel or designated location as defined by end-user. Classroom call-in destinations shall automatically return to default call destinations prior to the start of each school day.
- H. The platform shall lend itself to expansion by simple addition of hardware modules without having to adjust or change the main software.
- I. The system shall allow for the adjustment of individual volume levels of incoming intercom, paging and program volumes from within the classroom, by properly credentialed personnel on the interactive POE workflow interface. Locally adjusted volume levels shall not interfere with the volume and distribution of emergency notifications.
- J. The system shall include Text-To-Speech capability. Text-To-Speech is required to allow for the automatic distribution of audio messages generated by user-designated system activity. For Text-To-Speech audio messages, individual specifics of a classroom call-in shall be included in an audio notification which is then distributed to a speaker, group of speakers or all speakers. Messages shall also be displayed visually on designated message boards.

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1. This specific project requires the system to distribute an audio message to all speakers when an emergency call-in has been activated from a classroom. Audio message shall contain and identify the priority name, priority number, room name, room extension. (All call switches must be capable of initiating a minimum of normal and emergency call priorities from their location.)
 2. Example audio and visual page for this specific project: "...An emergency call has been activated in room 116..."
 3. Duration, volume and content shall be programmable and customizable but must include the origin location and priority of the call.
- K. The platform shall connect directly to an existing, standard protocol WAN/LAN network, without the need for a separate server or PC at each school location. Daily use, configuration, bell schedules, and emergency sequences shall all be accessible by an authorized user on the native, web-based user interface.
- L. The platform shall provide the ability to monitor individual classrooms in emergency situations from any administrative console or SIP trunk connected telephone from within the facility or from outside the facility. Communication from within the classroom shall be hands-free.
- M. The system shall provide but not be limited to the following during a Lockdown condition:
1. A prerecorded, condition specific (Lockdown) audio message, shall be distributed to every designated speaker within the affected facility.
 2. A visual notification shall be distributed to every designated message board in the facility.
 3. User defined, integrated systems shall be activated through logical, API integrations.
 4. User defined, automatic municipal notification.
 5. Classroom and zone status lights shall indicate lockdown and check-in status condition.
 6. Initiate classroom check-in requirement.
 7. Appropriate response instructions shall be sent to classrooms and viewable on the POE classroom workflow interface.
 8. Classrooms shall be capable of indicating the successful completion of their classroom lockdown procedures via their call switch and or POE classroom workflow interface. All check-in procedures shall be logged with the system activity logging software.
 9. Administrators shall be able to initiate two-way communication, without a pre-announcement tone, to the classroom during an emergency via the administrative console or any SIP trunk connected phone.
 10. Individual classroom check-in and school emergency status shall be viewed from the web-based user interface on the native mapping, a local Administrative Console, or the IOS/Android mobile application.
 11. Bell schedules shall be automatically disabled during user-selected emergency sequences.
 12. At the conclusion of the emergency, a system-wide All Clear shall be capable of being sent from an Administrative Console, classroom workflow interface or the native, web-based, user interface.
 13. Pre-recorded Lockdown audio message shall also be transmitted to all school district radios. If the owner desires, audio message shall also be capable of being transmitted to local municipal responder radios.
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- N. IP Addressable Classroom Speaker Modules for individual rooms shall be system programmable and may be assigned any two through six-digit number as well as name and description. Any extension may be reassigned at any time. Systems that do not allow for IP assignment of classroom control devices shall not be acceptable. Systems that limit or do not contain TCP/IP configuration or systems that only configure by a MAC address for classrooms shall not be acceptable.
- O. IP-enabled two-way voice communication shall be available from any administrative console, SIP trunk connected telephone to classroom speakers in a school within the district. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when the talk/listen path is active, complying fully with all privacy legislation. Preannounce tone, supervisory tones and bell schedule tones shall be programmed to automatically disable during designated emergencies. The system shall also be able to provide two-way intercom and messaging to the interactive POE workflow interface for general and emergency communications.
- P. The platform shall include a native, calendar-based scheduling application that allows users to view and amend bell schedules by selecting the month(s) and day(s) to view in a calendar format. Authorized users shall be able to configure multiple bell schedules per school, with a minimum of 500 unique events per schedule. Scheduled events shall include daily bell tones, relay actions, wayfinding announcements and direction, email notifications, visual messaging, status lights and paging exclusions as system configuration changes. The platform shall allow control of the bell schedules via the district WAN/LAN without the need for a separate server or PC at each school location. Bell schedules shall be locally or remotely created and changed by an authorized user through the native web-based user interface. Scheduling shall include the following minimum features:
1. 20 unique bell schedules per school
 2. Minimum of 5 simultaneously active schedules on any given campus.
 3. User selectable tones as well additional user created and uploaded audio files for class change signaling and messaging.
- Q. The platform shall connect to existing PA/intercom systems throughout the district and utilize them to provide distribution of live, pre-recorded, emergency or ad-hoc audio distribution as well as bell schedule tones. Connection to existing PA/intercom systems shall also support visual message boards, classroom status lights, POE classroom workflow interfaces and panic buttons in schools regardless of the manufacturer of the existing and installed intercom system in each school.
- R. The platform shall allow for the hybrid connection of existing 25 Volt analog speakers and call-in devices that remain connected on existing wiring to provide two-way audio, call-in, and event/bell scheduling, classroom check-in and software-based volume level adjustments. The system shall also provide for the ability to utilize IP-addressable classroom speakers and hybrid connectivity within the same school.
- S. The school district shall not be responsible for recurring annual licensing or subscription fees related to this system. A minimum of 12 years of licensing fees for the provided system shall be included and provided in this contract by the installing contractor at no additional cost to the owner.
- T. The platform allows for emergencies to be initiated as a "Drill." Drill sequences replicate all on-site emergency procedures and can be programmed to exclude any outside connection to municipal responders or actions as determined by the owner. All system activity for drills shall be documented on the included system reporting software.
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- U. The platform shall provide status lights that display the status of individual classrooms, and aggregately for hallways, zones or sections of a school and school-wide status. Status lights shall be customizable in color and flash rate based on event type and priority.
 - V. Visual message boards shall be available in 2 sizes. Small message boards shall have 8 by 40 LED display with 3 color LED's. Large message board shall provide 1 or 2 lines with 16 by 80 LED display with 3 color LED's. During idle time, the message boards can display date and time. Message boards shall also be capable of providing countdowns for class change, display emergency status, comply with COVID protocols for wayfinding and creating messages on the fly. Classroom message boards shall also be capable of a count-up/count-down function for testing.
 - W. During a lockdown, status lights shall be configurable so as not to display classroom status until first responders arrive. Check-in notifications shall still be viewable on web-based browser, the mobile application, system console(s) and mapping application with the appropriate administrative credentials.
 - X. The system shall include a native graphical map application accessible from the web-based user interface. The mapping feature shall include a visual floorplan of the school and informs the user of system activity in real-time. Call-ins, active audio, active emergencies, and device status shall be capable of being viewed on the mapping screen for any school or all schools.
 - Y. The system shall provide the ability to connect to other critical systems within this school via a REST API for logic based inbound and outbound control to and from other systems within a school that include but are not limited to; fire alarm, access control, security systems and IPCCTV cameras and systems. Systems that rely solely on unsupervised, electronic relay connection of inbound and outbound control shall not be acceptable.

2.02 EQUIPMENT AND MATERIAL

- A. Enterprise Server and Software
 - 1. Provides a Windows based, single server platform with district-wide connectivity for native, individual school intercom, paging, bell event scheduling, emergency notification, text to speech and configuration for individual schools from a single server, accessed from anywhere via the web-based browser interface. The enterprise platform also provides for native, district-wide communication, control, notification and classroom workflow enhancements. Systems that require individual servers or PCs at each school location or 3rd party or OEM additions to main system to accomplish the above, required performances shall not be acceptable.
 - 2. Shall be capable of being installed in a virtual or physical server environment.
 - 3. Supports HTTPS browsing.
 - 4. Supports advanced encryption to ensure secure access.
 - 5. Specified users shall receive email notifications when system devices go offline.
 - 6. Includes logging and reporting of all system activity for a minimum of one year. These reports shall be capable of being exported to .CSV.
 - 7. Shall provide a minimum of 20 bell schedules per school, with a minimum of 5 simultaneous schedules assignable to a specific school day. Bell schedules can be programmed to announce tones, activate relays, swing configurations, send emails, activate program distribution, and notify SIP trunk connected phones. Schedules shall be accessible from anywhere, via the native, web-based browser interface, with the proper credentials.

8. Shall allow for programmable end points to be automatically included or excluded for live paging, visual notifications, bell tones, or prerecorded audio, depending on the time of day or day of the week. These inclusions/exclusions shall be capable of being applied manually or automatically.
 9. The software shall provide a native, district-wide graphical map view of all schools and their current status including emergency and on/off-line statuses.
 10. The software shall provide the ability to identify individual classrooms that are not checked-in during an emergency using any web browser on the district's network. The software shall identify the name, extension, of the classroom that is not checked-in during the emergency.
 11. Shall provide a minimum of 18 customizable emergency sequences, including condition specific All-Clear – with the ability to return the system to normal status.
 12. Shall provide simultaneous communications to all schools or groups of schools within a district.
 13. The system provides the ability to export lists of bell schedule steps, emergency sequences, staff directory, users, peripherals, and zone targets.
- B. Campus Controller
1. Provides call routing for paging and intercom for a single school or building on the district's network.
 2. Supports a numbering plan allowing two, three, four, five, or six-digit extensions.
 3. Ability to upgrade priority level from individual call-in activation.
 4. The ability to automatically escalate incoming call-ins to an alternate console, telephone or group of telephones if a call-in remains unanswered for a predetermined amount of time.
 5. Synchronizes system time to the district network time server.
 6. Shall support a minimum of 100 independent zones for zone paging, program/music, distribution zones and class change tone zones; these assignments are a programmable function, changeable by time of day.
 7. Shall support program distribution to be activated manually or automatically through an event/bell schedule.
 8. Shall provide local survivability of 100% of local school communications if disconnected from the central server for a minimum of 14 days. Systems that cannot operate at all or operate in a degraded mode due to same conditions as indicated above, shall not be acceptable.
 9. Provides SIP trunk interface to a district provided Telephone Network and shall be capable of allowing connected phones to display classroom call-ins, answer internal intercom call-ins, make pages, and change priorities of call-ins in progress. SIP trunk Interface shall provide:
 - a. Audio paging access from any sip trunk connected telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
 - b. Ability to answer a call-in directed to a SIP trunk connected extension.
 - c. Ability to upgrade a call-in directed to a SIP trunk connected extension.
 - d. Ability to initiate a school-wide emergency including lockdown and evacuation sequences from a SIP trunk connected telephone.
 - e. SIP device shall display call-in identification including classroom name, room number, and priority level.
 - f. In administrative areas where there are no overhead speakers send audio pages to a SIP trunk connected phone or group of phones, as determined by the owner.

C. POE Administrative Console

1. A full color screen with 64 soft keys, 3-line select, volume control, push to talk, speakerphone mode and left/right and up/down scrolling.
2. Shall allow for a PIN code for all actions individually or selected actions. Systems that require a PIN for "all or none" shall not be acceptable.
3. Audio paging access from any Console to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire school as well as any owner defined SIP trunk connected phones or groups of phones.
4. Ability to perform intercom to any single IP Addressable Speaker Module.
5. Ability to display a minimum of 3 call-ins at a time on the screen while other call-ins are annunciating and the ability to scroll to view all call-ins.
6. Ability to upgrade a call-in priority via soft key.
7. Displays classrooms that have not activated a system check-in from a check-in activation, during an emergency event.

D. POE Kiosk

1. The POE, interactive, multi-touch, Kiosk provides a self-contained, full system control interface with two-way IP audio and contains features to enhance classroom workflow. The Kiosk shall be permanently mounted. See plans for locations. The Kiosk can be installed and associated with an IP classroom speaker module for control of classroom devices, classrooms controlled by the hybrid gateway interface or as a stand-alone control and communication device when a classroom endpoint is not needed. The Kiosk shall provide a minimum of 8 separate user-definable screens, protected by a 3-level hierarchy of protection: Public, Standard and Override. The control fields support up to 168 control options as defined by individual widgets or a combination of widgets. At minimum, the Kiosk shall support user definable actions that allow for any combination of the following:
 - a. Receive and initiate two-way audio with any console or SIP trunk connected phone.
 - b. Selection of up to 168 options for call-ins/workflow requests with up to 999 priorities from which to assign to each call/request. This project requires every classroom to be able to initiate these call-in/workflow request options for direct connection to:
 - 1) Custodian
 - 2) Library
 - 3) Security
 - 4) Office
 - 5) Nurse
 - 6) Needs Cleaning
 - 7) Cleaned
 - 8) Lockdown (with protected access by administration only)
 - c. Receive an audio page as part of a zone, multi-zone or all page.
 - d. Call any location that has an Administrative Console or SIP trunk connected phone.
 - e. Initiation of emergency sequences
 - f. Volume adjustments for the associated classroom speaker. Hard-wired, individual volume controls that are limited to all or none and do not allow for higher priority pages to bypass local volume settings shall not be acceptable.
 - g. Classroom Testing Mode shuts off normal pages, bell tones, intercom and program sources for testing while allowing all emergency notifications to come through. Shall also allow for the activation of the Status Light to owner selected color to indicate that testing is taking place inside the associated room.
 - h. Select program sources for music in the classroom with volume control.

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- i. Ability to disable the screen for a short time to clean it from a button.
 - j. Count up/count down time display
 - k. Call placed assurance indication
 - l. Call answered indication
 - m. Call ended indication
 - 2. Under Emergency conditions, the Kiosk in each classroom shall be capable of receiving and displaying written instructions outlining the appropriate response for each emergency condition. Classrooms are to follow these instructions. Kiosk shall also include a check-in option to acknowledge receipt of notification and the completed execution of classroom response protocols, specific to the condition that has been activated.
 - 3. The Kiosk widget assignment shall include the ability to select from a minimum of 999 call-in/workflow request priorities and apply them to a minimum of 168 desired actions associated with each individual widget. After final acceptance, changes in widget priority, destination, size, color and quantity shall not require the additions of cable or the installation of back-boxes to support the additions of call-in/workflow request priorities and targets based on the current or future needs of the classroom.
- E. The Kiosk shall be installed in all administrative rooms and offices that do not have a talk-back speaker and or call station. Hybrid Gateway
- 1. Provides integration of existing analog wiring consisting of shielded two-pair classroom field wiring. The Gateway provides the ability to reuse speaker wiring, speakers, and punch blocks to integrate analog infrastructure with IP platform.
 - 2. Shall output a minimum of 5 watts of power per port and 25 watts total per device.
 - 3. Shall support a minimum of 24 classrooms.
 - a. Systems that do not utilize industry standard 25-volt transformers shall not be acceptable.
 - 4. Shall support minimum of 999 call switch priorities per classroom and capable of lockdown check-in.
 - 5. Shall support classroom intercom and paging from browser-based user interface.
 - 6. Shall support installations that require a combination of analog Gateway and IP Addressable Modules.
- F. POE Classroom/Speaker Modules:
- 1. System shall include IP Addressable Classroom/Speaker Modules for classroom connection of speaker and other classroom devices.
 - 2. Shall support DHCP.
 - 3. Shall connect to network with a single RJ45 connector.
 - 4. Shall support privacy. When the Privacy switch is activated, it prevents administrative or classroom telephones from monitoring the specific classroom/location intercom speaker.
 - 5. Shall be designed to mount near ceiling and wall speakers in a plenum space
 - 6. Shall support intercom, paging and level adjustment through the browser-based user interface or associated Kiosk. Manual or analog classroom volume controls that do not allow for emergency notification announcements to override classroom volume settings, shall not be acceptable.
 - 7. Shall support and power a status light that displays individual classroom status including but not limited to call-ins of any priority, testing and emergency check-in.
 - 8. Shall support supervision of call-switches.
- G. POE Zone Paging Module
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1. Shall be IP addressable and connect multiple speakers for district all page, zone paging, bells, audio events and, emergency notification.
 2. Shall be rack and wall mountable.
 3. Shall be able to belong to one or more than one independent zones for live paging, bells, pre-recorded audio, and emergency notification.
- H. POE, Aux I/O Module
1. Shall be IP addressable with two input contacts and two output contacts.
 2. Contacts shall be individually addressable.
 3. Shall be wall and rack mountable.
 4. Shall be activated manually, by event/bell schedule, or as part of alternative condition sequence.
- I. POE Program Line Input Module
1. Shall be IP addressable and provide line level audio program distribution into system.
 2. Shall have a 3.5mm cable jack.
 3. Shall be configured via web-based user interface.
 4. Shall support assignment of system priority level such that emergency communications may override Line Input Module when active.
- J. POE Microphone Input Module
1. Shall be IP addressable.
 2. Shall support dynamic and condenser style microphones.
 3. Shall support microphones with or without Push-To-Talk functionality.
 4. Shall support configurable paging priorities.
 5. Shall have adjustable microphone gain levels.
 6. Shall support automatic increase of audio priority during an emergency.
- K. POE Zone Page Powered Amplifier Module
1. Shall be IP addressable and provide 14 or 35 watts output.
 2. Shall be wall or rack mounted.
 3. Powered with either a wall wort or POE+
- L. POE Visual message boards.
1. Shall be IP addressable and powered by POE or POE+.
 2. Shall be available in 2 sizes
 3. Large: 2 lines 16 by 80 LED display
 4. Small: 1 line 8 by 40 LED
 5. 3 color LEDs: Red, Amber and Green
 6. Shall be self-contained and mountable on a Sigle-gang box without additional backboxes.
 7. Shall be wall or ceiling mounted. Small messages boards shall be dual mountable (back-to-back.)
 8. Small message board may be mounted in combination speaker and message board baffle and installed either flush or surface mount.
 9. Shall be capable of displaying messages up to 100 characters long.
 10. Shall support the addition of a Status Light
 11. Shall be assigned to any or all zones or individually for message distribution.
 12. Shall be capable of displaying messages on the fly as generated in the user interface accessible through the web-based browser interface.
 13. Shall display location an emergency call-button or widget within a school.

14. Shall be convertible to a count-up/count-down mode with the addition of local control panel.
- M. POE Combination Speaker/Clock/Message Board
 1. Shall be IP addressable
 2. Houses a message board IP speaker module, and speaker in single baffle
 3. Includes a high efficiency, full range 8" speaker and a small message board
 4. Transmits system audio and shows time on digital display
 5. Visually indicates condition changes and audio messaging
 6. Shall be flush or surface mount
 7. Connects to IP Classroom module for control, programming, and distributed audio and visual messaging.
- N. Status Light
 1. Shall be powered and controlled by an IP Classroom Module.
 2. Shall support separation and individual indication of classroom status and school wide status.
 3. Shall provide customizable and user-definable colors and blink patterns based on status priorities.
 4. Shall indicated status of individual, associated classrooms as initiated by teacher via a call station or Kiosk.
 5. Shall provide an aggregate condition status of a selected zone of rooms or locations to indicate overall status of the selected zone.
- O. Normal/Emergency Call Switch
 1. Normal/Emergency call stations are a single station, two-button, supervised station that provides call-ins with individual priority for each button. The "NORMAL" call button shall be clearly labeled and color coded (white) and shall initiate a normal call to the pre-selected destination. The "EMERGENCY" button shall be clearly labeled and color coded (Red) and shall initiate an emergency call from the classroom to the preselected destination and shall be capable of changing the associated classroom status light to indicate the presence of an initiated emergency call from the classroom. Under Lockdown condition, the "NORMAL" button shall automatically serve as a classroom, Lockdown Check-in button and shall be capable of changing the associated classroom status light to indicate an absence of or confirmation of completed lockdown response actions by the teacher or designated person within the classroom. All call-in stations shall be supervised by the main system. See plans for required locations of the Normal/Emergency call stations.
- P. Emergency/Check-In Call Switch

1. Emergency/Check-in call stations are a single station, two-button, supervised station that provides call-ins with individual priority for each button. The "EMERGENCY" call button shall be clearly labeled and color coded (Red) and shall initiate an emergency call from the classroom to the preselected destination and shall be capable of changing the associated classroom status light to indicate the presence of an initiated emergency call from the classroom. Under Lockdown condition, the "CHECK-IN" button shall automatically serve as a classroom, Lockdown Check-in button and shall be capable of changing the associated classroom status light to indicate an absence of or confirmation of completed lockdown response actions by the teacher or designated person within the classroom. The "CHECK IN" button shall be clearly labeled and color coded (Blue.) All call-in stations shall be supervised by the main system. See plans for required locations of the Emergency/Check-in call stations.

END OF SECTION

SECTION 280153
CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM - American Society for Testing and Materials; Current.
- B. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).

1.02 SUMMARY

- A. Section Includes:
 - 1. RS-485 cabling.
 - 2. Fire alarm wire and cable.

1.03 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 PRODUCTS

2.01 RS-232 CABLE

- A. Standard Cable: NFPA 70, Type CM.
 - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Polypropylene insulation.
 - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - 4. PVC jacket.
 - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
 - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Plastic insulation.
 - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - 4. Plastic jacket.
 - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with NFPA 262.

2.02 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CM or CMG.

1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. PVC insulation.
 3. Unshielded.
 4. PVC jacket.
 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. Fluorinated ethylene propylene insulation.
 3. Unshielded.
 4. Fluorinated ethylene propylene jacket.
 5. Flame Resistance: NFPA 262, Flame Test.

2.03 FIRE ALARM WIRE AND CABLE

- 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. Comtran Corporation.
 2. Draka Cableteq USA.
 3. Genesis Cable Products; Honeywell International, Inc.
 4. Rockbestos-Suprenant Cable Corp.
 5. West Penn Wire; a brand of Belden Inc.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760 and plenum rated.
- C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation and plenum rated.
1. Low-Voltage Circuits: No. 16 AWG, minimum.
 2. Line-Voltage Circuits: No. 12 AWG, minimum.
 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

WIRING METHOD

- A. Install wiring in metal pathways and wireways.
1. Minimum conduit size shall be 3/4 inch. Control and data-transmission wiring shall not share conduits with other building wiring systems.
 2. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."
- B. Install cable, concealed in accessible ceilings, walls, and floors when possible.
- C. Comply with NECA 1 and NFPA 72.
- D. Wiring Method: Install wiring in metal pathway according to Section 260529 "Hangers and Supports for Electrical Systems."

1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.
- E. Wiring Method:
1. Cables and pathways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 2. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or pathway as signaling line circuits.
- F. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- G. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- H. Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and another for supervisory circuits. Color code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- I. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- J. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
1. CONNECTIONS
 - a. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

FIRESTOPPING**COMPLY WITH REQUIREMENTS IN SECTION 07 8413 "PENETRATION FIRESTOPPING."**

- A. Comply with TIA-569-D.
- B. Comply with BICSI Information Technology Systems Installation Methods Manual.
 1. GROUNDING
- C. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding."
 1. FIELD QUALITY CONTROL
 - a. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- D. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- E. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- F. Prepare test and inspection reports.

END OF SECTION

**SECTION 281000
ACCESS CONTROL**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Access control system requirements.
- B. Access control units and software.
- C. Access control point peripherals, including readers.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - FIRESTOPPING.
- B. Section 087100 - Door Hardware: Electrically operated door hardware, for interface with access control system.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
- D. Section 260533.13 - Conduit for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 271000 - Structured Cabling: Data cables for access control system IP network connections.

1.03 DEFINITIONS

- A. Access Control Cloud Services: Subscription-based hosted application utilizing Software as a Service (SaaS) delivery model in lieu of on-premises servers/software.

1.04 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 294 - Access Control System Units; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other installers to provide suitable door hardware as required for both access control functionality and code compliance.
 - 2. Coordinate the placement of readers with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 3. Coordinate the work with other installers to provide power for equipment at required locations.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Preinstallation Meetings:
 - 1. Conduct meeting with facility representative to review reader and equipment locations.

2. Conduct meeting with facility representative and other related equipment manufacturers to discuss access control system interface requirements.

1.06 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.
- D. Evidence of qualifications for installer.
- E. Manufacturer's detailed field testing procedures.
- F. Field quality control test reports.
- G. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.
- H. 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 that will be providing contract maintenance and trouble call-back service.
- I. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.07 QUALITY ASSURANCE

- A. Comply with the following:
 1. NFPA 70.
 2. NFPA 101 (Life Safety Code).
 3. The requirements of the local authorities having jurisdiction.
 4. Applicable TIA/EIA standards.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with access control systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.
- C. Maintenance Contractor Qualifications: Same entity as installer.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
- B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.09 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Access Control Units - Basis of Design: Brivo, as indicated under product descriptions below; www.brivo.com/#sle.
- B. Access Control Units:
 - 1. Brivo: www.brivo.com/#sle.
- C. Access Control Software - Existing Avigilon Unity Access 7 Professional
- D. Readers:
 - 1. HID: Signo Readers Model 20 to match existing building type.

2.02 ACCESS CONTROL SYSTEM REQUIREMENTS

- A. Provide modifications and extensions to existing access control system consisting of required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. System Battery Backup: Provide batteries/uninterruptible power supplies (UPS) as required for 90 minutes of full operation.
- C. Access Control Points:
 - 1. See article "ACCESS CONTROL POINT PERIPHERALS" below for device descriptions.
 - 2. Elevator Number 1:
 - a. Location: Each Floor.
 - b. Access: Free access to elevator call, controlled access to designated floors.
 - c. Peripherals Outside Elevator on Designated Floors:
 - 1) Reader: Contactless smart card reader.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 1. Access Control Units and Readers: Listed and labeled as complying with UL 294.

2.03 ACCESS CONTROL UNITS AND SOFTWARE

- A. Provide access control units compatible with readers to be connected.

2.04 ACCESS CONTROL POINT PERIPHERALS

- A. Provide devices compatible with control units and software.
- B. Provide devices suitable for operation under the service conditions at the installed location.
- C. Readers:
 - 1. General Requirements:
 - a. Provide readers compatible with credentials to be used.
 - 2. Reader Controllers:
 - a. Avigilon LP1501-1 (1) door reader controller.
 - b. Avigilon LP1502-2 (2) door access controller.
 - 3. Card Reader (CR):
 - a. Basis of Design: HID Signo Model 20.

- b. Credentials Supported: Communicates with 13.56 MHz smart cards and 125 kHz proximity cards.
 - c. Features:
 - 1) Mullion mount.
 - 2) Black color.
 - 3) 12V DC.
- D. Door Position Switches (DC):
 - 1. Magnetic Door Contacts: Encapsulated reed switch(es) and separate magnet; designed to monitor opened/closed position of doors.
 - 2. Contact Color: White unless otherwise indicated.
 - 3. Products:
 - a. Interlogix 1070D-G.
 - b. Substitutions: See Section 016000 - Product Requirements.
- E. Request to Exit Devices:
 - 1. Request-To-Exit Sensors (REX): Passive infrared.
 - a. Products:
 - 1) Bosch DS150i series or equal.
 - 2) Substitutions: See Section 016000 - Product Requirements.
- F. Door Locking Devices (Electric Strikes Locks): Furnished and installed by GC. refer to Division 087100.

2.05 ACCESSORIES

- A. Provide components as indicated or as required for connection of access control system to devices and other systems indicated.
- B. Unless otherwise indicated, credentials to be provided by Contractor.
 - 1. Provide credentials compatible with readers and control units/software to be used.
- C. Unless otherwise indicated, network switches required for network connections to system components to be provided by Owner.
- D. Provide cables as indicated or as required for connections between system components.
 - 1. Data Cables for IP Network Connections: Unshielded twisted pair (UTP) complying with Section 271000.
- E. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install access control system in accordance with NECA 1 (general workmanship).

- B. Install products in accordance with manufacturer's instructions.
- C. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
 - 1. Use suitable listed cables in wet locations, including underground raceways.
 - 2. Use suitable listed cables for vertical riser applications.
 - 3. Use listed plenum rated cables in spaces used for environmental air.
 - 4. Install wiring in conduit for the following:
 - a. Where required for rough-in.
 - b. Where required by authorities having jurisdiction.
 - c. Where exposed to damage.
 - d. Where installed outside the building.
 - e. For exposed connections from outlet boxes to devices.
 - 5. Conduit: Comply with Section 260533.13.
 - 6. Conceal cables unless specifically indicated to be exposed.
 - 7. Use power transfer hinges complying with Section 087100 for concealed connections to door hardware.
 - 8. Cables in the following areas may be exposed, unless otherwise indicated:
 - a. Equipment closets.
 - b. Within joists in areas with no ceiling.
 - 9. Route exposed cables parallel or perpendicular to building structural members and surfaces.
 - 10. Do not exceed manufacturer's recommended maximum cable length between components.
- D. Provide grounding and bonding in accordance with Section 260526.
- E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- F. Identify system wiring and components in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Prepare and start system in accordance with manufacturer's instructions.
- C. Program system parameters according to requirements of Owner.
- D. Test for proper interface with other systems.
- E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four hours of training.
3. Location: At project site.

3.06 PROTECTION

- A. Protect installed system components from subsequent construction operations.

3.07 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide trouble call-back service upon notification by Owner:
 1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION

**SECTION 282000
VIDEO SURVEILLANCE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Video surveillance system requirements.
- B. Video recording and viewing equipment.
- C. Cameras.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - FIRESTOPPING.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260529 - Hangers and Supports for Electrical Systems.
- D. Section 260533.13 - Conduit for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 271000 - Structured Cabling: Data cables for IP video surveillance system network connections.

1.03 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- C. NECA 303 - Standard for Installing Closed-Circuit Television (CCTV) Systems; 2025.
- D. 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 cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 2. Coordinate the work with other installers to provide power for cameras and equipment at required locations.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Preinstallation Meetings:
 - 1. Conduct meeting with facility representative to review camera and equipment locations and camera field of view objectives.
 - 2. Conduct meeting with facility representative and other related equipment manufacturers to discuss video surveillance system interface requirements.

1.05 SUBMITTALS

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

- B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.
- D. Design Data:
 - 1. Standby battery/UPS calculations.
 - 2. Video storage capacity calculations.
- E. Certify that proposed system design and components meet or exceed specified requirements.
- F. Evidence of qualifications for installer.
- G. Evidence of qualifications for maintenance contractor (if different entity from installer).
- H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- I. Manufacturer's detailed field testing procedures.
- J. Field quality control test reports.
- K. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.
- L. 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 that will be providing contract maintenance and trouble call-back service.
- M. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- N. Maintenance contracts.
- O. Software: One copy of software not resident in read-only memory.

1.06 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70.
 - 2. Applicable TIA/EIA standards.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with video surveillance systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.
 - 1. Contract maintenance office located within 100 miles of project site.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.
- B. Store products in manufacturer's unopened packaging, keep dry 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 minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 VIDEO SURVEILLANCE SYSTEM

- A. Provide modifications and extensions to existing video surveillance system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated. Existing System is Avigilon Unity Video Enterprise.
- B. System Description: IP system with connection to network (IP) cameras.
 - 1. Video Storage Capacity: Upgrade existing storing video from all cameras for 30 days.
 - 2. System Battery Backup: Provide additional batteries/uninterruptible power supplies (UPS) as required for 90 minutes of full operation.
- C. Cameras Required:
 - 1. See article "CAMERAS" below for product descriptions.
- D. Video Recording and Viewing Equipment Required:
 - 1. See article "VIDEO RECORDING AND VIEWING EQUIPMENT" below for product descriptions.
- E. Provide products listed, classified, and labeled as suitable for the purpose intended.
- F. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.02 VIDEO RECORDING AND VIEWING EQUIPMENT

- A. Utilize existing DVR/NVR system recorders and software.
- B. Provide additional DVR/NVR recording capacity to accommodate (37) additional cameras to system with minimum 30 days recording storage.
- C. Network Video Recorders (NVRs):
 - 1. Supports connection of network (IP) cameras.
 - 2. Supports continuous and event-based recording.
 - 3. Network Video Recorder Type NVR6 Premium Form D:
 - a. Basis of Design: Avigilon NVR6-PRM-Form-d-160TB-S22.
 - b. Capacity: 160 TB.
- D. Software:
 - 1. Unless otherwise indicated, provide all software and licenses required for fully operational system.

2. Video Management System:
 - a. Basis of Design: Existing Avigilon Unity Video Enterprise Edition ACC 7 .

2.03 CAMERAS

- A. Provide cameras and associated accessories suitable for operation under the service conditions at the installed location. Provide additional components (e.g. enclosures, heaters, blowers, etc.) as required.
- B. Where not factory-installed, provide additional components (e.g. lenses, mounting accessories, etc.) as necessary for complete installation.
- C. Network (IP) Cameras:
 1. Signal-to-Noise Ratio: Not less than 50 dB.
 2. Provide the following standard features:
 - a. Automatic electronic shutter.
 - b. Automatic gain control.
 - c. Automatic white balance.
 - d. Web-based interface for remote viewing and setup.
 - e. Password protected security access.
 3. Network (IP) Camera 3-Head Sensors - Avigilon (C-3, C-2)
 - a. 24C-H5A-3MH
 - b. H5AMH-AD-PEND1
 - c. H5AMH-DO-COVR1
 - d. WLMT-1001
 - e. H4AMH-AD-IRIL1
 - f. POE60U01BTE
 4. Network (IP) Camera 2-Head Sensors - Avigilon 10.0C-H6ADH-D01-1R (C-14, C-16, C-24, C-26 C-27, C-29, C-31, C-35, C-37)
 5. Network (IP) Camera - Avigilon 4.0C-H6A-D1 (C-4, C-5, C-9, C-10, C-11, C-12, C-13, C-15, C-17, C-18, C-19, C-20, C-21, C-22, C-23, C-28, C-30, C-32, C-33, C-34, C-36)
 6. Network (IP) Camera - Avigilon 8.0C-H6A-BO1-1R (C-1, C-2).
 7. Network (IP) Camera - Avigilon 16.0C-H6ADH-D01-1R (C-6, C-7, C-8)
- D. Camera Enclosures and Mounting Brackets:
 1. Where not factory-installed, provide accessory camera enclosures suitable for operation under the service conditions at the installed location.
 2. Where not factory-installed, provide accessory camera mounting brackets necessary for installation.

2.04 ACCESSORIES

- A. Provide components as indicated or as required for connection of video surveillance system to devices and other systems indicated.
- B. Provide components as indicated or as required for system power and network connections.
- C. Provide accessory controllers as indicated or as required for operator control.
- D. Provide cables as indicated or as required for connections between system components.
 1. Data Cables for IP Network Connections: Unshielded twisted pair (UTP), minimum Category 6A , complying with Section 271000.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system where applicable.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install video surveillance system in accordance with NECA 1 (general workmanship) and NECA 303.
- B. Install products in accordance with manufacturer's instructions.
- C. Provide required support and attachment in accordance with Section 260529.
- D. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
 - 1. Use suitable listed cables in wet locations, including underground raceways.
 - 2. Use suitable listed cables for vertical riser applications.
 - 3. Use listed plenum rated cables in spaces used for environmental air.
 - 4. Install wiring in conduit for the following:
 - a. Where required for rough-in.
 - b. Where required by authorities having jurisdiction.
 - c. Where exposed to damage.
 - d. Where installed outside the building.
 - e. For exposed connections from outlet boxes to cameras.
 - 5. Conduit: Comply with Section 260533.13.
 - 6. Conceal all cables unless specifically indicated to be exposed.
 - 7. Cables in the following areas may be exposed, unless otherwise indicated:
 - a. Equipment closets.
 - 8. Route exposed cables parallel or perpendicular to building structural members and surfaces.
 - 9. Include service loop cable lengths to allow relocation of cameras within 20 feet of installed location.
- E. Provide grounding and bonding in accordance with Section 260526.
- F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- G. Identify system wiring and components in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- C. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.
- D. Program system parameters according to requirements of Owner.

- E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 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 system to Owner, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Location: At project site.

3.06 PROTECTION

- A. Protect installed system components from subsequent construction operations.

3.07 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of video surveillance system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- C. Provide trouble call-back service upon notification by Owner:
 - 1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION

**SECTION 283111
BUILDING INTRUSION DETECTION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Intrusion detection system requirements.
- B. Keypads.
- C. Initiating devices.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - FIRESTOPPING.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260533.13 - Conduit for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 634 - Connectors and Switches for Use with Burglar-Alarm Systems; Current Edition, Including All Revisions.
- D. UL 639 - Intrusion-Detection Units; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate compatibility of devices for the installed locations with work provided under other sections or by others.
 - 2. Coordinate the placement of sensors and keypads with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install sensors and keypads 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 standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.
 - 1. Motion Detectors: Include detailed motion detection coverage range diagrams.
- C. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include system interconnection schematic diagrams. Include requirements for interface with other systems.
- D. Design Data: Include standby battery calculations.

- E. Evidence of qualifications for installer.
- 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, installation, and operation of product.
- G. Manufacturer's detailed field testing procedures.
- H. 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 that will be providing contract maintenance and trouble call-back service.
- I. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- J. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with intrusion detection systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized representative of control unit manufacturer.
- 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.
- B. Store products in manufacturer's unopened packaging, keep dry 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 minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 INTRUSION DETECTION SYSTEM REQUIREMENTS

- A. Provide modifications and extensions to existing intrusion detection system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Alarm Control Unit: Existing addressable alarm control panel located as indicated.

- C. Keypads: Located as indicated.
 - 1. Within 6 feet
- D. Initiating Device Requirements:
 - 1. Protected Premises: Entire building as indicated.
 - 2. Provide magnetic contacts to monitor opened/closed position for:
 - a. All perimeter doors in project.
 - b. All overhead doors.
 - 3. Provide motion detectors to detect intruder in designated areas.
- E. Provide products listed, classified, and labeled as suitable for the purpose intended.
- F. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.02 ALARM CONTROL UNIT

- A. Manufacturers:
 - 1. Modify/expand existing Alarm Control Panel Vista 20.
- B. Alarm Initiating Circuits: Supervised.
 - 1. Hardwired Zones: Supports both normally closed and normally open conventional (non-addressable) initiating devices.
 - 2. Addressable Zones: Supports addressable initiating devices and modules using multiplexed polling loops.
- C. Alarm Notification Circuits: Supervised.
- D. Keypads: Supervised.
 - 1. Minimum Number of Keypads Supported: Equivalent to basis of design.

2.03 KEYPADS

- A. Manufacturer: Same as manufacturer of existing alarm control unit.
- B. Provides interface to alarm control unit for system control and remote annunciation.
- C. Provides visual notification of system status and zone information.
- D. Provides audible notification to indicate system status, entry/exit delay, and alarm situations; provide separate distinguishable sounds for alarm and trouble conditions.
- E. LCD Keypads: Displays system status and zone information using plain English on alphanumeric display; illuminated keys.

2.04 INITIATING DEVICES

- A. Manufacturers: Same as existing manufacturer of alarm control units where possible.
- B. General Requirements:
 - 1. Provide devices suitable for intended application and location to be installed.
 - 2. Outdoor Units: Weather resistant, suitable for outdoor use.
 - 3. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by control unit.
 - b. Provide suitable addressable modules for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
- C. Contacts:
 - 1. Listed and labeled as complying with UL 634.

2. Magnetic Contacts: Encapsulated reed switch(es) and separate magnet; designed to monitor opened/closed position of doors or windows.
 - a. Use standard security contacts (not balanced magnetic type) unless otherwise indicated.
 3. Contact Color: White unless otherwise indicated.
 4. Basis of Design Products:
 - a. Interlogix 1076N.
- D. Motion Detectors:
1. Listed and labeled as complying with UL 639.
 2. Dual Technology PIR/Microwave Motion Detectors: Designed to detect intruder using combination of passive infrared technology (by sensing movement of thermal energy between zones) and microwave technology (by sensing frequency shifts in emitted and reflected high frequency microwave signals).

2.05 ACCESSORIES

- A. Provide components as indicated or as required for connection of alarm control unit to devices and other systems indicated.
- B. Provide cables as indicated or as required for connections between system components.
- C. Provide end-of-line resistors (EOLR) as required for supervision of hardwired zones.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.
- E. 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. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
 1. Use listed plenum rated cables in spaces used for environmental air.
 2. Conduit: Comply with Section 260533.13.
 3. Conceal all cables unless specifically indicated to be exposed.
 4. Route exposed cables parallel or perpendicular to building structural members and surfaces.
- D. Provide grounding and bonding in accordance with Section 260526.
- E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- F. Identify system wiring and components in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Prepare and start system in accordance with manufacturer's instructions.
- C. Inspection and testing to include, at a minimum:
 - 1. Test each initiating device for proper response by alarm control unit.
 - 2. Test for proper operation of output relays.
- D. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.04 ADJUSTING

- A. Program system parameters according to requirements of Owner.

3.05 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

3.07 PROTECTION

- A. Protect installed system components from subsequent construction operations.

3.08 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of intrusion detection system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- C. Provide trouble call-back service upon notification by Owner:
 - 1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION

**SECTION 284600
FIRE DETECTION AND ALARM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.

1.02 RELATED REQUIREMENTS

- A. Section 211300 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
- B. Section 233300 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Drawings must be prepared using AutoCAD Release ____.
- C. Evidence of designer qualifications.
- D. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. System zone boundaries and interfaces to fire safety systems.
 - 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 - 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 - 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 - 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.

9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 11. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
 12. Certification by Contractor that the system design complies with Contract Documents.
- E. Evidence of installer qualifications.
- F. Evidence of instructor qualifications; training lesson plan outline.
- G. Evidence of maintenance contractor qualifications, if different from installer.
- H. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- I. Operating and Maintenance Data: See Section 017800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Complete set of specified design documents, as approved by authority having jurisdiction.
 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- J. Project Record Documents: See Section 017800 for additional requirements; have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- K. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
- L. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.

2. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
3. In addition to the items in quantities indicated in PART 2, furnish the following:
 - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 - b. One copy, on CD-ROM, of all software not resident in read-only-memory.

1.05 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
- D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- E. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Alarm Control Units and Accessories:
 1. Simplex, a brand of Johnson Controls: www.simplex-fire.com/#sle.
 2. Provide control units made by the same manufacturer.
- B. Initiating Devices and Notification Appliances:
 1. Simplex, a brand of Johnson Controls: www.simplex-fire.com/#sle.
 2. Same manufacturer as control units.

3. Provide initiating devices and notification appliances made by the same manufacturer, where possible.
- C. Substitutions: See Section 016000 - Product Requirements.
 1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.
 2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.02 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system: Tie into existing Simplex 4100ES.
 1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
 2. Protected Premises: Entire building shown on drawings.
 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the local authority having jurisdiction, which is _____.
 - c. Applicable local codes.
 - d. Contract Documents (drawings and specifications).
 - e. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
 5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
 6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
 7. Program notification zones and voice messages as directed by Owner.
 8. Fire Alarm Control Unit: New, located at fire command center.
 - B. Supervising Stations and Fire Department Connections:
 1. Public Fire Department Notification: By on-premises supervising station.
 2. On-Premises Supervising Station: Existing proprietary station operated by Owner, located at _____.
 3. Means of Transmission to On-Premises Supervising Station: Directly connected noncoded system.
 - C. Circuits:
 1. Initiating Device Circuits (IDC): Class B, Style A.
 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
 3. Notification Appliance Circuits (NAC): Class B, Style W.
 - D. Power Sources:
 1. Primary: Dedicated branch circuits of the facility power distribution system.
 2. Secondary: Storage batteries.
-

3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
4. Each Computer System: Provide uninterruptible power supply (UPS).

2.03 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
 1. Sprinkler water control valves.
 2. Dry-pipe sprinkler system pressure.
 3. Dry-pipe sprinkler valve room low temperature.
 4. Elevator shut-down control circuits.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
 1. Sprinkler water flow.
 2. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
 3. Duct smoke detectors.
- C. Elevators:
 1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
 2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
 3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.
- D. HVAC:
 1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
- E. Doors:
 1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 087100.

2.04 COMPONENTS

- A. General:
 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.
- C. Addressable Fire Alarm Control Unit - Basis of Design: Simplex Integrated Voice Emergency Evacuation Panel; www.pottersignal.com/#sle.
 1. System Capacity: 4,064 addresses; six notification appliance circuits (NACs), expandable to 192; four input/output (I/O) circuits; 1,500 software zones.
 2. Voice Integration:
 - a. Support two hours of message storage; internal library of predefined messages and tones; 255 customizable audio patterns; text-to-speech custom text translation.
 - b. Provide supervised low-level auxiliary input to interface with external audio sources and support background music applications.
 - c. Provide eight programmable push buttons for speaker and emergency communication system (ECS) zone assignment, expandable to 104 pushbuttons.

- d. Support connection of up to 31 single-channel amplifiers (SCA) or dual-channel amplifiers (DCA), 30 Model LOC-1000 local operator consoles, and one Model FFT-1000 firefighter telephone system supporting 24 phone circuits, expandable to 96.
- 3. Features: Strobe synchronization; dedicated alarm, supervisory and trouble relays; 4,000 event history buffer; built-in IP communicator; Ethernet port for programming and network connectivity; e-mail system status, reports and event information.
- D. Master Control Unit: _____.
- E. Remote Annunciators: _____.
- F. Addressable Modules:
 - 1. Provide addressable modules suitable for connection to fire alarm control unit signaling line circuits.
 - 2. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.
 - 3. Monitor Modules: Unless devices are explicitly permitted to be connected together as zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable fire alarm control unit.
 - 4. Control Modules: Provide as indicated or as required for selective control of notification appliances.
 - 5. Releasing Control Modules: Provide as indicated or as required for control of listed solenoids in releasing applications.
 - 6. Relay Modules: Provide as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.
 - 7. Signaling Line Circuit (SLC) Isolating Modules: Provide as indicated or as required to automatically isolate short circuits on connected sections of SLC loops and allow other sections to continue to function normally. Provide automatic reset upon correction of short circuit.
- G. Initiating Devices:
 - 1. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
 - b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
 - 2. Manual Pull Stations: _____.
 - 3. Smoke Detectors: _____.
 - 4. Duct Smoke Detectors: _____.
 - 5. Heat Detectors: _____.
- H. Notification Appliances:
 - 1. Speakers: _____.
 - 2. Strobes: _____.
- I. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.
- J. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
- K. Locks and Keys: Deliver keys to Owner.

- L. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
 - 1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 - 2. Provide one for each control unit where operations are to be performed.
 - 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 - 4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.

3.02 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.03 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 - 1. Hands-On Instruction: On-site, using operational system.
 - 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 - 1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
- D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.04 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.

2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 5. Repeat demonstration until successful.
- B. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
1. Approved operating and maintenance data has been delivered.
 2. Spare parts, extra materials, and tools have been delivered.
 3. All aspects of operation have been demonstrated to Owner.
 4. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 5. Specified pre-closeout instruction is complete.

3.05 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- C. Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 2 hours of notification.
 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- D. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- E. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- F. Comply with Owner's requirements for access to facility and security.

END OF SECTION

**SECTION 310519
GEOSYNTHETICS FOR EARTHWORK**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Geotextile for protection.
- B. Geogrid for reinforcement.

1.02 RELATED REQUIREMENTS

- A. Section 311000 - Site Clearing.
- B. Section 312200 - Grading.
- C. Section 312316 - Excavation.
- D. Section 312316.13 - Trenching.
- E. Section 312323 - Fill.
- F. Section 312500 - Erosion and Sedimentation Controls.

1.03 REFERENCE STANDARDS

- A. AASHTO M 288 - Standard Specification for Geosynthetic Specification for Highway Applications; 2017.
- B. ASTM D1621 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics; 2016.
- C. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus; 2014 (Reapproved 2018).
- D. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 2020.
- E. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles; 2015 (Reapproved 2023).
- F. ASTM D4595 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method; 2017.
- G. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 2015a.
- H. ASTM D4716/D4716M - Standard Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head; 2022.
- I. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile; 2020a.
- J. ASTM D4873/D4873M - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples; 2017 (Reapproved 2021).
- K. ASTM D4886 - Standard Test Method for Abrasion Resistance of Geotextiles (Sandpaper/Sliding Block Method); 2018.
- L. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics; 2012 (Reapproved 2019).
- M. ASTM D5321/D5321M - Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear; 2021.

- N. ASTM D6241 - Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile- Related Products Using a 50-mm Probe; 2014.
- O. ASTM D6706 - Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil; 2001 (Reapproved 2013).

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data on each product to be used, including physical properties, seaming materials, and installation instructions.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 016000 - Product Requirements for additional requirements.
- B. Identify, store, and handle geosynthetic rolls and samples according to ASTM D4873/D4873M.
- C. Protect materials from sunlight and other ultraviolet light sources during storage.
- D. Handle geosynthetics with care and prevent dragging, dropping, or imbalanced lifting.

1.07 FIELD CONDITIONS

- A. Temperature Requirements: Do not place geosynthetic when ambient air or base surface temperature is less than 40 degrees F or above 140 degrees F (60 degrees C).
- B. Surface Requirements: Do not place geosynthetic when the receiving surface is saturated or has ponded water.
- C. Follow recommendations of geosynthetic manufacturer.

PART 2 PRODUCTS

2.01 GEOSYNTHETIC

- A. Provide geosynthetic in largest size sheets as possible to minimize field joining.
- B. Uniform thickness according to ASTM D5199.
- C. Resistant to mildew, chemicals in soil, stable under freeze-thaw cycles, will not shrink or expand under wet conditions, and will not unravel or become clogged during use.
- D. Ultraviolet Stability: 65 percent, minimum, when tested in accordance with ASTM D4355/D4355M.

2.02 GEOTEXTILE

- A. General: As indicated on the drawings
 - 1. Material: Polyethylene consisting of 5 percent maximum regrind and free of contaminants.
 - 2. AASHTO M 288.
 - 3. Manufacturer as indicated on the drawings, or similar.
- B. Geotextile for Protection: Capable of absorbing and dissipating stress.
 - 1. Type: Woven.
 - 2. Seams: Mechanically sewn.
 - a. Overlap: 3 inches (7.6 cm).
 - b. Stitch: Flat; continuous; tied off at ends.

3. Grab Strength: 500 lb (2.2 kN), minimum, when tested in accordance with ASTM D4632/D4632M.
 4. Puncture Strength: 650 lb (2.9 kN), minimum, when tested in accordance with ASTM D6241.
 5. Sewn Seam Strength: 300 lb (1.3 kN), minimum, when tested in accordance with ASTM D4632/D4632M.
 6. Trapezoid Tear Strength: 120 lb (530 kN), minimum, when tested in accordance with ASTM D4533/D4533M.
- C. Geotextile Accessories:
1. Seaming Thread: High-strength; as recommended by manufacturer; contrasting color.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify the receiving surface is smooth, without ruts or protrusions, and grades are according to design drawings.
- B. Verify the geosynthetic is free of defects or flaws that may degrade physical performance.

3.02 PREPARATION

- A. Remove vegetation, boulders, and rocks larger than 3/4 inch in size and other sharp objects in accordance with Section 311000.
- B. Remove unsuitable materials in accordance with Section 312316.
- C. Fill in holes, including stake holes, backfill, and fill in accordance with Section 312323.

3.03 INSTALLATION

- A. General:
 1. Prevent surface drainage from eroding under geosynthetic. Repair undermined areas prior to backfill.
 2. Position geosynthetic smooth and wrinkle free on prepared surface; unroll or unfold carefully, avoiding stretching.
 3. Perform seaming in adequate lighting. Seam each geosynthetic member immediately after final placement. Clean sheets of dust, dirt, and other foreign matter prior to seaming.
- B. Protection:
 1. Install geotextile according to manufacturer's recommendations.
 2. Lay sheets in the direction of incline.
 3. Repairs: Remove damaged portion of geotextile and seam an additional layer to cover the affected area in all directions.

3.04 BACKFILL

- A. Obtain approval for geosynthetic sheet installation from Architect before placing fill.
- B. Backfill in a manner to prevent damage to geosynthetic. Repair geosynthetic damaged during backfill operations.
- C. Cover geosynthetic in the installed direction in accordance with Section 312323.
 1. Cover geosynthetic within time limits specified by manufacturer.
 2. Drive only on earth cover and use only rubber-tired or rubber-tracked vehicles.

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.

- B. Provide manufacturer's field representative at all times during geosynthetic installation.
- C. Inspect completed liner for pinholes, punctures, and tears; inspect seams and joints for unbonded areas. Repair any defects or damages found.

3.06 PROTECTION

- A. Do not exceed geosynthetic manufacturer's recommended exposure to UV radiation.
- B. Prevent surface water runoff from contaminating geosynthetic.
- C. Do not use pins or staples where risk of damaging underlying geosynthetic layer is present.
- D. Erect barricades to prevent traffic over geosynthetic before it is filled.

END OF SECTION

**SECTION 311000
SITE CLEARING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clearing and grubbing.
- B. Selective removal and trimming.
- C. Repair and restoration.
- D. Debris removal.

1.02 REFERENCE STANDARDS

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sedimentation Barrier: See Section 015713 - Temporary Erosion and Sediment Control.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Comply with additional requirements specified in Section 017000 - Execution and Closeout Requirements.

3.02 PREPARATION

- A. Coordinate work with utility companies; notify before starting work and comply with local requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are to remain.
- E. Install sedimentation barrier according to Section 015713 - Temporary Erosion and Sediment Control.

3.03 CLEARING AND GRUBBING

- A. Clearing: Cut trees, stumps, shrubs, downed timber, and other vegetation for removal within identified area as indicated on drawings according to 29 CFR 1910.266. Follow recommendations of ANSI Z133 and best local practices for species involved.
- B. Clear site after relocating vegetation in accordance with ANSI A300 Part 6.
- C. Do not remove or damage vegetation beyond limits indicated on drawings.
- D. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum subsoil disturbance.

3.04 SELECTIVE REMOVAL AND TRIMMING

- A. Selective Removal: Individual tree and shrub identified for removal as indicated on drawings according to 29 CFR 1910.266.
- B. Selective Trimming: Individual limbs and branches cut back according to ANSI A300 Part 1 identified for removal as indicated on drawings. Follow recommendations of ANSI Z133 and best local practices for species involved.

3.05 REMOVED VEGETATION PROCESSING

- A. Do not burn, bury, landfill, or leave on-site, except as indicated on drawings.
- B. Trees: Sell if marketable.

3.06 REPAIR AND RESTORATION

- A. Remaining Existing Facilities, Utilities, and Site Features: If damaged due to this work, repair or replace to original condition.
- B. Vegetation: Replace damaged or destroyed vegetation identified to remain as indicated on drawings at no cost to Owner:
 - 1. Outside removal limits.
- C. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner or the Owners Representative.

3.07 DEBRIS REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and windblown debris from public and private lands.

END OF SECTION

**SECTION 312200
GRADING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rough grading.
- B. Fine grading.

1.02 RELATED REQUIREMENTS

- A. Section 311000 - Site Clearing.

1.03 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Gravel: Excavated on-site.
 - 1. Graded according to ASTM D2487 Group Symbol GW, GP, or SP.
- B. Topsoil - Soil Type ____: Complying with State of NY, Highway Department standards.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify survey bench mark and intended elevations for grading areas are as indicated.
- B. Verify the absence of standing or ponding water.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect above- and below-grade utilities to remain.
- D. Provide temporary means and methods to remove standing or ponding water from areas prior to grading.
- E. Protect site features to remain, including but not limited to bench marks, survey control points, and fences.

3.03 ROUGH GRADING

- A. Excavate and fill subgrade material to elevations indicated on plans.
- B. Remove and replace unsuitable materials as specified fill.

3.04 FINE GRADING

- A. Scrape and spread subgrade material uniformly smooth and without disruptions as indicated on drawings.

3.05 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Leave site clean and raked, ready to receive work.

END OF SECTION

**SECTION 312316.13
TRENCHING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Trench excavation.
- B. Utility bedding and cover.
- C. Backfill and compaction.
- D. Dewatering.

1.02 RELATED REQUIREMENTS

- A. Section 311000 - Site Clearing.
- B. Section 312200 - Grading.
- C. Section 312316 - Excavation.
- D. Section 312323 - Fill.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.
- B. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop; 2025.
- C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2019.
- D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012, with Editorial Revision (2015).
- E. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012, with Editorial Revision (2015).

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Deliver fill to project site in advance of need.
- C. When fill materials need on-site storage, locate stockpiles where indicated on drawings.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill: Comprised of sand and gravel; free of shale, clay, friable materials, and debris.
- B. General Fill - Fill Type Fill Type Satisfactory Soils.: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations..

- C. Structural Fill - Fill Type Select Granular Item 203.07: Complying with State of NYS DOT standard.
- D. Granular Fill - Fill Type Bedding Stone: Angular crushed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 1 inch sieve: 100 percent passing.
 - b. 1/4" sieve: 35 to 60 percent passing.
 - c. No. 40: 10 to 25 percent passing.
- E. Granular Fill - Fill Type Drainage Course : Comply with the NYS DOT Specification.
 - 1. Material shall meet the requirements of Item 605.0901, Type 1, or a 50-50 mixture of Type I and Type II (605.1001) as defined in the New York State Department of Transportation "Standard Specification".
- F. Sand: ASTM C 33; fine aggregate Complying with State of New York Highway Department standard.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify survey benchmarks and intended elevations for work are as indicated on drawings.
- B. Perform assessment of adjacent structures and exterior improvements to establish existing conditions. Notify Architect of existing cracks, sags, or other damages prior to starting work.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 311000 for site clearing and topsoil removal.
- C. Protect survey benchmarks, control points, and monuments from excavating equipment and vehicular traffic.
- D. Protect existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Protect plants, lawns, rock outcroppings, and other features to remain.
- F. Locate and identify existing utilities to remain as indicated on drawings and protect from damage.
- G. Notify utility company to remove and relocate utilities as indicated on drawings.

3.03 SUPPORT AND PROTECTION

- A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.

3.04 DEWATERING

- A. Prevent surface water and groundwater from entering excavations and surrounding areas.
- B. Dispose of water without causing surface erosion, sediment buildup, or endangering public health or property.
- C. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Owner.

3.05 TRENCH EXCAVATION

- A. Notify Owner of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Hand trim excavations. Remove loose matter.
- F. Remove excavated material that is unsuitable for re-use from site.
- G. Remove excess excavated material from site.
- H. Provide temporary means and methods, as required, to remove all water from trenching. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.
- I. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Architect.

3.06 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.07 BACKFILL AND COMPACTION

- A. Backfill to contours and elevations indicated on drawings using unfrozen materials.
- B. Employ placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen, or spongy subgrade surfaces.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. General Fill: Place and compact materials in equal continuous layers not exceeding 8 inches compacted depth.
- F. Granular Fill: Place and compact material in equal continuous layers not exceeding 6 inches compacted depth.
- G. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- H. Correct areas that are over-excavated.
 - 1. Thrust-Bearing Surfaces: Fill with concrete.
 - 2. Other Areas: Backfill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- I. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under sidewalks paving, slabs-on-grade, and similar construction: 95 percent of maximum dry density.
 - 2. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
 - 3. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent for non-traffic areas and 95% for traffic areas.

- J. Reshape and re-compact fills subjected to vehicular traffic.

3.08 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Utility Piping
 - 1. Bedding: Use Fill Type Granular Bedding Stone.
- B. At Pipe Culverts:
 - 1. Bedding: Use Fill Type Granular Bedding Stone.
- C. At French Drains:
 - 1. Use Fill Type Drainage Course .

3.09 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for general requirements for field inspection and testing.
- B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 modified proctor, AASHTO T 180, or ASTM D698 standard proctor.
- C. Nonconforming Work: For failed tests, remove work, replace, and retest.
- D. Frequency of Tests - At each compacted initial and final backfill layer, at least one test for every 50 lineal feet or less of trench length, but no fewer than two tests.

3.10 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Stockpile excavated material re-used in area designated on-site; see Section 312200.
- C. Remove excavated material unsuitable for re-use from site.
- D. Remove excess excavated material from site.

END OF SECTION

**SECTION 312316.26
ROCK REMOVAL**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal of discovered rock during excavation.

1.02 DEFINITIONS

- A. Site Rock: Solid mineral material with a volume in excess of 1/3 cubic yard or solid material that cannot be removed with a 3/4 cubic yard capacity power shovel without drilling.
- B. Rock: Solid mineral material of a size that cannot be removed with a 3/4 cubic yard capacity power shovel.

PART 3 EXECUTION

2.01 EXAMINATION

- A. Verify site conditions and note subsurface irregularities affecting work of this section.

2.02 PREPARATION

- A. Identify required lines, levels, contours, and datum.

2.03 ROCK REMOVAL

- A. Excavate and remove rock by mechanical methods only; use of explosives is prohibited.
- B. Mechanical Methods: Drill holes and utilize expansive tools to fracture rock.
- C. Form level bearing at bottom of excavations.
- D. Remove shaled layers to provide sound and unshattered base for footings.
- E. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.
- F. Remove excavated materials from site.

2.04 FIELD QUALITY CONTROL

- A. Independent agency field inspection will be provided under provisions of Section 014000 - BSD Quality Requirements.

END OF SECTION

**SECTION 312316
EXCAVATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and protection.
- B. Excavation.
- C. Excavation repairs.

1.02 RELATED REQUIREMENTS

- A. Section 312200 - Grading.
- B. Section 312323 - Fill.
- C. Section 329119 - Landscape Grading.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Delegated Design Documents: Support and protection plan drawings and calculations sealed by designer.
- C. Field Quality Control Submittals: Document visual inspection of loadbearing excavated surfaces.
- D. Designer's qualification statement.
- E. Shoring installer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design under direct supervision of professional engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- B. Shoring Installer Qualifications: Company specializing in performing shoring and bracing work of this section with minimum 3 years of documented experience.

1.06 FIELD CONDITIONS

- A. Ambient Conditions: Do not perform excavation during periods of heavy rain as directed by Architect.
- B. Utility Location: Notify Call Before You Dig (811) before excavation to request approximate underground utility marking.
- C. Stormwater: Comply with requirements, see Section 015713 - Temporary Erosion and Sediment Control.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify survey bench mark elevations are as indicated on drawings.

- B. Survey existing adjacent structures and exterior improvements to establish exact elevations at fixed points for bench marking.
- C. Verify prevailing groundwater level is as indicated on drawings.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate and identify known utilities to remain and protect from damage.

3.03 SUPPORT AND PROTECTION

- A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
- B. Remove support and protection systems not required to remain in place subject to approval of Architect.
 - 1. Prevent harmful disturbance to underlying soils and damage to buildings, structures, pavements, facilities, and utilities.

3.04 EXCAVATION

- A. General Excavation:
 - 1. Excavate to indicated contours, elevations, and grades.
- B. Excavation to accommodate foundations, underground tanks, and underground utilities.
 - 1. Excavate to specified elevations.
 - 2. Over-excavate to safely install, adjust, and remove forms, bracing, or supports necessary for installation of work.
- C. Notify Architect of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- D. Do not interfere with 45-degree bearing splay of foundations.

3.05 EXCAVATION REPAIRS

- A. Notify Architect of over-excavations.
- B. Correct areas over-excavated with native soil.

3.06 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Provide access for visual inspection of loadbearing excavated surfaces by Architect before proceeding with work.
- C. Resurvey existing adjacent structure and exterior improvement bench marks. Notify Architect of changes in elevations, positions, or slopes.

3.07 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Stockpile excavated material for re-use in area designated on-site; see Section 312200.
- C. Remove excavated material unsuitable for re-use from site.
- D. Remove excess excavated material from site.

3.08 PROTECTION

- A. Divert surface water away from excavations.
- B. Maintain stability of banks and loose soils; prevent from falling into excavations.

- C. Maintain excavations in satisfactory, undisturbed condition.
- D. Protect bottom of excavations from freezing.

END OF SECTION

**SECTION 312319
DEWATERING**

ACTION SUBMITTALS

1.01 SHOP DRAWINGS:

- A. For dewatering system, prepared by or under the supervision of a qualified professional engineer.
- B. Include plans, elevations, sections, and details.
- C. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
- D. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
- E. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

FIELD CONDITIONS

2.01 PROJECT SITE INFORMATION

- A. A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
- B. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

2.02 PRODUCTS

- A. PERFORMANCE REQUIREMENTS
 - 1. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
 - 2. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
 - 3. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
 - 4. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 5. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 6. Remove dewatering system when no longer required for construction.
 - 7. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

2.03 EXECUTION

A. PREPARATION

1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 2. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
 3. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
- C. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- D. Provide temporary grading to facilitate dewatering and control of surface water.
- E. Protect and maintain temporary erosion and sedimentation controls, during dewatering operations.

2.04 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- B. Space well points or wells at intervals required to provide sufficient dewatering.
- C. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- D. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- E. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

2.05 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
- C. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

- F. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

2.06 FIELD QUALITY CONTROL

- A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.
- B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
- C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
- D. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- E. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.
- F. Prepare reports of observations.

2.07 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION

SECTION 312323
FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Filling, backfilling, and compacting for slabs-on-grade, paving, and sidewalks.
- B. Backfilling and compacting for utilities outside the building .
- C. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.
- D. Lightweight concrete fill.

1.02 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data for Manufactured Fill.
- C. Materials Sources: Submit name of imported materials source.
- D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
 - 1. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - a. Classification according to ASTM D 2487.
 - b. Laboratory compaction curve according to ASTM D 698
 - c. Gradation table.
- E. Compaction Density Test Reports.
- F. Testing Agency Qualification Statement.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.
- B. The use of recycled or non-virgin materials is prohibited. No contaminated materials will be accepted.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When fill materials need to be stored on site, locate stockpiles where indicated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials including .

1.05 WARRANTY

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

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Use all fill materials as listed below unless otherwise noted within the contract drawings.

- B. General Fill - Fill Type Satisfactory Soils: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
 - 1. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
 - 2. Complying with ASTM D2487 Group Symbol GW, GP, GM, SW, SP, and SM .
 - 3. On-site material may be used outside of foundation, structure, slab-on-grade and paved areas. Testing methods must follow section 1.02.D. of this specification.
- C. Subbase Stone (Crushed Stone) - Fill Type Subbase Course: Complying with State of New York Department of Transportation (Item 304.12 - Type 2 Subbase Course and Section 733-04) standard.
- D. Structural Fill (Compacted Subbase) - Fill Type Select Granular: Complying with State of New York Department of Transportation (Item 203.07 and Section 733-11) standard, meeting the below gradation requirements:
 - 1. Graded in accordance with ASTM C136/C136M, within the following limits:
 - 2. 3 inch sieve: 100 percent finer by weight.
 - a. 1/4 inch sieve: 30 to 75 percent finer by weight.
 - b. No. 40: 5 to 40 percent finer by weight.
 - c. No. 200: 0 to 10 percent finer by weight.
 - 3. No recycled materials will be accepted. All structural fill to be 100% virgin material quarried and processed to finished sizes.
- E. Concrete for Fill: Lean concrete.
- F. Granular Fill (Drainage Stone) - Fill Type Drainage Course: Drainage stone should consist of a blend of crusher run stone or crushed gravel meeting the material and gradation requirements of ASTM C33 size 57 Coarse Aggregate as follows:
 - 1. 1-1/2 inch sieve: 100 percent finer by weight.
 - 2. 1 inch sieve: 95 to 100 percent finer by weight.
 - 3. 1/2 inch sieve: 25 to 60 percent finer by weight.
 - 4. No. 40 sieve: 0 to 10 percent finer by weight.
 - 5. No. 8 sieve: 0 to 5 percent finer by weight.
- G. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter.
 - 1. Grade in accordance with ASTM D2487 Group Symbol SW.
- H. Engineered Fill - Lightweight Concrete:
 - 1. Materials:
 - a. Cement: ASTM C150/C150M.
 - b. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.
 - c. Admixtures: As recommended by lightweight concrete fill manufacturer.
 - d. Expansion Material: Manufacturer's recommended expansion material.
 - e. Mix Design: By manufacturer.

2.02 ACCESSORIES

- A. Subsurface Drainage Geotextile: As called out on the drawings or: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, complying with AASHTO M 288 . Provide the following or an approved equal: Mirafi S-Series Nonwoven Polypropylene , by Tencate

- B. Separation Geotextile: As called out on the drawing or: Woven geotextile fabric, manufactured for separation applications, ; complying with AASHTO M 288. Provide the following or an approved equal. Mirafi HP 370 or HP 570, by TenCate

2.03 SOURCE QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Verify areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

- A. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.
- E. If Owner's Representative determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- F. Authorized additional excavation and replacement material will be paid for per Contract provisions for unit prices / allowances or changes in the Work as applicable.
- G. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner's Representative, without additional compensation.

3.03 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
- H. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- I. Correct areas that are over-excavated.
 - 1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 100 percent of maximum dry density.

2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- J. Compaction Density Unless Otherwise Specified or Indicated:
 1. Under paving, slabs-on-grade, and similar construction: 95 percent of maximum dry density.
 2. At other locations turf or unpaved or non- traffic areas : 90 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.
- L. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 ENGINEERED FILL - LIGHTWEIGHT CONCRETE

- A. Install lightweight concrete fill according to manufacturer's written instructions.
- B. Use batching, mixing, and placing equipment approved by the manufacturer.
- C. Prevent segregation of material.
- D. Tolerance: Finished surface within 2 inches of elevation indicated on drawings.

3.05 FILL AT SPECIFIC LOCATIONS

- A. Use general fill unless otherwise specified or indicated.
- B. Structural Fill below slabs, pavements and at locations indicated on the drawings.:
 1. Use structural fill per section 2.01.C of this specification.
 2. Maximum depth per lift: 8 inches, compacted.
 3. Compact to minimum 95 percent of maximum dry density.
- C. Over Buried Utility Piping in Trenches:
 1. Bedding: Use structural fill.
 2. Cover with general fill use structural fill below roadways and pavements.
 3. Fill up to subgrade elevation.
 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density 90 percent in non traffic or lawn areas.
- D. At Lawn Areas:
 1. Use general fill.
 2. Compact to 90 percent of maximum dry density.
 3. See Section 329119 for topsoil placement.
- E. At Planting Areas Other Than Lawns :
 1. Use general fill.
 2. Compact to 90 percent of maximum dry density.
 3. See Section 329119 for topsoil placement.
- F. At French Drains:
 1. Use Drainage Fill .
- G. Under Pavers Set on Sand Leveling Bed:
 1. Use Fill Type structural fill.
 2. Fill up to bottom of sand leveling bed.
 3. Compact to 95 percent of maximum dry density.

4. See unit pavers section for leveling bed placement.

3.06 TOLERANCES

- A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.
- B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.07 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for general requirements for field inspection and testing.
- B. Soil Fill Materials:
 - 1. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
 - 2. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.
 - 3. If tests indicate work does not meet specified requirements, remove work, replace and retest.
 - 4. Frequency of Tests:
 - a. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1) Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2,500 square feet or less of paved area or building slab, but in no case fewer than three tests.
 - 2) Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 50 lineal feet or less of wall length, but no fewer than two tests.
 - 3) Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 50 lineal feet or less of trench length, but no fewer than two tests
- 5. Proof roll compacted fill at surfaces that will be under slabs-on-grade, pavers, and paving or gravel roads.
 - a. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - b. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
 - c. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Owner's Representative. Place No. 3/No. 4 size stone to stabilize subgrades as directed by Engineer or onsite geotechnical engineer and approved by Owner's Representative. Replace excavated soil with compacted backfill or fill as directed

3.08 CLEANING

- A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.
- B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

**SECTION 312500
EROSION AND SEDIMENTATION CONTROL**

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 work of this section.
- B. New York State Standards and Specifications for Erosion and Sediment Control.

1.02 WORK OF THIS SECTION

- A. Work covered in this section includes the control of erosion, siltation, and sedimentation pursuant to Section 402 of the Clean Water Act. All costs associated with the temporary or permanent erosion control measures shall be included in the Contractor's bid.
- B. All Contractors and their subcontractors must agree to implement all applicable provisions of the Erosion Control Plans and Stormwater Pollution Prevention Plan (SWPPP) prior to commencement of any construction activity. The SWPPP is appended to this Specification or bound separately as part of the contract documents.

1.03 QUALITY ASSURANCE

- A. Contractor shall comply with the Erosion Control Plans and Stormwater Pollution Prevention Plan prepared for the site. All workers responsible for site work activities shall be familiar with these Plans.
- B. Contractor shall designate one individual responsible for implementing and maintaining site-wide erosion and sediment control measures who shall be thoroughly familiar with the types of materials being installed and the best methods for their installation. This individual shall conduct daily inspections of erosion and sediment control measures.
- C. Clear only what is required for immediate construction activities. Disturbed areas of the site that will not be re-disturbed for 21 days or more must be stabilized by the 14th day following the last disturbance.
- D. Upstream storm water runoff should be diverted away from disturbed areas. Contractor shall provide and maintain temporary erosion and sediment control measures, such as berms, dikes, slope drains, silt stops, and sedimentation basins, until permanent drainage facilities and erosion control features have been completed and are operative.
- E. The limits of cleared areas shall be physically delineated to protect areas designated as undisturbed.
- F. Take every reasonable precaution and do whatever is necessary to avoid erosion and to prevent silting of rivers, streams, impoundments, and drainage ditches, swales or any off-site water body.
- G. Continue erosion control measures until the permanent measures have been sufficiently established and are capable of controlling erosion on their own.
- H. The control of dust, erosion and sediment originating from construction operations is considered a critical responsibility of the Contractor. The Owner's Representative will be the final judge of the adequacy of the Contractor's dust, erosion and sedimentation control. The Owner's Representative may suspend work until adequate dust, erosion and sedimentation control is attained. The Contractor shall bear the costs of repair work and restoration of damaged items.

PART 2 PRODUCTS

2.01 MULCHING

- A. Hay and straw mulches shall be air-dried mowings (<15% moisture content) of acceptable herbaceous growth reasonably free from swamp grass, weeds, twigs, debris, and other deleterious material, and free from rot, mold, primary noxious weed seeds, and rough or woody materials. Mulches containing mature seed of species which would volunteer and be detrimental to the permanent seeding, or would result in overseeding, or would produce growth which is aesthetically unpleasing, are not permitted. Materials may be baled, however, loose or broken bales are not acceptable.
- B. Temporary Type Mulch Nets: Lightweight, extruded photodegradable netting, with approximate openings of 1½" x ¾", with manufacturer recommended staples or anchoring method.
- C. Wood fiber mulch with tackifier (Terra Tack). Apply wood fibers at the rate of 500 lbs./acre and tackifier at the rate of 40-45 gallons/acre.
- D. Hardwood Stakes: Stakes shall be new hardwood, 1½" x 1½", minimum 3 feet long.

2.02 MATTING/BLANKETS

- A. Jute Matting: Undyed and unbleached jute yarn woven into a uniform open, plain weave mesh, furnished in rolled strip, with 78 warp ends per yard width of cloth, 41 weft ends per linear yard, weighing approximately 0.9 pounds per square yard of fabric.
- B. Erosion Control Blanket: Blanket shall be machine-produced 100% biodegradable consisting of a 70% agricultural straw / 30% coconut fiber blend having a functional longevity of 18 months. Blanket shall covered top and bottom sides with 100% biodegradable woven natural organic fiber netting, with an approximate mesh of 0.5 x 1 inch. Blanket mesh and netting shall be sewn together on 1.5-inch centers.
- C. Staples: As specified by the manufacturer of the blanket/matting, constituting a complete system.

2.03 SEED AND SOD FOR EROSION CONTROL

- A. For temporary seeding in spring, summer or early fall, seed the area with ryegrass, (annual or perennial) or approved equal at 30 lbs per acre. For temporary seeding in late fall or early winter, seed the area with Certified winter rye (cereal rye) or approved equal at 100 lbs per acre. Mulch area with hay or straw at 2 tons per acre. Mulch anchoring may be required where wind or areas of concentrated water are a concern.
- B. For permanent seeding on slopes, provide a seed according to the following or as shown on the Contract Drawings
 - 1. Erosion control areas are to be seeded at a rate of: 50 pounds per acre with a mix consisting of 70% Ernst Best Strip Mine Mix (ERNMX-101) and 30% Ernst Shaded Roadside Mix (ERNMX-140), as supplied by Ernst Conservation Seeds, or as approved by Owner.

2.04 SILT FENCES

- A. Prefabricated silt fencing with UV-stabilized geotextile fabric, with hardwood or steel posts, mesh reinforced backing and appropriate fasteners. Fabric shall be 48" minimum width.

2.05 STABILIZED CONSTRUCTION ENTRANCE

- A. Material shall be clean, sound, crushed stone of uniform quality.
- B. Geotextile filter cloth (Mirafi 600X, or equal) designed for heavy-duty haul road use.

2.06 TEMPORARY STRUCTURAL MEASURES

- A. Temporary structural measures for erosion control include, but are not limited to, earth dikes, temporary swales, perimeter swales, rip rap outlet protection, sediment traps, and sediment basins.
- B. Each measure shall be designed in accordance with New York State Guidelines for Urban Erosion and Sediment Control, as well as New York State Standards and Specifications for Erosion and Sediment Control. Materials and construction measures shall be consistent with these measures.

PART 3 EXECUTION

3.01 HAY AND STRAW MULCHING

- A. Install hay or straw mulch immediately after each area has been properly prepared. Place at a rate of 2 tons per acre (approximately 100 to 120 bales per acre). Mulching shall be applied to a uniform thickness of 2 to 3 inches (loose, uncompacted) by hand or broadcast. No clumping, matting, bale fragments, or excessive thickness shall be permitted. The intent is to allow 20% to 40% of the ground surface to be seen in a uniform coverage.
- B. Place mulch on seeded areas within 24 hours after seeding.
- C. Where winds may blow the mulch, or when ground slopes exceed 10%, or when otherwise required to maintain the mulch firmly in place. Apply temporary netting, chemical bonding, or other anchoring devices, or use mechanical crimping, punching or rolling, to anchor the mulch. Unless otherwise directed, remove netting or other acceptable anchoring system prior to the acceptance of the work.

3.02 MATTING/BLANKETS - GENERAL

- A. Prepare surfaces of ditches and slopes to conform to the grades, contours and cross sections as shown on the Drawings and finish to a smooth and even condition with all debris, roots, stone, and lumps raked out and removed. Loosen the soil surface to permit bedding of the matting. Unless otherwise noted, seed prior to the placement of the matting.
- B. Unroll matting parallel to the direction of flow of water and loosely drape, without folds or stretching, so that continuous ground contact is maintained.
- C. The ditches and swales, and on slopes, each upslope and each downslope end of each piece of matting shall be placed in a 6" trench, stapled at 12" on center, backfilled, and tamped. Similarly, bury edges of matting along the edges of catch basins and other structures. Owner's Representative may require that any other edge, exposed to more than normal flow of water, be buried in a similar fashion.
- D. Tightly secure matting to the soil by staples driven approximately vertically into the ground, flush with the surface of the matting. In driving the staples, take care not to form depressions or bulges in the surface of the matting.
- E. Decrease the specified spacing of staples when varying factors, such as the season of the year or the amount of water encountered or anticipated, requires additional anchoring.

3.03 SEED FOR EROSION CONTROL

- A. Sow seed when soils are moderately dry and when wind does not exceed five miles per hour or as directed by the Owner's Representative.
- B. Areas that will be regraded or otherwise disturbed later during construction may be seeded as directed by the Owner's Representative to obtain temporary control.

3.04 SILT FENCES

- A. Provide silt fences, as required, for the temporary control of erosion and to stop silt and sediment from reaching surface waters, adjacent properties, or entering catch basins, or damaging the work.
- B. Erect silt fences and bury bottom edge in accordance with the manufacturer's recommended installation instructions. Provide a sufficient length of fence to accommodate runoff without causing any flooding and to adequately store any silt, sediment, and debris reaching it. Place silt fences along contours so that low areas are minimized.
- C. Maintain and leave silt fences in place until permanent erosion control measures have been established.

3.05 STABILIZED CONSTRUCTION ENTRANCES

- A. Stabilized pads of aggregate underlain with filter cloth shall be constructed as shown on the Contract Drawings.
- B. Geotextile fabric shall be placed over the entire area to be covered with aggregate prior to placing of the stone.

3.06 TEMPORARY STRUCTURAL MEASURES

- A. Temporary structural measures shall be maintained throughout the duration of the contract or until the drainage area has been properly stabilized as approved by the Owner's Representative.
- B. Temporary sediment traps must provide at least 3,600 cubic feet of storage for every acre of drainage area.
- C. Sediment shall be removed and trap restored to its original dimensions when sediment has accumulated to 1/2 the design depth of the trap.
- D. Removed sediment shall be properly disposed of.
- E. Inspect all erosion control measures following each rainfall event exceeding ½ inch in a 24-hour period. Correct all damage immediately.

3.07 MAINTENANCE

- A. If any staples become loosened or raised, or if any matting becomes loose, torn, or undermined, or if any temporary erosion and sediment control measures are disturbed, repair them immediately.
- B. If the seed is washed out before germination, repair any damage, refertilize, and reseed.
- C. Maintain mulched and matted areas, silt stops, and other temporary control measures until the permanent control measures are established and no further erosion is likely.
- D. All sediment spilled, dropped, or washed onto the driveway or public right-of-way shall be removed immediately.
- E. Maintain ditches and swales at all times so that they effectively drain. Refill, reshape, and recompact where ruts or erosion occurs.
- F. Maintain areas temporarily seeded including repair of all damages, re-seeding, and refertilizing.

- G. Take special precautions in the use of construction equipment to minimize erosion. Do not leave wheel tracks where erosion might begin. Prevent direct discharge from dewatering pumps and surface runoff from the construction sites to storm sewers, culverts, streams or ditches. Intercept and conduct surface runoff and discharge from dewatering pumps to silt ation ponds before discharging to natural drainage channels.

END OF SECTION

**SECTION 315000
EXCAVATION SUPPORT AND PROTECTION**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes temporary excavation support and protection systems.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

1.03 FIELD CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
1. Notify Owner's representative no fewer than two days in advance of proposed interruption of utility.
 2. Do not proceed with interruption of utility without Owner's written permission.
- B. Survey Work: Where necessary to complete the work, engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 1 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Provide, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
 4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.02 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
1. Corners: Site-fabricated mechanical interlock or roll-formed corner shape with continuous interlock as available.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

- E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- F. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- G. Tiebacks: Steel bars, ASTM A 722/A 722M.
- H. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 1 EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.02 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.03 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.
- B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.04 TIEBACKS

- A. Drill, install, grout, and tension tiebacks.
- B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
 - 1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.
- C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.05 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
 - 2. Install internal bracing if required to prevent spreading or distortion of braced frames.
 - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.06 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.
- C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.07 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
 - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
 - 2. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
 - 3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.
- B. Leave excavation support and protection systems permanently in place, as required or necessary.

END OF SECTION

**SECTION 316615
HELICAL SCREW FOUNDATION PILES**

I. General

- A.** HELICAL PIER[®] Foundation Systems Screw Piles shall be installed by authorized A. B. Chance Dealers. These Dealers shall have satisfied the certification requirements relating to the technical aspects of the product and the ascribed installation techniques.
- B.** All work as described herein shall be performed in accordance with all applicable safety codes in effect at the time of installation.
- C.** The Dealer shall employ a skilled, experienced work force who are familiar with the requirements and methods necessary for proper performance of the work as outlined in these specifications.

II. Screw Pile Location

- A.** Screw piles should be installed as shown on the Engineer's Plan of Repair (PR). If an Engineer's PR is not available, then the Dealer shall submit a written plan of repair to the owner or owner's representative.
- B.** Plan of Repair shall include, but is not limited to the following:
 - 1. Total number of screw piles required
 - 2. Locations of the individual screw piles
 - 3. Size and number of helices per screw pile
 - 4. Minimum installed depth of the screw piles
 - 5. Minimum final installation torque / working load of the screw piles

III. Screw Pile Selection

- A.** The lead sections with helices and extension sections shall be manufactured by the A. B. Chance Company and as shown on attached drawings.
- B.** All units shall conform to the material specifications as referenced on these drawings.
- C.** The number and sizes of helices, and the shaft size of screw pile shall be as shown on the Plan of Repair.
- D.** The Dealer shall have the option of performing a soil test using either the A. B. Chance Soil Probe or other method approved by the engineer. The data acquired along with other information available about the site shall be used in determining the proper screw pile.

IV. Installation Equipment

A. Installing Units

1. Installation units shall consist of rotary type torque motors with forward and reverse capabilities. These units shall be either electrically or hydraulically powered.
2. These units shall be capable of developing the minimum torque / working load as required by the Plan of Repair.
3. These units shall be capable of positioning the screw pile at the proper installation angle. This angle varies between 0 (vertical) to 10 degrees depending upon application and type of foundation termination specified.
4. These units shall be in good working condition and capable of being operated in a safe manner

B. Installation Tooling

1. Adapters approved by the Engineer of Record shall be employed to safely connect the installation units to the screw piles and extensions.
2. These adapters shall have torque capacity ratings at least equal to the minimum ultimate torque rating of the screw piles as specified for the project.
3. These adapters shall be securely connected to the screw pile during installation so as to prevent accidental separation.

C. Torque Monitoring Devices

1. The torque being applied by the installing units shall be monitored throughout the installation process.
2. Torque monitoring devices shall be either a part of the installing unit or an independent device in-line with the installing unit. Calibration data for either unit shall be available for review by the owner or owner's representative.

V. Installation Procedures

- A. The screw pile shall be positioned as shown on the Plan of Repair. Proper angular alignment shall be established at the start of installation.
- B. The screw pile shall be installed in a smooth, continuous manner. The rate of screw pile rotation shall be in the range of 5 to 20 revolutions per minute.
- C. Sufficient down pressure shall be applied to advance the screw pile.
- D. Plain extension material may be required to position the screw pile at the depth required by the Plan of Repair. Extensions shall be coupled to the screw pile using the bolts provided with the

extension. These bolts shall be installed and tightened to approximately 40 ft. lb. of torque.

- E. Installation torque shall be monitored throughout the installation process.
- F. If underground obstructions are encountered during installation, the Dealer shall have the option of removing the obstruction if possible or relocating the screw pile. This latter option may require the relocation of adjacent screw piles.

VI. Termination of Installation

- A. The maximum installation torque shall at no time exceed the torque rating of the screw pile shaft as specified for the project.
- B. Screw piles shall be installed to the minimum torque / working load value as shown on the Plan of Repair.
 - 1. If the minimum torque / working load requirement has not been satisfied at the minimum depth level, the Dealer shall have the following options:
 - a. Install the screw pile deeper using additional plain extension material until the specified torque level is obtained. , or
 - b. Add additional screw piles.
- C. The minimum depth of installation shall be ten feet (10'). If the installer cannot achieve this depth, the engineer shall be contacted before proceeding further.
 - 1. If the minimum torque rating of the screw pile and/or installing unit has been reached prior to satisfying the minimum depth level, the Dealer shall have the option to terminate the installation at the depth obtained - upon approval by the Engineer of Record).

VII. Connection Bracket/Haunch

- A. The screw pile shall be connected to the structure using an A. B. Chance Company approved steel bracket or properly designed steel-reinforced concrete haunch capable of safely transferring the structural loads to the screw pile.

VIII. Installation Records

Written installation records shall be maintained for each screw pile. These records shall include, but are not limited to the following:

- A. Project name and/or location
- B. Name of authorized A. B. Chance Dealer
- C. Name of Dealer's foreman or representative who witnessed the installation

- D. Date and time of installation
- E. Location and reference number of screw pile
- F. Descriptions of lead section and extensions installed
- G. Overall depth of installation as referenced from bottom of grade beam or footing
- H. Torque readings for the last three (3) feet of installation if practical. In lieu of this requirement, the termination torque shall be recorded as a minimum
- I. Any other applicable information relating to the installation

IX. Material Specifications

A. Helix Bearing Plate:

- 1. SS5 - Hot rolled carbon steel sheet, strip, or plate per ASTM A572, or A935, or A656 or A936. Plate thickness is $\frac{3}{8}$ ".
- 2. SS150 and SS175 - Hot rolled steel sheet, strip, or plate per ASTM A656 or A936. Plate thickness is $\frac{3}{8}$ ".
- 3. Helix bearing plates are formed on matching metal dies to true helical shape.

B. Screw Anchor Shaft:

- 1. SS5 - Hot rolled Round-Cornered-Square (RCS) $1\frac{1}{2}$ " solid steel shafts conforming to the general requirements of ASTM A29. Medium carbon steel grade with improved strength due to fine grain size.
 - ☒ Installation Torque Rating: 5,500 ft.-lbs.
 - ☐ Minimum Ultimate Tension Strength: 70 kips (Criteria - Coupling Bolt)
 - ☐ Minimum Ultimate Tension Strength: 55 kips (Criteria - Torque)
- 2. SS150 ($1\frac{1}{2}$ " solid steel shaft), and SS175 ($1\frac{3}{4}$ " solid steel shaft) - Hot rolled Round-Cornered-Square (RCS) conforming to the general requirements of ASTM A29. High Strength Low Alloy (HSLA), low to medium carbon steel grade with improved strength due to fine grain size.

SS Anchor Type	Installation Torque Rating, ft.-lb.	Minimum Ultimate Tension Strength, kips
SS150	7,000	70

SS175	10,000	100

C. Coupling Bolts:

1. SS5, SS150 - $\frac{3}{4}$ " diameter bolt per ASTM A320 Grade L7, S_y (min) = 105 ksi, S_u (min) = 125 ksi.
2. SS175 - $\frac{7}{8}$ " diameter bolt per ASTM A193 Grade B7, S_y (min) = 105 ksi, S_u (min) = 125 ksi.

D. Extension Section Couplings:

1. Shall be formed as integral part of the plain extension shaft material. For SS anchors, couplings shall be hot upset forged sockets.

E. Foundation Repair Bracket:

1. Brackets are formed from steel that meets or exceeds the requirements of ASTM A36, and have a hot-dipped galvanized coating per ASTM A153.

F. Welding:

1. All welding shall be in accordance with AWS D1.1, latest revision.
2. All welders shall be A. B. Chance Co. certified to AWS specifications.

G. Finish, Galvanized:

1. All material shall be hot-dipped galvanized in accordance with ASTM A153 after fabrication.

END OF SECTION

**SECTION 321120
SUBBASE AND AGGREGATE BASE COURSES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Subbase course.
- B. Aggregate base course.

1.02 RELATED REQUIREMENTS

- A. Section 312200 - Grading.
- B. Section 312316.13 - Trenching.
- C. Section 312323 - Fill.
- D. Section 321623 - Sidewalks.

1.03 REFERENCE STANDARDS

- A. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2019.
- B. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method; 2024.
- C. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012, with Editorial Revision (2015).
- D. ASTM D3665 - Standard Practice for Random Sampling of Construction Materials; 2024.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Geogrid indicating tensile strength.
- C. Test Reports:
 - 1. Aggregate Composition: Results of laboratory tests on proposed and actual materials used.
 - 2. Compaction Density: Results of laboratory tests on compacted course.
- D. Field Quality Control Submittals: Submit compaction density testing results.
- E. Testing agency's qualification statement.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Aggregate Storage: Prevent material intermixing, contamination, and deterioration.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Subbase Course:
 - 1. Type 304.12 : Comply with State of New York Department of Transportation standard.

2.02 SOURCE QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. If tests indicate materials do not meet specified requirements, change material and retest.
- C. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.
- B. Verify substrate has been inspected, and gradients and elevations are correct and dry.

3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and recompacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 PLACEMENT

- A. Under Bituminous Concrete Paving:
 - 1. Subbase Compacted Thickness: According to design drawings.
 - 2. Compact to 95 percent of maximum dry density.
- B. Under Portland Cement Concrete Paving:
 - 1. Subbase Compacted Thickness: According to design drawings.
 - 2. Compact to 95 percent of maximum dry density.
- C. Place course in maximum 4 inch layers and roller compact to specified density.
- D. Level and contour surfaces to elevations and gradients indicated.
- E. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

- A. Variation From Design Elevation: Within 1/2 inch.
- B. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- C. Scheduled Compacted Thickness: Within 1/4 inch.

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Subbase Compaction Density Testing: In accordance with ASTM D1556/D1556M.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor").
- D. Frequency of Tests: In accordance with ASTM D3665.
- E. Remove, replace, and retest work that does not meet specified requirements.
- F. Proof roll compacted aggregate at surfaces going underneath flexible paving.
- G. Synthetic Turf : Follow ASTM F2898 standard test method for permeability of synthetic turf sports field base stone and surface system by non-confined area flood test method.

3.06 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove unused materials and grade areas to prevent standing surface water.

END OF SECTION

**SECTION 321216
ASPHALT PAVING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Single course bituminous concrete paving.
- C. Hot-mix asphalt patching.
- D. Hot-mix asphalt paving.
- E. Hot-mix asphalt overlay
- F. Surface sealer.

1.02 QUALITY ASSURANCE

- A. Perform Work in accordance with NYS DOT Standards and Village of Ossining Department of Public Works Standards.
- B. Mixing Plant: Complying with NYS DOT Standards.
- C. Obtain materials from same source throughout.

1.03 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.
- B. Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
- C. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
- D. Asphalt Surface Course: Minimum surface temperature of 45 deg F at time of placement

PART 2 PRODUCTS

2.01 MATERIALS

- A. Asphalt Cement: ASTM D946.
- B. Aggregate for Base Course: In accordance with State of New York Highways standards.
- C. Aggregate for Binder Course: In accordance with State of New York Highways standards.
- D. Aggregate for Wearing Course: In accordance with State of New York Highways standards.
- E. Tack Coat: Meeting the requirements of NYSDOT cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.02 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes in compliance with the with NYSDOT specification mix requirements. If not otherwise called out on the drawings (plans), provide the following:
- B. Provide mixes with a history of satisfactory performance in geographical area where the project is located.
 - 1. Top Course: NYSDOT Item No. 404.097101
 - 2. Binder Course: NYSDOT Item No. 404.197901

3. Base Course: NYSDOT Item No. 404.377901
 4. Emulsified-Asphalt Slurry: ASTM D 3910, Type 2.
- C. Asphalt Base Course: 3.0 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that compacted subgrade, granular base, and asphalt base/binder is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 2. Revise the minimum weight or type of vehicle in first subparagraph below if required.
 3. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
- D. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer , and replace with compacted backfill or fill as directed.

3.02 AGGREGATE BASE COURSE

- A. Place and compact aggregate base course.

3.03 PREPARATION - PRIMER

- A. Apply primer in accordance with manufacturer's instructions.
- B. Apply primer on aggregate base or subbase at uniform rate of 1/3 gal/sq yd.
- C. Use clean sand to blot excess primer.

3.04 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat on all asphalt or concrete surfaces over subgrade surface at uniform rate of 0.1 to .15 gal/sq yd.
- C. Apply tack coat on the contact surfaces between all HMA pavement lifts in accordance with the NYS DOT Standards prior to placing HMA mixture regardless of time period between lifts. The only exception to this is the surface of permeable base courses. Paving over a tack coat should not commence until the emulsion has broken (goes from brown to black) or is tacky when touched.
- D. Apply tack coat to contact surfaces of curbs, gutters and and objects that are adjacent to pavement courses.

3.05 PLACING ASPHALT PAVEMENT - SINGLE COURSE

- A. Install Work in accordance with State of New York Highways standards.
- B. Place asphalt within 24 hours of applying primer or tack coat.
- C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- D. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.06 SEAL COAT

- A. Apply seal coat to asphalt surface course and asphalt curbs in accordance with AI MS-19.

3.07 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 16 foot straight edge.
B. Variation from True Elevation: Within 1/2 inch.
C. Variations exceeding 1/4 inch will be appropriately corrected or the pavement be removed and replaced at no additional cost to the Owner.

3.08 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for general requirements for quality control.
B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549/D 3549M.
D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979/D 979M.
F. Replace and compact hot-mix asphalt where core tests were taken, if any.
G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

**SECTION 321413
PRECAST CONCRETE UNIT PAVING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interlocking concrete paver units.
- B. Sand setting bed.
- C. Polymeric sand joint filler.

1.02 REFERENCE STANDARDS

- A. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2018.
- B. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2025.
- C. ASTM C936/C936M - Standard Specification for Solid Concrete Interlocking Paving Units; 2024.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide characteristics of paver unit, dimensions, and special shapes.
- C. Product Data: Provide characteristics of polymeric sand, including base material, additive(s), compressive strength, and color.
- D. Samples: Submit two samples of each paver type, illustrating style, size, color range and surface texture of units being provided.
- E. Manufacturer's Installation Instructions: Indicate substrate requirements and installation methods.
- F. Maintenance Materials: Provide the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Pavers: 10 of each type and size.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Interlocking Concrete Pavers:
 - 1. Hanover Architectural Products, Inc; Prest Brick: www.hanoverpavers.com/#sle.

2.02 MATERIALS

- A. Interlocking Concrete Pavers: Hydraulically pressed concrete, configured for interlocking with adjacent units and complying with ASTM C936/C936M.
 - 1. Compressive Strength: 8000 pounds per square inch (55 MPa) average, with minimum of 7200 pounds per square inch (50 MPa).
 - 2. Thickness: 2-3/8 inches (60 mm).
 - 3. Type: Rectangular 4"x8"
 - 4. Color: Selected from manufacturer's full range.
- B. Sand for Setting Bed: Clean washed natural sand or crushed stone complying with gradation requirements of ASTM C33/C33M for fine aggregates.
- C. Polymeric Sand: Fine sand complying with ASTM C144 combined with polymer binders for creating semi-solid joints between pavers.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate is level or to correct gradient, smooth, capable of supporting pavers and imposed loads, and ready to receive work of this Section.
- B. Verify gradients and elevations of substrate are correct.
- C. Verify dry weather forecast without rain for a minimum of 24 hours with temperatures above 55 degrees Fahrenheit (13 degrees Celsius).
- D. Verify that pavers are completely dry prior to polymeric sand installation.

3.02 PREPARATION

- A. Treat soil with herbicide to retard plant growth.
- B. Wear clothing and equipment to protect from excessive exposure to polymeric sand.

3.03 INSTALLATION OF SOLID PAVER UNITS

- A. Spread sand bedding evenly over prepared substrate surface to a depth of 1".
- B. Dampen and roller compact sand to level and even surface.
- C. Screed and scarify top 1 inch (12 mm) of sand.
- D. Place paver units in pattern shown on drawi.
- E. Cut paver units at edges with masonry saw.
- F. Place half units at edge and interruptions. Maintain tight joints.
- G. Spread polymeric sand uniformly over surface. Use a push broom to fill joints and remove excess while not sweeping long distances. Sweep all excess with a fine bristle brush and remove residues with a leaf blower.
- H. Tamp and level paver units with mechanical vibrator until units are firmly bedded, level, and to correct elevation and gradients. Do not tamp unrestrained edges.
- I. Using a sprayer set to shower, apply water on specific areas between 100 square feet (10 m) and 500 square feet (50 m) to a depth of 1 1/2 inches (4 cm). Complete one section at a time and avoid flooding the pavers.

3.04 CLEANING

- A. Do not clean pavers until pavers and mortar are dry.
- B. Clean soiled surfaces using cleaning solution. Do not harm pavers, joint materials, or adjacent surfaces.
- C. Use non-metallic tools in cleaning operations.
- D. Rinse surfaces with clean water.
- E. Broom clean paving surfaces. Dispose of excess sand.

3.05 PROTECTION

- A. Do not permit traffic over unprotected paver surface.

END OF SECTION

**SECTION 321623
SIDEWALKS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete sidewalks.
- B. Concrete wheelchair ramps.

1.02 RELATED REQUIREMENTS

- A. Section 321120 - Subbase and Aggregate Base Courses.
- B. Section 321726 - Tactile Warning Surfacing.

1.03 REFERENCE STANDARDS

- A. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.
- B. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.
- C. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- D. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.
- E. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2020.
- F. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2019.
- G. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete; 2019.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Concrete: Provide data on admixtures.

1.05 FIELD CONDITIONS

- A. Temperature Requirements: Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.
- B. Follow recommendations of ACI PRC-305 and ACI PRC-306 when concreting during hot and cold weather, respectively.
- C. Follow recommendations of polymeric sand manufacturer.

PART 2 PRODUCTS

2.01 CONCRETE SIDEWALKS AND WHEELCHAIR RAMPS

- A. Gravel Subbase: Thickness as indicated on drawings.
- B. Concrete Forms: wood, or steel.
- C. Concrete Materials: Comply with ASTM C94/C94M.
- D. Aggregate: Pit Run, washed, 3/8 inch (1 cm) stone; free of shale, clay, friable material and debris.
- E. Reinforcement as indicated on drawings :

1. Steel Welded Wire Reinforcement: ASTM A1064/A1064M, plain type, flat sheets, unfinished.
 2. Fiber Reinforcement: minimum 1.5 LBS/ CY of Concrete synthetic fibers 1/2" to 3/4" length, according to ASTM C1116/C1116M.
- F. Joint Filler: Preformed expansion, with a thickness of 1/2 inch.
- G. Curing Compound: Synthetic, Type 1, Class A, according to ASTM C309.
- H. Surface Sealer: Topical, Type 1, Class A, according to ASTM C1315.
- I. Tactile Warning Surfaces: See Section 321726.
- J. Joint Sealants: Use Sikaflex Self Leveling Sealant or approved equivalent.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify gradients and elevations of the subgrade are correct as shown on drawings. Where poor subgrade material is encountered, remove and replace with suitable material.
- B. Verify compacted subgrade is acceptable, ready to support imposed loads and paving, and ready to receive work.

3.02 SUBBASE PREPARATION

- A. Maintain subgrade in a smooth, compacted condition with required section and established grade until concrete is placed.
- B. See Section 321120 for aggregate subbase.

3.03 CONCRETE SIDEWALK AND WHEELCHAIR RAMP INSTALLATION

- A. Forming:
 1. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
 2. Sidewalk Forms: Place and secure forms to location, dimension, profile, and gradient shown on drawings. Height equal to the full depth of the finished sidewalk.
 3. Wheelchair Ramps: Place and secure forms to location, dimension, profile, and gradient shown on drawings. Comply with ADA Standards.
- B. Reinforcement:
 1. Place wire-mesh reinforcement mid-height of forms.
- C. Placement:
 1. Place concrete in a single lift.
 2. Consolidate concrete by tamping and spading.
- D. Joints:
 1. Spacing: As indicated on the drawings or provide scored joints every 5 feet (1.5 m).
 2. Filler height equal to the full depth of the finished concrete.
- E. Finishing:
 1. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge, 1/4 inch radius.
 2. Wheelchair Ramps: Broomed perpendicular to slope.
 3. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.
 4. Place surface sealer on exposed concrete surfaces after hardening. Apply in accordance with manufacturer's instructions.

3.04 TOLERANCES

- A. Surface Flatness: 1/4 inch, maximum, measured with 10 foot straight edge.

3.05 PROTECTION

- A. Immediately after placement, protect sidewalk from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian traffic over sidewalk for 5 days minimum after finishing.

END OF SECTION

**SECTION 321723
PAVEMENT MARKINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Painted pavement markings.

1.02 RELATED REQUIREMENTS

- A. Section 321216 - Asphalt Paving.
- B. Section 321313 - Concrete Paving.
- C. Section 321623 - Sidewalks.

1.03 REFERENCE STANDARDS

- A. AASHTO M 237 - Standard Specification for Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete; 2024.
- B. AASHTO MP 24 - Standard Specification for Waterborne White and Yellow Traffic Paints; 2015 (Reapproved 2020).
- C. FHWA MUTCD - Manual on Uniform Traffic Control Devices; 2023, with Editorial Revision (2025).

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate traffic management plan with barricades, cones, and temporary markings.
- C. Product Data: Manufacturer's data sheets on each product to be used.

1.05 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

1.06 SEQUENCING

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of markings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Painted Pavement Markings:
 - 1. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Flat Zone Marking Paint.
 - 2. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Velvet Zone Marking Paint.
 - 3. PPG Traffic Solutions; Ennis Flint Fast Dry Waterborne Traffic Paint, 9852x Series.
 - 4. The Sherwin Williams Company.
 - 5. Substitutions: See Section 016000 - Product Requirements.

2.02 PAINTED PAVEMENT MARKINGS

- A. Comply with State of NYS DOT standards.

- B. Painted Pavement Markings: As indicated on drawings, or as ordered by the Owner or Owner's Representative.
 - 1. Formulated for use as a pavement marking material.
 - 2. Be VOC compliant and lead chromate free.
 - 3. Yellow paints must use organic yellow pigments COlor Index Pigment Yellow 65 (C.I. 11740) and/or 74 (C.I. 11741)
 - 4. Conform to current Federal, State, and Local air pollution regulations, including those for the control (emission) of volatile organic compounds (VOC) as established by the U.S. EPA, and the NYSDEC.
 - 5. %Pigment: (ASTM D3723) 58%-62%
 - 6. %Total Solids: (ASTM D3723) 76% Minimum
 - 7. %Vehicle Non-Volatile (ASTM D3723) 43% Minimum.
 - 8. Directional Reflectance (ASTM E1347)
 - 9. Marking Paint:
 - a. Parking Lots: Yellow.
 - b. Symbols and Text: White.
 - c. Wheelchair Symbols: Provide blue and white.
 - d. Play Area Striping: As existing depicts.
 - 1) Final color shall be approved by the Owner and/or Owner's Representative.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Verify that pavement is dry and ready for installation.
- B. Notify Architect of unsatisfactory conditions before proceeding.

3.02 PREPARATION

- A. Place barricades, warning signs, and flags as necessary to alert approaching traffic.
- B. Clean surfaces prior to installation.
 - 1. Remove dust, dirt, and other debris.
 - 2. Remove rubber deposits, existing paint markings, and other coatings.
- C. Apply paint stencils by type and color at necessary intervals.

3.03 INSTALLATION

- A. General:
 - 1. Position pavement markings as indicated on drawings.
 - 2. Field location adjustments require approval of Architect/Engineer/Owner's Representa.
- B. Painted Pavement Markings:
 - 1. Apply in accordance with manufacturer's instructions.
 - 2. Apply in accordance with State of New York Department of Transportation standards.
 - 3. Marking Paint: Apply uniformly, with sharp edges.
 - a. Applications: One coat.
 - b. Wet Film Thickness: 0.015 inch, minimum.
 - c. Stencils: Lay flat against pavement, align with striping, remove after application.

3.04 TOLERANCES

- A. Maximum Variation From True Position: 3 inches (76 mm).
- B. Maximum Offset From True Alignment: 3 inches (76 mm).

3.05 PROTECTION

- A. Prevent approaching traffic from crossing newly applied pavement markings.
- B. Replace damaged or removed markings at no additional cost to Owner.

END OF SECTION

**SECTION 321726
TACTILE WARNING SURFACING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Plastic tactile and detectable warning tiles for pedestrian walking surfaces.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - CAST-IN-PLACE CONCRETE: Concrete for sidewalks and platforms.

1.03 REFERENCE STANDARDS

- A. 49 CFR 37 - Transportation Services for Individuals with Disabilities (ADA); current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- D. ATBCB PROWAG - Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way; 2023.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's product data, standard details, details specific to this project; written installation and maintenance instructions.
- C. Warranty: Submit manufacturer warranty; complete forms in Owner's name and register with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to project site in manufacturer's protective wrapping and in manufacturer's unopened packaging.
- B. Store covered and elevated above grade and in manufacturer's unopened packaging until ready for installation. Maintain at ambient temperature between 40 and 90 degrees F.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Cast Iron Tiles: Provide manufacturer's standard ten year warranty against manufacturing defects, breakage or deformation.
- C. Plastic Tiles: Provide manufacturer's standard five year warranty against manufacturing defects, breakage or deformation.

PART 2 PRODUCTS

2.01 TACTILE AND DETECTABLE WARNING DEVICES

- A. Provide per NYS DOT Standard.
- B. Plastic Tactile and Detectable Warning Tiles: ADA Standards compliant glass fiber and carbon fiber reinforced, exterior grade, matte finish polyester sheet with truncated dome pattern, solid color throughout, internal reinforcing of sheet and of truncated domes, integral radius cut lines on back face of tile; with factory-applied removable protective sheeting.
 - 1. Pattern: In-line pattern of truncated domes complying with ADA Standards.

2.02 ACCESSORIES

- A. Fasteners: ASTM A666/A666M, Type 304 stainless steel
 - 1. Type: Countersunk, color matched composite sleeve anchors
 - 2. Size: 1/4 inch diameter and 1-1/2 inches long.
- B. Adhesive: Type recommended and approved by surfacing tile manufacturer.
- C. Sealant: Elastomeric sealant of color to match adjacent surfaces; approved by surfacing tile manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. When installation location is near site boundary or property line, verify required location using property survey.
- B. Verify that work area is ready to receive work:
 - 1. Examine work area with installer present.
 - 2. If existing conditions are not as required to properly complete the work of this section, notify Architect.
 - 3. Do not proceed with installation until deficiencies in existing conditions have been corrected.
- C. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

3.02 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's written instructions.
 - 1. Do not install damaged, warped, bowed, dented, abraded, or otherwise defective units.
 - 2. Do not install when ambient or substrate temperature has been below 40 degrees F during the preceding 8 daylight hours.
- B. Field Adjustment:
 - 1. Cut units to size and configuration shown on drawings.
 - 2. Do not cut plastic tiles to less than 9 inches wide in any direction.
 - 3. Locate relative to curb line in compliance with ATCB PROWAG, Sections 304 and 305.
 - 4. Orient so dome pattern is aligned with the direction of ramp.
 - 5. Align truncated dome pattern between adjacent units.
- C. Install units fully seated to substrate, square to straight edges and flat to required slope.
- D. Align units so that tops of adjacent units are flush and joints between units are uniform in width.

3.03 INSTALLATION, CAST IN PLACE PLASTIC TILES

- A. Concrete:
 - 1. See Section 321313.
 - 2. Slump: 4 to 7 percent.
- B. Tamp and vibrate units as recommended by manufacturer.
- C. Place and position weights on units while concrete cures as recommended by manufacturer. Ensure no voids or air pockets exist between top surface of concrete and underside of units.

3.04 INSTALLATION, SURFACE APPLIED PLASTIC TILES

- A. Cure concrete surfaces for a minimum of 4 days before installing units.
- B. Mechanically roughen surface as required to remove contaminants and prepare surface for adhesive and sealant application.

- C. When installing multiple adjacent units, leave a 1/8 inch gap between tiles to allow for expansion.
- D. Drill fastener holes straight, true and to depth recommended by manufacturer.
- E. Apply adhesive to back of unit as recommended by manufacturer.
- F. Mechanically fasten to substrate. Avoid striking or damaging the unit itself during installation.
- G. Apply sealant to edges in cove profile.

3.05 INSTALLATION - CAST IN PLACE, CAST IRON PLATES

- A. Concrete: See Section 321313
- B. When installing multiple adjacent units, connect plates before placing.
- C. Install by method described in manufacturer's written instructions.
- D. Place units into wet concrete.
- E. Press assembly into concrete to achieve final elevation.
- F. Finish concrete adjacent to plate. Remove wet concrete spilled onto plate surface.

3.06 CLEANING PLASTIC UNITS

- A. Remove protective plastic sheeting within 24 hours of installation.
- B. Remove excess sealant or adhesive from joints and edges.
- C. Clean four days prior to date of scheduled inspection.

3.07 PROTECTION

- A. Protect installed units from traffic, subsequent construction operations or other imposed loads until concrete is fully cured.
- B. Touch-up, repair or replace damaged products prior to Date of Substantial Completion.

END OF SECTION

SECTION 323113
CHAIN LINK FENCE AND GATES

SUMMARY

1.01 SECTION INCLUDES:

- A. Chain-link fences.
- B. Backstops
- C. Swing gates.
- D. Horizontal-slide gates.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
- C. Fence and gate posts, rails, and fittings.
- D. Chain-link fabric, reinforcements, and attachments.
- E. Gates and hardware.
- F. Shop Drawings: For each type of fence and gate assembly.
- G. Include plans, elevations, sections, details, and attachments to other work.
- H. Include accessories, hardware, gate operation, and operational clearances.
- I. Samples for Initial Selection: For each type of factory-applied finish.

1.04 FIELD CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.05 WARRANTY

- A. Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
- B. Failures include, but are not limited to, the following:
- C. Failure to comply with performance requirements.
- D. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- E. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 CHAIN-LINK FENCE FABRIC

- A. General: Match Existing Fence or Provide fabric in one-piece heights measured between top and bottom of outer edge of selva ge knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:
- B. Fabric Height: As indicated on Drawings.

- C. Fabric Gage: As indicated on Contract Drawings. 9-gage if not indicated.
- D. Mesh Size: 2 inches. 1.75 inches for tennis court applications as required.
- E. Fabric Heights 8-foot or greater. Zinc-Coated Fabric: ASTM A 392, Type II, with zinc coating applied before weaving.
- F. Fabric Heights 6-foot or less. Polymer-Coated Fabric: ASTM F 668, Class 2A, fusion-bonded and adhered to 9 gage steel wire, applied before weaving. Color shall be Black.
- G. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.
- H. Selvage: Knuckled at both selvages.

2.02 FENCE FRAMEWORK

- A. Posts and Rails: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
- B. Fence Height: As indicated on Drawings.
- C. Industrial-Strength Material: Group IC, Standard Weight, Schedule 40, round steel pipe, electric-resistance-welded pipe, 50,000 PSI minimum yield strength.
- D. Line Post: As indicated on Contract Drawings.
- E. End, Corner, and Pull Posts: As indicated on Contract Drawings.
- F. Horizontal Framework Members: Intermediate top and bottom rails according to ASTM F 1043.
- G. Top / Bottom Rail: 1.66 inches in diameter.
- H. Brace Rails: ASTM F 1043.
- I. Metallic Coating for Steel Framework 6->
- J. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating according to ASTM A 653/A 653M.
- K. Polymer coating matching fabric over metallic coating for framework less than less than 6-foot. Color shall be Black.

2.03 SWING GATES

- A. General: ASTM F 900 for gate posts and single and double swing gate types, as indicated on the Contract Drawings.
- B. Gate Leaf Width: As indicated and shall be clear opening width.
- C. Pipe and Tubing:
- D. Zinc-Coated Steel: ASTM F 1043 and ASTM F 1083; manufacturer's standard protective coating and finish.
- E. Gate Posts: Round tubular steel.
- F. Gate Frames and Bracing: Round tubular steel.
- G. Frame Corner Construction: Welded.
 - 1. Hardware:
 - a. Hinge: Commercial grade - 360-degree inward and outward swing.
 - b. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate. Coordinate hasp size with Owner locks.

2.04 HORIZONTAL-SLIDE GATES (WHERE INDICATED ON CONTRACT DRAWINGS)

- A. General: ASTM F 1184 for gate posts and single sliding gate types.
- B. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.
- C. Gate Frame Width and Height: As indicated.
- D. Pipe and Tubing:
 - 1. Zinc-Coated Steel: Manufacturer's standard protective coating and finish.
 - 2. Gate Posts: ASTM F 1184. Provide round tubular steel posts.
 - 3. Gate Frames and Bracing: Round tubular steel.
 - 4. Frame Corner Construction: Welded with end caps.
- E. Hardware:
 - 1. Hangers, Roller Assemblies, and Stops: Fabricated from galvanized steel.
 - 2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
 - 3. Lock: Manufacturer's standard internal device.

2.05 FITTINGS

- A. Provide fittings according to ASTM F 626.
- B. Post Caps: Provide for each post.
 - 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
 - 1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
 - 2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.
- E. Tension and Brace Bands: Pressed steel.
- F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
- I. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
- J. Hot-Dip Galvanized Steel: 0.148-inch-diameter wire.
- K. Aluminum: ASTM B 211; Alloy 1350-H19; 0.148-inch-diameter, mill-finished wire.

2.06 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

- B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 CHAIN-LINK FENCE INSTALLATION

- A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.
 - 1. Install fencing on established boundary lines inside property line.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - 3. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
 - 4. Concealed Concrete: Place top of concrete below grade as indicated on Drawings to allow covering with surface material.
 - 5. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
 - 6. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of as indicated on Drawings. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at as indicated on the contract documents, with a maximum post spacing of 10 feet for fence heights of six feet or less.

- F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
 - 1. Locate horizontal braces at mid-height of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- H. Intermediate and Bottom Rails: Secure to posts with fittings.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing frame work or facing athletic field areas. Leave 1-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.
- K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
- L. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.

3.04 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.05 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding and are compatible with Owner locks.

END OF SECTION 323113

END OF SECTION

**SECTION 323119
DECORATIVE METAL FENCES AND GATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Decorative steel fences.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - CAST-IN-PLACE CONCRETE.
- B. Section 312316 - Excavation.

1.03 REFERENCE STANDARDS

- A. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2025.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- C. 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: Submit manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings:
 - 1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
 - 2. Foundation details, concrete design mix and reinforcing schedule for anti-ram barrier system.
- D. Manufacturer's Qualification Statement.
- E. Installer's Qualification Statement.
- F. Manufacturer's Warranty.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.07 WARRANTY

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Decorative Metal Fences and Gates:
 - 1. AFS, Inc. - Vanguard Aluminum Fences; _____: www.americanfencesystem.com/#sle.
 - 2. Alumi-Guard; _____: www.alumi-guard.com/#sle.
 - 3. Ameristar Perimeter Security, USA; _____: www.ameristarperimeter.com/#sle.
 - 4. CDH Custom Roll Form, LLC; Palisade Security Fence: www.cdhrollform.com/#sle.
 - 5. Stewart Iron Works, LLC; _____: www.stewartironworks.com/#sle.
 - 6. Substitutions: See Section 016000 - Product Requirements.

2.02 FENCES

- A. Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
- B. Electro-Deposition Coating: Multistage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
 - 1. Total Coating Thickness: 2 mils, minimum.
- C. Steel: ASTM A653/A653M; tensile strength 45,000 psi, minimum.
 - 1. Hot-dip galvanized; ASTM A653/A653M, G60.
 - 2. 62 percent recycled steel, minimum.
- D. Fasteners: ASTM A276/A276M, Type 302 stainless steel; finished to match fence components.
- E. Hinges: Finished to match fence components.
 - 1. Brackets: Round.
 - 2. Mounting: Center.
 - 3. Closing: Manual.
- F. Latches: Finished to match fence components.
 - 1. Brackets: Round.
 - 2. Locking: Mechanical.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Set fence posts in accordance with the manufacturer recommended spacing.
- C. When cutting rails immediately seal the exposed surfaces by:
 - 1. Removing metal shavings from cut area.
 - 2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
 - 3. Apply two coats of custom finish spray paint matching fence color.

- 4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.
- D. Space gate posts according to the manufacturers' drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
 - 1. Base type and quantity of gate hinges on the application, weight, height, and number of gate cycles.
 - 2. Identify the necessary hardware required for the application on the manufacturer's gate drawings.
 - 3. Provide gate hardware by the manufacturer of the gate and install in compliance with manufacturer's recommendations.
- E. Excavate post holes in accordance with Section 312316.
- F. Install operator in accordance with manufacturer's instructions and in accordance with NFPA 70.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From Indicated Position: 1 inch.
- C. Minimum Distance from Property Line: 6 inches.

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.
- C. Post Settings: Randomly inspect two locations against design for:
 - 1. Hole diameter.
 - 2. Hole depth.
 - 3. Hole spacing.
- D. Fence Height: Randomly measure fence height at three locations or at areas that appear out of compliance with design.
- E. Gates: Inspect for level, plumb, and alignment.
- F. Workmanship: Verify neat installation free of defects.

3.06 CLEANING

- A. Leave immediate work area neat at end of work day.
- B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- C. Clean fence with mild household detergent and clean water rinse well.
- D. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.
- E. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.
- F. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstrate proper operation of equipment to Owner's designated representative.
- D. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance of each component.
- E. 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.
 - 3. Location: At project site.

3.08 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION

**SECTION 323300
SITE FURNISHINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Benches.
- B. Waste receptacles.

1.02 REFERENCE STANDARDS

- A. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Samples: Submit two sets of manufacturer's available colors for metal furnishings.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

1.05 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide manufacturer's warranty against defects in materials or workmanship for ductile iron castings for a period of 10 years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Furnishings:
 - 1. Victor Stanley, Inc: www.victorstanley.com.

2.02 METAL FURNISHINGS

- A. Metal Furnishings, General:
 - 1. Cast iron components: Ductile iron castings complying with ASTM A536; cleaned, treated, and powder-coated.
 - a. Color: black.
 - 2. Wood components: Ipe with eased edges, and clear wood preservative coating.
 - 3. Hardware: Stainless steel.
- B. Benches: Metal frame and seat section with back.
 - 1. Frame: Cast iron.
 - 2. Seat: Wood slat.
 - 3. Length: 74 inches (____ mm).
 - 4. Width: 24.5 inches (____ mm).
 - 5. Height: 31.25 inches (____ mm).
 - 6. Mounting: Surface.
 - 7. Products:
 - a. Victor Stanley FB-324
- C. Waste Receptacles: Steel frame with laser cut steel panels with perforations and side openings.
 - 1. Capacity: 36 gallons (136 liters).

2. Shape: Round.
3. Diameter: 25 inches (____ mm).
4. Height: 41 7/8 inches (____ mm).
5. Inserts: Removable plastic containers for waste material.
6. Mounting: Surface.
7. Products:
 - a. Victor Stanley, Inc SGE-36SA-P www.victorstanley.com.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify proper installation of mounting surfaces, preinstalled anchor bolts, and other mounting devices; and ready to receive site furnishing items.

3.02 INSTALLATION

- A. Install site furnishings in accordance with approved shop drawings, and manufacturer's installation instructions.

END OF SECTION

**SECTION 325990
RESTORATION OF SURFACES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 WORK DEFINED

- A. Various types of street surfaces, shoulders, gutters, culverts, guide rails, sidewalks, driveways, lawns, landscape, signs, mailboxes, planting boxes, fences, hedges, walls, trees, shrubbery, etc. disturbed, damaged, or destroyed during the work shall be restored and/or replaced and maintained as specified herein and as shown and directed.
- B. The finished pavements, shoulders, sidewalks, and driveways, gutters, and culverts shall be maintained in satisfactory condition during a period of one year following final acceptance of the work.
- C. The Contractor shall be responsible for watering and maintenance of all new and restored trees, hedges, shrubs and grass until final acceptance of the Contract. Any trees or plantings damaged such that they may die within a time period of one year after completion and acceptance of work shall be replaced at the Contractor's expense.
- D. The Contractor shall be responsible to remove and reset or protect various existing site and landscaping amenities to complete the work. Any amenities disturbed, damaged, or destroyed during the work shall be restored and/or replaced.

1.03 SUBMITTALS

- A. Before removing any hedges, shrubbery and trees, or other structure outside the work area, the Contractor shall notify the Engineer as to those he proposes to remove so that a record can be made of the type, kind, and location of such articles and their condition before removal. All articles to be removed shall be included on the project video.
- B. A schedule of replacement operations shall be worked out by the Contractor and approval of the Engineer shall be obtained. The program shall be adhered to and, any deviation shall be approved by the Engineer.
- C. Concrete mix design for structural concrete shall be submitted for approval in conformance with Section 03 3000.
- D. Adequate copies of certification of materials to indicate conformance with standards specified shall be submitted.
- E. Product Data for subbase and pavement material.

1.04 QUALITY ASSURANCE

- A. All work in shall be performed under the direction of individuals experienced in the restoration work required.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL

- A. The materials used in the restoration or replacement shall produce a street surface, shoulder, sidewalk, curb, gutter, culvert, driveway, or lawn and landscaped areas, fences, trees, and shrubbery equal to or better than the condition of each before the work began.

2.02 TREES AND SHRUBS (IF APPLICABLE)

- A. All trees for replacement or new installation shall be hardy, healthy, nursery grown with straight trunks and single leader, and symmetrically branched six to seven feet from the ground and of overall height of at least ten feet, with a minimum diameter breast height of 3 inches.
- B. All shrubs including root spread and ball size shall be in accordance with current edition of U.S.A. Standard for Nursery Stock.

2.03 TOPSOIL

- A. Topsoil shall be approved material obtained from excavation and grading work unless otherwise directed by the Engineer. All topsoil shall be 4 inches in depth.

2.04 PERMANENT PAVEMENT

- A. Pavement materials shall match existing.

PART 3 - EXECUTION

3.01 TEMPORARY RESURFACING AND PERMANENT REPAVING GENERAL MANNER OF EXECUTION

- A. Immediately upon completion of refilling of the trench or excavation, the Contractor shall place a temporary surface over all disturbed areas of the streets, driveways, alleys, and other traveled places where the original surface has been disturbed by his operation. The temporary surface shall be safe for public travel, and provided at no cost to the Owner. This work shall be performed promptly and as directed by the Engineer. If such work is not completed within the 24 hours of written notice, then the Engineer shall order the work done by others and the cost of the same will be deducted from the Contract price.
- B. The temporary pavement surface shall consist of an asphalt bituminous wearing surface and/or granular material placed upon the required trench backfill material. The temporary asphalt surface shall be maintained as necessary to minimize traffic disturbance.
- C. The permanent and final repaving of all streets, driveways, and similar surfaces where pavement has been removed, disturbed, settled, or damaged by or on account of the work of the Contractor, shall be repaired and replaced by the Contractor, by a new and similar pavement at such time as directed. All new surfaces shall be replaced in type, kind, and quality to the original. Pavement in State Highways, County Highways, City, Village, or Town roads shall conform to the requirements of their established standards.
- D. Prior to placing new pavement, any temporary pavement shall be removed. All service boxes, manhole frames, and covers and similar structures within the area of pavement to be repaired shall be set to match existing grades. The new pavement shall be compacted with ten ton roller. All joints shall be saw cut, tack coated, and trimmed to provide a smooth surface. Contractor shall maintain the permanent pavement for one year after the placement and acceptance. Any depression or failure of the pavement shall be corrected promptly at no cost to the Owner.

3.02 TREES

- A. All trees shall be placed in accordance with suppliers recommendations.

3.03 GUTTERS, CULVERTS, AND STONE WALLS

- A. The Contractor shall permanently repair and replace all gutters, culverts, and stone walls, where the same have been broken, injured, or disturbed by the Contractor, in executing any of the work covered by the Contract. He shall restore the same in a manner, to a condition and with material, either new or old as required, similar and equal to that existing before such construction was made.

3.04 FENCES, GUIDE RAIL, STONE WALLS

- A. Where it is necessary to remove a fence, guide rail, stone wall, or portion thereof, the Contractor shall carefully remove and preserve such and, upon completion of the work at that point, shall restore the fence, guide rail, or stone wall to its original position in as good condition as it was before removal.

3.05 ANY DAMAGE CAUSED BY THE OPERATIONS OF THE CONTRACTOR UNDER THIS CONTRACT TO EITHER THE UNMOVED OR THE REMOVED PORTIONS SHALL BE RESTORED OR REPLACED BY THE CONTRACTOR AT HIS OWN EXPENSE.

3.06 MAINTENANCE

- A. Properly maintain all turfed areas by watering, cultivating, weeding, mowing, re-seeding, filling eroded areas and all other repairs and replacements until final acceptance of the work.
- B. Re-seed all areas where seed has failed to germinate and where seeded areas have been damaged by erosion, people, vehicular traffic or other causes.
- C. Any depression or failure of temporary or permanent pavement shall be corrected promptly. The Contractor shall be responsible for the repair to all existing asphalt concrete pavement if damaged as a result of this work.

END OF SECTION

**SECTION 329219
SEEDING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Placing topsoil.
- B. Hydroseeding, seeding, mulching and fertilizer.
- C. Maintenance.

1.02 RELATED REQUIREMENTS

- A. Section 312200 - Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.

1.03 DEFINITIONS

- A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Topsoil samples.
- C. Certificate: Certify seed mixture approval by authority having jurisdiction.
- D. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer .

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.
- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.01 SEED MIXTURE

- A. Seed Mixtures:
 - 1. See landscape plans.

2.02 SOIL MATERIALS

- A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

2.03 ACCESSORIES

- A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
- B. Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen,; recommended for grass, with fifty percent of the elements derived from

organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis. Fertilizer shall be selected and applied in accordance with all local and New York State laws. Fertilizer shall be phosphorus free unless soil tests indicate phosphorus levels are insufficient. Fertilizer shall not be applied between December 1 and April 1.

- C. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.
- D. Erosion Fabric: Jute matting, open weave.
- E. Herbicide: provided in conformance with NYS and Local laws..
 - 1. Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides or herbicides unless authorized in writing by authorities having jurisdiction.
 - a. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
 - b. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.
- F. Stakes: Softwood lumber, chisel pointed.
- G. String: Inorganic fiber.

2.04 TESTS

- A. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
- B. Submit minimum 10 oz (280 g) sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.
- C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared soil base is ready to receive the work of this Section.

3.02 PREPARATION

- A. Place topsoil in accordance with Section 312200.

3.03 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions nad all local laws.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
- D. Mix thoroughly into upper 2 inches (50 mm) of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.04 SEEDING

- A. Apply seed at manufacturer's recommended rate evenly in two intersecting directions. Rake in lightly.

- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- D. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.
- E. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.
- F. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.05 HYDROSEEDING

- A. Apply seeded slurry with a hydraulic seeder at a rate of 1500-lb/acre dry weight evenly in two intersecting directions.
- B. Do not hydroseed area in excess of that which can be mulched on same day.
- C. Immediately following seeding, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.
- D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.
- E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.06 MAINTENANCE

- A. Provide maintenance at no extra cost to Owner.
- B. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.
- C. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition, but no less than 12 months.
- D. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches (65 mm). Do not cut more than 1/3 of grass blade at any one mowing.
- E. Neatly trim edges and hand clip where necessary.
- F. Immediately remove clippings after mowing and trimming.
- G. Water to prevent grass and soil from drying out.
- H. Roll surface to remove minor depressions or irregularities.
- I. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- J. Immediately reseed areas that show bare spots.
- K. Protect seeded areas with warning signs during maintenance period.

END OF SECTION

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**SECTION 329300
PLANTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Topsoil bedding.
- C. New trees, plants, and ground cover.
- D. Mulch and Fertilizer.
- E. Maintenance.
- F. Tree Pruning.

1.02 DEFINITIONS

- A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Plants: Living trees, plants, and ground cover specified in this Section , and described in ANSI Z60.1.

1.03 REFERENCE STANDARDS

- A. ANSI/AHIA Z60.2 - American Standard for Nursery Stock; 2025.
- B. ANSI A300 Part 1 - American National Standard for Tree Care Operations - Tree, Shrub, and Other Woody Plant Management - Standard Practices (Pruning); 2017.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Certificate: Certify fertilizer and herbicide mixture approval by authority having jurisdiction.
- C. Certificate: Submit certificate for plants free of disease or hazardous insects; certified by federal department of agriculture; free of disease or hazardous insects.
- D. Submit list of plant life sources.

1.05 QUALITY ASSURANCE

- A. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- B. Protect and maintain plant life until planted.
- C. Deliver plant life materials immediately prior to placement. Keep plants moist.

1.07 FIELD CONDITIONS

- A. Do not install plant life when ambient temperatures may drop below 35 degrees F (2 degrees C) or rise above 90 degrees F (32 degrees C).
- B. Do not install plant life when wind velocity exceeds 30 mph (48 k/hr).

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide one year warranty.
- C. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer and herbicide composition.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of plants, fertilizer and herbicide mixture.

2.02 PLANTS

- A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

2.03 SOIL MATERIALS

- A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; minimum pH value of 5.4 and maximum 7.0.

2.04 SOIL AMENDMENT MATERIALS

- A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis.
- B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight, pH range of 4 to 5; moisture content of 30 percent.
- C. Bone Meal: Raw, finely ground, commercial grade, minimum of 3 percent nitrogen and 20 percent phosphorous.
- D. Lime: Ground limestone, dolomite type, minimum 95 percent carbonates.
- E. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

2.05 MULCH MATERIALS

- A. Mulching Material: Shredded hardwood bark, free of growth or germination inhibiting ingredients.

2.06 ACCESSORIES

- A. Wrapping Materials: Burlap.
- B. Stakes: Softwood lumber, pointed end.
- C. Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.
- D. Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.

2.07 PLANT SOIL MIX

- A. See landscape plans.

2.08 SOURCE QUALITY CONTROL

- A. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared subsoil and planters are ready to receive work.
- B. Saturate soil with water to test drainage.
- C. Verify that required underground utilities are available, in proper location, and ready for use.

3.02 PREPARATION OF SUBSOIL

- A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.
- C. Scarify subsoil to a depth of 3 inches (75 mm) where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
- D. Dig pits and beds 6 inches (150 mm) larger than plant root system.

3.03 PLACING TOPSOIL

- A. Spread topsoil to a minimum depth of 4 inches (100 mm) over area to be planted. Rake smooth.
- B. Place topsoil during dry weather and on dry unfrozen subgrade.
- C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
- D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
- E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches (150 mm).

3.04 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after initial raking of topsoil.
- C. Mix thoroughly into upper 2 inches (50 mm) of topsoil.
- D. Lightly water to aid the dissipation of fertilizer.

3.05 PLANTING

- A. Place plants for best appearance.
- B. Set plants vertical.
- C. Remove non-biodegradable root containers.
- D. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches (of 150 mm) under each plant. Remove burlap, ropes, and wires, from the root ball.
- E. Place bare root plant materials so roots lie in a natural position. Backfill soil mixture in 6 inch (150 mm) layers. Maintain plant life in vertical position.

- F. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.06 INSTALLATION OF ACCESSORIES

- A. Wrap deciduous shade and flowering tree trunks and place tree protectors.

3.07 PLANT SUPPORT

- A. Brace plants vertically with plant protector wrapped guy wires and stakes to the following:
1. Tree Caliper: 2 to 4 inches (50 to 100 mm); Tree Support Method: 3 guy wires with eye bolts and turn buckles

3.08 TREE PRUNING

- A. Prune trees as recommended in ANSI A300 Part 1.
- B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.09 MAINTENANCE

- A. Provide maintenance at no extra cost to Owner.
- B. Maintain plant life for 12 months after Date of Substantial Completion.
- C. Irrigate sufficiently to saturate root system and prevent soil from drying out.
- D. Remove dead or broken branches and treat pruned areas or other wounds.
- E. Neatly trim plants where necessary.
- F. Immediately remove clippings after trimming.
- G. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions.
- H. Control insect damage and disease. Apply pesticides in accordance with manufacturers instructions.
- I. Remedy damage from use of herbicides and pesticides.
- J. Replace mulch when deteriorated.
- K. Maintain wrappings, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

END OF SECTION

**SECTION 330110.58
DISINFECTION OF WATER UTILITY PIPING SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Disinfection of site domestic water lines and site fire water lines specified in Section 331416.

1.02 RELATED REQUIREMENTS

- A. Section 331416 - Site Water Utility Distribution Piping.

1.03 REFERENCE STANDARDS

- A. AWWA B300 - Hypochlorites; 2024.
- B. AWWA B301 - Liquid Chlorine; 2024.
- C. AWWA B302 - Ammonium Sulfate; 2023.
- D. AWWA B303 - Sodium Chlorite; 2024.
- E. AWWA C651 - Disinfecting Water Mains; 2023.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Test Reports: Indicate results comparative to specified requirements.
- C. Certificate: From authority having jurisdiction indicating approval of water system.
- D. Certificate: Certify that cleanliness of water distribution system meets or exceeds specified requirements.

1.05 QUALITY ASSURANCE

- A. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of the State in which the Project is located.

PART 2 PRODUCTS

2.01 DISINFECTION CHEMICALS

- A. Chemicals: AWWA B300 Hypochlorite, AWWA B301 Liquid Chlorine, AWWA B302 Ammonium Sulfate, and AWWA B303 Sodium Chlorite.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping system and water well has been cleaned, inspected , and pressure tested.
- B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

3.02 DISINFECTION

- A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.
- B. Provide and attach equipment required to perform the work.
- C. Introduce treatment into piping system.
- D. Maintain disinfectant in system for 24 hours.
- E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.

- F. Replace permanent system devices removed for disinfection.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 014000.
B. Test samples in accordance with AWWA C651.

END OF SECTION

**SECTION 330561
CONCRETE MANHOLES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Precast concrete manholes.
- B. Grade adjustments.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions for each product indicated on the drawings.
- C. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of penetrations.
- D. Manufacturer's qualification statement.

PART 2 PRODUCTS

2.01 CONCRETE MANHOLES

- A. Weight Rating: H-20 according to AASHTO HB.
- B. Precast Concrete Manholes: Comply with ASTM C478/C478M, reinforced.
 - 1. Wall Thickness: 6 inches (152 mm) or as indicated on the drawings.
 - 2. Base Thickness: 12 inches (305 mm) or as indicated on the drawings .
 - 3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
 - 4. Joint Sealant: Comply with ASTM C990.
- C. Grade Adjustments:
 - 1. Concrete Bricks: ASTM C1634 or ASTM C55 Grade N.
- D. Frame and Cover: Cast iron construction, ASTM A48/A48M Class 30B, machined flat bearing surface; _____.

2.02 ACCESSORIES

- A. Steps: Formed galvanized steel rungs; 3/4 inch diameter. Formed integral with manhole sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify items provided by other sections of work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for manholes is correct.

3.02 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.03 INSTALLATION

- A. Establish elevations and pipe inverts for inlets and outlets as indicated in drawings.

- B. Precast Concrete Manholes:
 - 1. Place base section plumb and level.
 - 2. Install joint sealant uniformly around section lip.
- C. Grade Adjustments:
 - 1. Place adjacent materials tight, and smooth following design grades.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Perform field inspection for pipe invert elevations.
- C. If inspections indicate work does not meet specified requirements, adjust work and reinspect at no cost to Owner.

END OF SECTION

SECTION 331416
SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water pipe for site conveyance lines.
- B. Pipe valves.
- C. Fire hydrants.

1.02 REFERENCE STANDARDS

- A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2018.
- C. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- D. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
- E. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- F. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2024.
- G. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2020.
- H. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter; 2022.
- I. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019 (Reapproved 2025).
- J. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- K. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- L. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.
- M. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges; 2020.
- N. AWWA C502 - Dry-Barrel Fire Hydrants; 2024.
- O. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; 2023.
- P. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.
- Q. AWWA C800 - Underground Service Line Valves and Fittings; 2025.
- R. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm); 2022.
- S. AWWA C901 - Polyethylene (PE) Pressure Pipe, Tubing, and Fittings, 3/4 In. (19 mm) Through 3 In. (76 mm), for Water Service; 2025.
- T. UL 246 - Hydrants for Fire-Protection Service; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with MCWA requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

1.06 WARRANTY

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

PART 2 PRODUCTS

2.01 WATER PIPE

- A. Ductile Iron Pipe: AWWA C151/A21.51:
 - 1. Fittings: Ductile iron, Class 52 thickness, cement lined.
 - 2. Joints: AWWA C111/A21.11, Styrene butadiene rubber (SBR) or vulcanized SBR gasket with mechanical joints.
 - 3. Polyethylene Jackets: AWWA C105/A21.5 polyethylene jacket.
- B. Copper Tubing: ASTM B88, Type K, Annealed:
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.
- C. PVC Pipe: AWWA C900 Class 100:
 - 1. Pipe: As indicated on the drawings or: AWWA C900, With bell end with gasket, and with spigot end. PVCO Pipe shall meet AWWA C909.
 - 2. Pressure Class as indicated on the drawings or DR-18 (235 psi)
 - 3. Comply with UL 1285 for fire-service mains if indicated.
 - 4. PVC Fabricated Fittings: AWWA C900, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 5. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 6. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 7. Gaskets: AWWA C111, rubber.
 - 8. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 9. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. HDPE PIPE AND FITTINGS
 - 1. ASTM Pipe: ASTM D2239, (AWWA 901), SIDR No.7, or 9; with PE compound number required to give pressure rating not less than **200 psig**.
 - a. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
 - b. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

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2. AWWA Pipe: AWWA C906, DR No.11; with PE compound number required to give pressure rating not less than **200 psig**.
 3. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than **200 psig**.
 4. Fittings: AWWA C111/A21.11, Schedule 40 per ASTM D2466 or schedule 80 per ASTM D2467.
 5. Joints: ASTM D3139 compression gasket ring.
- E. Polyethylene Pipe: AWWA C901:
1. Fittings: AWWA C901, molded or fabricated.
 2. Joints: Compression.
- F. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.

2.02 VALVES

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gate Valves 3 Inches and Over:
1. Manufacturer and Model: Kennedy Resilient Wedge Gate Valves or approved equal.
 2. AWWA C509, iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, mechanical joint ends, control rod, valve key, and traffic rated extension box with "WATER" cast into cover.

2.03 HYDRANTS

- A. Hydrants: 5.25 " valve opening. Three nozzle (two discharge 180 degrees apart, one pumper)
- B. AWWA C502, UL 246, dry barrel type.
- C. Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length.
- D. Hose and Streamer Connection: Match sizes with utility company, two hose nozzles , one pumper nozzle.
- E. Finish: Primer and two coats of enamel lead-free paint..

2.04 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 312316.13.
- B. Cover: As specified in Section 312316.13.

2.05 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 033000.
- B. Backflow Preventer: Size and type s indicated on the drawings .
- C. Meter: Size and type as indicated on the drawings .
- D. Sectionalized Aluminum Exterior Enclosure: Location, size and type as indicated on the drawings
1. The enclosure shall be of reinforced aluminum construction, providing adequate access for testing/certification purposes. It must also be totally removable for maintenance purposes.
 2. Aluminum sheeting shall be 3003 aluminum (.051"/16 gauge), stucco embossed finish and shall meet ASTM B209. Stucco embossed finish reduces the glare and helps hide any surface scratches or imperfections received in the field.

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3. Insulation shall be approximately 1.5" unicellular, non-wicking, polyisocyanate foam sprayed in place that forms a monolithic bond between the aluminum bracing and aluminum sheeting.
 4. R-Value = 10 (minimum).
 5. Enclosures shall be designed to support a minimum vertical load of 100lb/sf.
 6. Enclosures shall be designed to support wind speeds up to 120mph, all larger sizes shall be designed to support wind speeds up to 80mph.
 7. Drain ports are sized for full port backflow discharge and are designed for a one way operation allowing backflow discharge but not allowing wind, debris and small animals to enter the enclosure.
 8. The enclosure is provided with means of permanent anchor and "lockable" access doors and/or lid to prohibit theft or vandalism.
 9. No wood or particle board shall be allowed in assembly.
 10. Insulation mounted with glue will be cause for rejection.
 11. The enclosure shall contain drain openings sized to accommodate the maximum discharge of the reduced pressure zone assembly.
 12. Drain openings shall open to discharge under the most severe conditions. These openings are protected against intrusion of either wind, debris or animal.
 13. The enclosure is provided with means of permanent anchor and "lockable" access doors and/or lid to prohibit theft or vandalism.
 14. Heating equipment shall be ETL listed for wet/damp locations and protect the piping and equipment from exterior temperatures to -30°F. ETL listed thermostatically controlled wall mounted air forced heaters shall be furnished and designed by the enclosure manufacturer to maintain the equipment at +40°F, in accordance with ASSE 1060 1.2.2.1.
 15. Heating equipment shall be wall mounted to the supplied heater plates and a minimum of 8" above the slab unless it is UL or ETL certified and NEC approved for submersion.
 16. Power source shall be protected with a GFI receptacle, U.L. 943, NEMA.3R. Mounted a minimum of 8" from the bottom of the receptacle to the top of the slab.
 17. Separate 20 amp circuits are recommended for each heater, so in the event a circuit fails all other circuits will remain powered. Installations must be in accordance with the local and national codes.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.02 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

3.03 TRENCHING

- A. See the sections on excavation and fill for additional requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Form and place concrete for pipe thrust restraints at each change of pipe direction. Place concrete to permit full access to pipe and pipe accessories.

- D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION - PIPE

- A. Maintain separation of water main from sewer piping in as indicated on the drawings.
- B. Install pipe to indicated elevation to within tolerance of 5/8 inches.
- C. Install ductile iron piping and fittings to AWWA C600.
- D. Route pipe in straight line.
- E. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- F. Slope water pipe and position drains at low points.
- G. Install trace wire 6 inches above top of pipe; coordinate with Section 312316.13.

3.05 INSTALLATION - VALVES AND HYDRANTS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway in accordance with the local fire department requirements.
- D. Set hydrants to grade, with nozzles at least 20 inches above ground in accordance with the local fire department requirements.
- E. Locate control valve 4 inches away from hydrant.
- F. Provide a drainage pit 36 inches square by 24 inches deep filled with 2 inches washed gravel. Encase elbow of hydrant in gravel to 6 inches above drain opening. Do not connect drain opening to sewer.
- G. Paint hydrants in accordance with Section 099113.

3.06 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements, for additional requirements.
- B. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water. Perform testing in accordance with the authority having jurisdiction.
- C. Hydrostatic Tests: In accordance agency have jurisdiction requirements. Test at not less than one-and-one-half times working pressure for two hours or 200 psi, whichever is more, per NFPA 24 (16) .
- D. Test each backflow prevention device including, reduced pressure principle backflow, double check backflow and/or double-check detector assembly backflow as required by the authority having jurisdiction and as required by the manufacturer.

END OF SECTION

**SECTION 333113
SITE SANITARY SEWERAGE GRAVITY PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary sewerage drainage piping, fittings, and accessories.
- B. Connection of building sanitary drainage system to municipal sewers.

1.02 RELATED REQUIREMENTS

1.03 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.04 REFERENCE STANDARDS

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 pipe, pipe accessories, and fittings .
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

- A. Provide products as indicated on the drawings and that comply with applicable code(s).
- B. Cast Iron Pipe: ASTM A74, service type, inside nominal diameter of 4 to 6 inches hub and spigot end.
- C. Joint Seals for Cast Iron Pipe: ASTM C564 rubber gaskets.
- D. Ductile Iron Pipe: ASTM A746, Pressure Class 350, with asphaltic lining, inside nominal diameter of 6 to 12 inches, bell and spigot end.
- E. Joint Seals for Ductile Iron Pipe: AWWA C111/A21.11; styrene butadiene rubber (SBR) or vulcanized SBR gaskets.
- F. Concrete Pipe: Nonreinforced, ASTM C14 or ASTM C14M, Class 1; inside nominal diameter of 8 to 36 inches, bell and spigot end joints.
- G. Joint Seals for Concrete Pipe: ASTM C443 (ASTM C443M) rubber compression gaskets.
- H. Plastic Pipe: ASTM D2729 or ASTM 2241, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 3 to 18 inches, bell and spigot style solvent sealed joint end or gaskets meeting ASTM D3212 and F477.
- I. Plastic Pipe: ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 6 to 15 inches, bell and spigot style t end gasketed or solvent weld.
- J. Plastic Pipe: ASTM D1785, Schedule 40, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 4 to 6 inches, bell and spigot style solvent sealed joint end.

- K. Plastic Pipe: ASTM D3350, SDR 11, High Density Polyethylene (HDPE) material; inside nominal diameter of 4 to 48 inches, with cell classification of 335434C or better, thermal butt fusion joints and fittings in accordance with manufacturer's recommendations; pipe and fittings same material utilizing transition fittings when connecting to existing piping.
- L. Joint Seals: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- M. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.02 PIPE ACCESSORIES

- A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service" in large letters.
- B. Casing Spacer: Polyethylene spacer designed to maintain pipe casing integrity.
 - 1. Manufacturers:
 - a. Advance Products & Systems, LLC: www.apsonline.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.03 CLEANOUTS

- A. Cast-Iron Cleanouts- unless otherwise indicated provided :
 - 1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 2. Loading Classification(s): **Heavy Duty**.
 - 3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts:
 - 1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.04 BEDDING AND COVER MATERIALS

- A. Pipe Bedding Material: As specified in Section 312323.
- B. Pipe Cover Material: As specified in Section 312323.

PART 3 EXECUTION

3.01 GENERAL

- A. Perform work in accordance with applicable code(s).

3.02 TRENCHING

- A. See Section 312316.13 for additional requirements.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.03 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.

- C. Connect to building sanitary sewer outlet and municipal sewer system , through installed sleeves.
- D. Install trace wire 6 inches above top of pipe; coordinate with Section 312316.13.

3.04 INSTALLATION - CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.05 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 014000.
 - B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
 - C. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
 - D. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 - E. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
-

1. Test plastic gravity sewer piping according to ASTM F1417.
 2. Test concrete gravity sewer piping according to ASTM C1628.
- F. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than **150 psig**.
1. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
 2. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
- G. Manholes: Perform hydraulic test according to ASTM C969 .
- H. Leaks and loss in test pressure constitute defects that must be repaired.
- I. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.06 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

**SECTION 334100
SUBDRAINAGE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building Perimeter, Retaining Wall, and Under-Slab Drainage Systems.
- B. Filter aggregate and fabric and bedding.

1.02 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe drainage products, pipe accessories, and fittings.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with applicable code for materials and installation of the work of this section.

2.02 PIPE MATERIALS

- A. Polyvinyl Chloride Pipe: ASTM D2729; plain end, 6 inch inside diameter; with required fittings.
- B. Corrugated Plastic Pipe: Flexible type; 4 inch diameter, unless other shown on the drawings with required fittings.
- C. Use perforated pipe at subdrainage system; unperforated through sleeved walls.

2.03 AGGREGATE AND BEDDING

- A. Filter Aggregate and Bedding Material: Granular fill as specified in Section 312323.
- B. Filter Sand and Bedding Material: Sand as specified in Section 312323.

2.04 ACCESSORIES

- A. Pipe Couplings: Solid plastic.
- B. Filter Fabric: Water pervious type, black polyolefin. As indicated on the drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

3.02 PREPARATION

- A. Hand trim excavations to required elevations. Correct over-excavation with General Fill.
- B. Remove large stones or other hard matter that could damage drainage piping or impede consistent backfilling or compaction.

3.03 INSTALLATION

- A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.
- B. Place drainage pipe on clean cut subsoil.
- C. Lay pipe to slope gradients noted on drawings and slope drains toward outlet without causing dips or low spots in the line; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Loosely butt pipe ends. Place joint cover strip 12 inches wide, around pipe diameter centered over joint.

- E. Install filter aggregate at sides, over joint covers and top of pipe. Provide top cover compacted thickness of 12 inches.
- F. Place filter fabric over levelled top surface of aggregate cover prior to subsequent backfilling operations.
- G. Place aggregate in maximum 4 inch lifts, consolidating each lift.

3.04 FIELD QUALITY CONTROL

- A. Section 014000 - BSD Quality Requirements: Field inspection and testing.

3.05 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION

**SECTION 334211
STORMWATER GRAVITY PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stormwater drainage piping.
- B. Stormwater pipe accessories.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories, and fittings.
- C. Project Record Documents:
 - 1. Record location of pipe runs, connections, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 STORMWATER PIPE MATERIALS

- A. Provide products as indicated on the drawings and that comply with applicable code(s).
- B. Plastic Pipe: ASTM D3034, Type PSM, Poly Vinyl Chloride (PVC) material; bell and spigot style solvent sealed joint end or gasketed type fittings .
- C. Plastic Pipe: ASTM D3350, High Density Polyethylene (HDPE) corrugated wall pipe with integrally formed smooth liner; meeting the requirements of AASHTO M 252, Type S, for diameters between 3 inches and 10 inches and AASHTO M 294, Type S, for diameters between 12 inches and 60 inches, soil-tight, bell and spigot joints with rubber gaskets, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C.

2.02 PIPE ACCESSORIES

- A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- B. Downspout Boots: Smooth interior without boxed corners or choke points; include integral lug slots and on-body cleanout and cover with neoprene gaskets.
 - 1. Configuration: Angular.
 - 2. Material: Cast iron; ASTM A48/A48M; casting thickness 3/8 inch (9.5 mm), minimum.
 - 3. Finish: Manufacturer's standard factory applied powder coat finish.
 - 4. Accessories: Manufacturer's standard stainless steel fasteners, stainless steel building wall anchors, and rubber coupling.
- C. STORMWATER PIPE END SECTIONS
 - 1. Galvanized steel.
 - 2. Flat strap connector with galvanized bolt.

2.03 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in .
- B. Cover: As specified in Section 312316.13.

PART 3 EXECUTION

3.01 TRENCHING

- A. See Section 312316.13 - Trenching for additional requirements.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION

- A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- C. Connect to building storm drainage system, foundation drainage system, and utility/municipal system.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection in accordance with Section 014000 - BSD Quality Requirements.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- C. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Deflection no greater than the pipe manufacturers maximum allowable.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- D. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping in accordance with ASTM F1417.
 - 6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than **150** psig.

- a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
- b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.

3.04 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

**SECTION 334230
STORMWATER DRAINS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Precast concrete catch basins.
- B. Prefabricated drop inlets.
- C. Prefabricated trench drains.
- D. Frames and grates.

1.02 RELATED REQUIREMENTS

- A. Section 334211 - Stormwater Gravity Piping.

1.03 REFERENCE STANDARDS

- A. ASTM C478/C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections; 2020.
- B. ASTM C923/C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; 2020.
- C. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants; 2009 (Reapproved 2019).

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Weight rating for catch basins, drop inlets, trench drains, and frame and grates.
- C. Manufacturer's qualification statement.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Project Record Documents:
 - 1. Record invert elevations of catch basins, drop inlets, and trench drains.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Drainage Basins:
 - 1. Nyloplast : www.nyloplast-us.com
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Trench Drains: As indicated on the drawings.
 - 1. ACO, US: <https://www.acousa.com/>.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- C. Trench Drain Grates: As indicated on drawing or grates conforming to AASHTO HS20.
 - 1. ACO, US: <https://www.acousa.com/>.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 CATCH BASINS

- A. Weight Rating: H 20 according to AASHTO HB.
- B. Precast Concrete Catch Basins: Comply with ASTM C478/C478M, reinforced.
 - 1. Wall Thickness: 6 inches min.
 - 2. Base Thickness: 6 inches min.
 - 3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
 - 4. Joint Sealant: Comply with ASTM C990.
- C. Grade Adjustments:
 - 1. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
 - 2. Pipe Connectors: ASTM C923 resilient, of size required, for each pipe connecting to base section.
 - 3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.
- D. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron or ASTM A-48 Gray Iron designed for AASHTO HS20-44, structural loading. Include flat grate with small square or short-slotted drainage openings.
 - 1. Size: 24 by 24 inches minimum unless otherwise indicated.
 - 2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.03 CATCH BASIN, TRENCH DRAIN, CLEANOUT, AND AREA DRAIN COMPONENTS

- A. Cast-Iron Cleanouts- unless otherwise indicated provide:
 - 1. Source Limitations: Obtain cast-iron cleanouts from single manufacturer.
 - 2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside caulk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts:
 - 1. Source Limitations: Obtain PVC cleanouts from single manufacturer.
 - 2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.04 PREFABRICATED TRENCH DRAINS

- A. Prefabricated Trench Drain: Polymer concrete, glass fiber reinforced, metal installation brackets.
 - 1. Weight Rating: HS20 according to AASHTO HB.
 - 2. Bottom: Sloped.
 - 3. Frames and Grates: Galvanized steel support, cast iron grate, linear pattern, match drain opening size.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify items provided by other sections of work are properly sized and located.
- B. Verify built-in items are in proper location and ready for roughing into work.

- C. Verify excavation location and depth are correct.

3.02 EXCAVATION AND FILL

- A. Hand trim excavation for accurate placement to indicated elevations.
- B. Backfill with cover fill, tamp in place and compact, then complete backfilling.

3.03 INSTALLATION

- A. Establish elevations and pipe inverts for inlets and outlets as indicated in drawings.
- B. Precast Concrete Catch Basins:
 - 1. Place base section plumb and level.
 - 2. Install joint sealant uniformly around section lip.
- C. Prefabricated Drop Inlets or Trench Drains:
 - 1. Place base section plumb and level.
 - 2. Install according to manufacturer's instructions.
 - 3. Secure installation brackets.
- D. Grade Adjustments:
 - 1. Lay concrete ring on mortar bed plumb and level. Top with mortar, plumb and level.
 - 2. Place adjacent materials tight and smooth following design grades.
- E. Frames and Grates:
 - 1. Place frame plumb and level.
 - 2. Mount frame on mortar bed at indicated elevation.
 - 3. Place grate in frame securely.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - BSD Quality Requirements for additional requirements.
- B. Perform field inspection for pipe invert elevations.
- C. If inspections indicate work does not meet specified requirements, adjust work and reinspect at no cost to Owner.

END OF SECTION

SECTION 340551
TRAFFIC MAINTENANCE AND PROTECTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Work of this Section consists of maintaining traffic and protecting the public from damage to persons and property within the limits of and for the duration of this contract.
- B. Maintain traffic over a reasonably smooth traveled way marked by signs, delineators, guiding devices and other acceptable methods in conformance with the New York State Manual of Uniform Traffic Control Devices (MUTCD).

1.02 APPLICABILITY

- A. The Work of this Section shall be required in all areas within the project limits that will be open to vehicular traffic.

1.03 RESPONSIBILITY

- A. Assume responsibility for conducting operations in a manner to insure the safety and convenience of all travelers and adjoining property owners within the limits of and for the duration of the contract.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Comply with the requirements of DOT Section 700 Materials as they apply to the various materials required for the Work of this Section.
- B. Provide sign panels of aluminum, galvanized steel or plywood with faces of reflective sheet material and non-reflective black characters conforming to DOT Section 730-13.
- C. Provide delineators, barricades and lighting for construction barricades in accordance with the requirements of MUTCD. Where reflective materials are required, conform to DOT Section 730-05.02 except where glass or plastic buttons are used as delineators. Barricades, cones and drums may use reflective materials conforming to DOT Section 730-05.01.
- D. Provide pavement delineation of reflective paint or reflective pressure sensitive pavement marking tape. Line segments shall be a minimum of 4 inches wide and 36 inches long applied with the long axis of the segment parallel to the direction of traffic.

PART 3 - EXECUTION

3.01 GENERAL

- A. Remove construction equipment and materials from roadway and parking areas during non-working hours or provide protection in such a manner that they will not constitute a traffic hazard.
- B. Conduct and schedule the Work in a manner that will minimize the time during which the traveling public will be exposed to hazards.
- C. Do not park employees' personal vehicles within the work area in a manner that they will constitute a traffic hazard.
- D. Provide a traveled way suitable for two lanes of moving traffic. Keep traveled way reasonably smooth and hard at all times.

- E. Keep the traveled way of all roadways and parking areas utilized for hauling materials to or from this project free of foreign objects that may fall or drop from transporting vehicles.
- F. Correct dusty conditions resulting from the Work by the use of calcium chloride and/or water. Distribute water uniformly by the use of suitable spray heads or spray bar. The Owner's Representative will be the sole judge of the need for the application of water for dust control. Apply water at the intervals and locations ordered by the Owner's Representative.
- G. Whenever it becomes necessary to maintain traffic on one lane, provide adequate traffic controls on the Section of Roadway on which vehicle traffic is maintained. Provide competent flag persons or traffic signals at the location, which will in the judgment of the Owner's Representative adequately and continuously, control one-lane traffic.
- H. Provide a sufficient number of competent flag persons in areas where construction operations are in potential conflict with vehicular traffic. Flag person shall wear orange hats or caps and vests in conformance with MUTCD.
- I. Maintain safe and adequate ingress and egress to and from intersecting highways, residences and commercial establishments.
- J. The Contractor is not responsible for removal of snow and ice from pavements or traveled ways open to vehicular traffic.
- K. Maintain existing and new drainage structures, culverts and ditches to adequately drain the traveled way.
- L. Provide, maintain, move and remove delineation and guiding devices to properly delineate a safe and reasonable roadway. Delineate areas on which it is unsafe to travel.
- M. Delineate drop-offs less than 6 inches by providing approved delineators at intervals of not more than 200 feet. Where the drop off is between 6 inches and 18 inches, the spacing between delineators shall not be more than 100 feet. Where the drop off is greater than 18 inches, a continuous delineation consisting of 2 inch or wider brightly colored flexible tape shall be used in addition to individual delineators provided they are properly painted and reflectorized in accordance with MUTCD.
- N. Maintain existing signs, markers, delineators and their supports. Where necessary, relocate existing signs in conformance with MUTCD. Replace signs lost or damaged as a result of contract operations.

3.02 CONSTRUCTION SIGNS

- A. Provide, maintain, move and remove reflectorized construction signs in accordance with the requirements of MUTCD.
- B. Paint supports and backs of sign panels with two coats of white paint.
- C. Mount construction signs a minimum of 5 feet above the surface of the traveled way.

3.03 CONSTRUCTION BARRICADES

- A. Provide, maintain, move and remove lighted construction barricades in accordance with the requirements of MUTCD.
- B. Provide flashing barricade lights of Type A low intensity conforming to the requirements of Section 294.3 of MUTCD.
- C. Hours of operation for barricade lights shall be from dusk to dawn.

3.04 PAVEMENT DELINEATION

- A. Provide pavement delineation in accordance with MUTCD on any course of asphalt concrete upon which traffic will be maintained.
- B. Apply pavement delineation before the end of the working day.

3.05 OPENING ROADWAY TO TRAFFIC PRIOR TO CONTRACT ACCEPTANCE

- A. Maintain and protect traffic on any portion of pavement or structure ordered in writing by the Owner or as shown on the drawings to be opened to traffic prior to contract acceptance.

3.06 REMOVAL OF TRAFFIC CONTROL DEVICES

- A. Promptly remove all delineators, signs, barricades and pavement workings when in the opinion of the Owner's Representative their presence constitutes a hazard or inconvenience to the traveling public.
- B. Remove all remaining traffic control devices upon completion of the Work of this contract unless otherwise ordered in writing by the Owner's Representative.

END OF SECTION

